# DP Country Alignment Studies: Alignment of the South Korean High School Certificate of Graduation (KHSCG)

**Submitted by Ecctis to the IB**

**Commercial in confidence**

**November 2022**

Ecctis

## Acronyms

| | |
|---|---|
| **AA** | mathematics: analysis and approaches |
| **AHL** | additional higher level |
| **AI** | mathematics: applications and interpretation |
| **ATL** | approaches to teaching and learning |
| **CP** | Career-related Programme |
| **CAS** | creativity, activity, service |
| **CEA** | creative experiential activities |
| **CSAT** | College Scholastic Ability Test |
| **DP** | Diploma Programme |
| **HL** | higher level |
| **IB** | International Baccalaureate |
| **IBO** | International Baccalaureate Organisation |
| **KICE** | Korea Institute of Curriculum and Evaluation |
| **KHSCG** | South Korean High School Certificate of Graduation |
| **MOE** | Ministry of Education |
| **MYP** | Middle Years Programme |
| **NAEA** | National Assessment of Educational Achievement |
| **NCS** | National Competency Standards |
| **PYP** | Primary Years Programme |
| **RfP** | Request for Proposal |
| **RQ** | Research Question |
| **SL** | standard level |
| **TOK** | theory of knowledge |
| **USA** | United States of America |
| **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 USA (United States of America), 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 South Korea. The comparison programme in question is the South Korean High School Certificate of Graduation (KHSCG).

## 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 South Korean upper secondary curriculum? In what way are the curricula similar and in what way are they different in demand and difficulty? To what degree are the curricula compatible?

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

2.1: Philosophical underpinnings
- Objectives
- Principles
- Values.

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

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

2.4: Assessment

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

2.5: Student learning pathways

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

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

3.1: Content

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

3.2: Expected learning outcomes

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

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

At programme-level, this involved the comparative analysis of key components of the DP and the KHSCG, 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 KHSCG subjects, including: learning outcomes, content, and demand.

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

## Key Findings

### Programme-level

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

- **Philosophical underpinnings**: significant overlap was found between the KHSCG's and DP's philosophical underpinnings, with most of the key themes within the IB's learner profile, approaches to teaching and learning (ATL), and philosophy of international mindedness being present to at least some extent in the KHSCG's Vision of an Education Person and the Educational Goals. Although some themes, such as real-world linkages and conceptual thought and understanding, do not receive the

[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).

same level of explicit emphasis in the KHSCG's philosophical underpinnings, they are implicitly present and evidenced in the curriculum.

- **Programme structure**: both programmes take a baccalaureate-style approach to encouraging breadth of study; require students to study subjects from broadly similar subject areas; allow students to specialise in particular subjects; and include curricula components that sit alongside subjects (such as community activities). However, there are significant structural dissimilarities between both programmes. While the KHSCG is three years in duration, the DP is only two. Moreover, the KHSCG's 204-unit structure leads to a larger number of subjects being experienced by students, whereas the DP's six-subject structure leads to a smaller number of subjects. The two programmes also differ in that the theory or knowledge (TOK) and the extended essay core components are only evident in the DP, while the KHSCG includes certain subjects that are absent from the DP, such as technology and home economics, and the option to replace elective courses with specialised subjects.[2]

- **Entry requirements**: the DP and the KHSCG take different approaches to entry requirements at the start of their programmes. The IB encourages students and teachers to consult subject guides around expected prior learning but does not provide fixed entry requirements. In contrast, admission to general high schools in Korea is contingent on successful completion of middle school, and often on academic grades and test scores achieved. Moreover, autonomous schools, special-purpose schools, and vocational high schools often choose to use additional selection criteria, such as interviews, teacher recommendation letters, or by administering their own entrance examinations.

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

- **Assessment methods**: whereas the DP uses external terminal assessment to make up most of its assessment in each individual subject, the KHSCG does not make use of external assessment – instead, it uses internal assessment to comprise the full weighting of assessment in all subjects. However, the flexibility of the KHSCG's internal assessment could result in a practical student experience that is similar to the DP's assessment patterns, as the types of assessment, questions and skills assessed in each programme appear to be broadly aligned, with the exception of the KHSCG's

[2] Specialised subjects are offered in areas such as: management/finance, public health/public welfare, design/cultural contents, beauty treatment/tourism/leisure, cooking, construction, machinery, materials, chemical engineering, textile/clothing, electric/electronics, information/communications, processing, printing/publishing crafts, environment/safety, agriculture fisheries & maritime, and ship operations.

additional focus on assessment of emotional competency – an aspect that is entirely absent from the DP's assessment objectives.

**Subject-level**

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

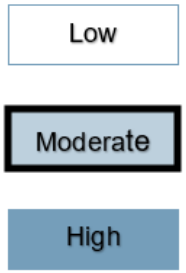
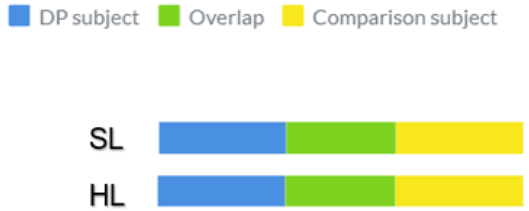
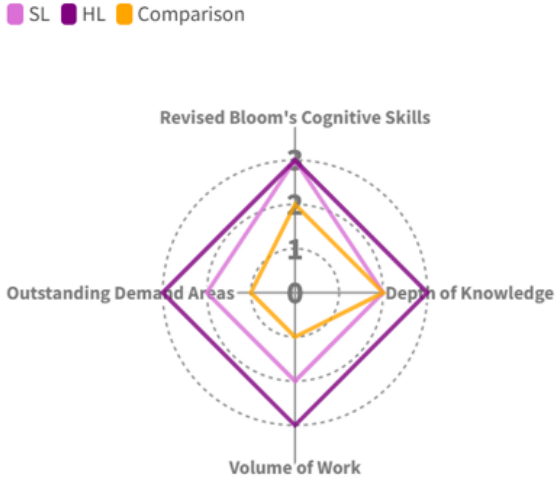
*Table: Subject areas for comparison of the DP and the KHSCG curricula*

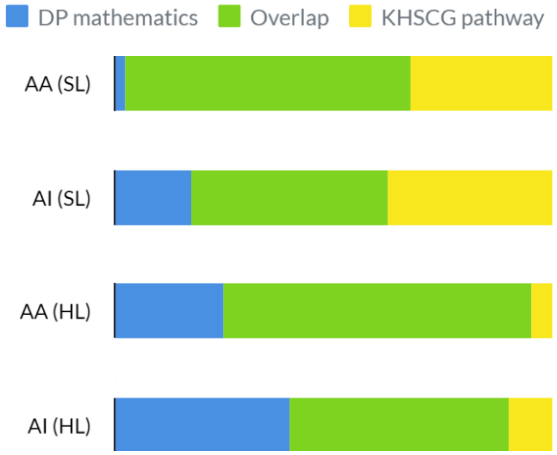
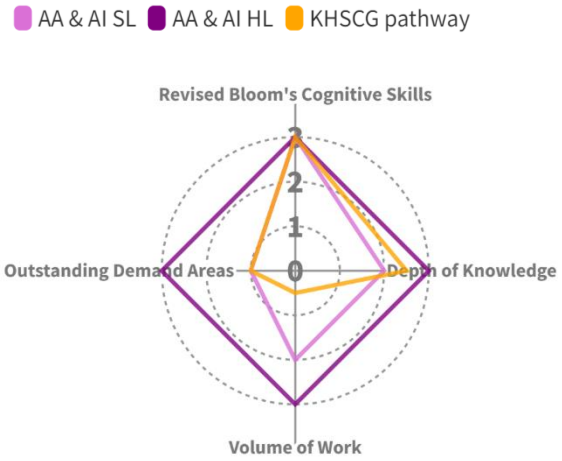
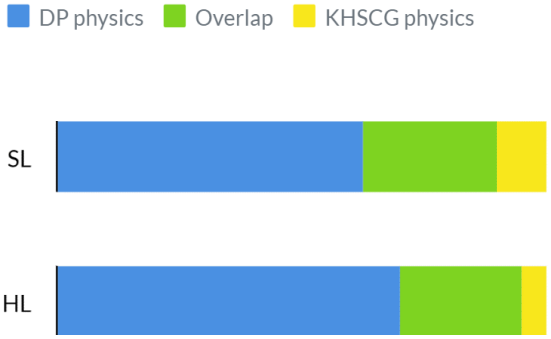
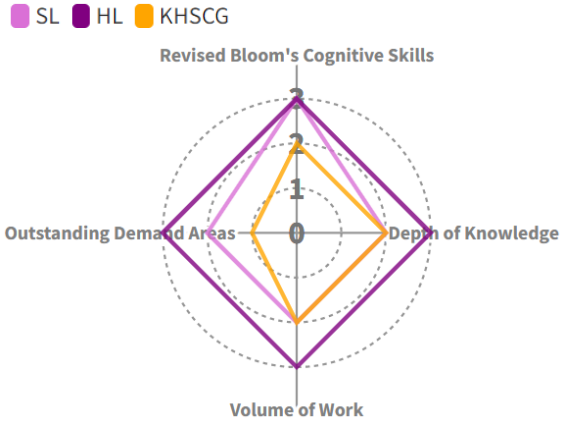
<table>
<tr><th>DP subject (group)</th><th colspan="2">KHSCG subjects</th></tr>
<tr><td>SCIENCES</td><td colspan="2"></td></tr>
<tr><td>biology SL and HL</td><td>Biology I, Biology II</td><td rowspan="3">Integrated Science, Scientific Investigation (common courses)</td></tr>
<tr><td>chemistry SL and HL</td><td>Chemistry I, Chemistry II</td></tr>
<tr><td>physics SL and HL</td><td>Physics I, Physics II</td></tr>
<tr><td>MATHEMATICS</td><td colspan="2"></td></tr>
<tr><td>mathematics: analysis and approaches (AA) SL and HL</td><td colspan="2" rowspan="2">Pathway:<br>Mathematics (common course)<br>Mathematics I<br>Mathematics II<br>Probability and Statistics,<br>Geometry<br>Calculus.<br><br>Other electives:<br>Economic Mathematics<br>Mathematical Inquiry Task<br>Artificial Intelligence Mathematics</td></tr>
<tr><td>mathematics: applications and interpretation (AI) SL and HL</td></tr>
</table>

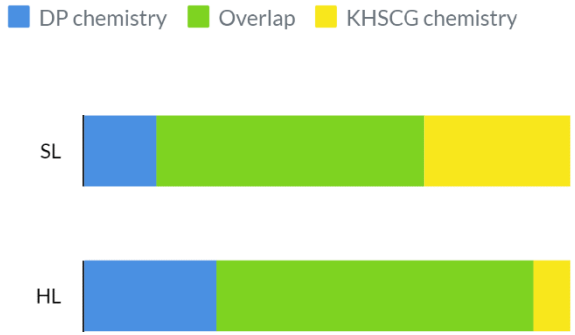
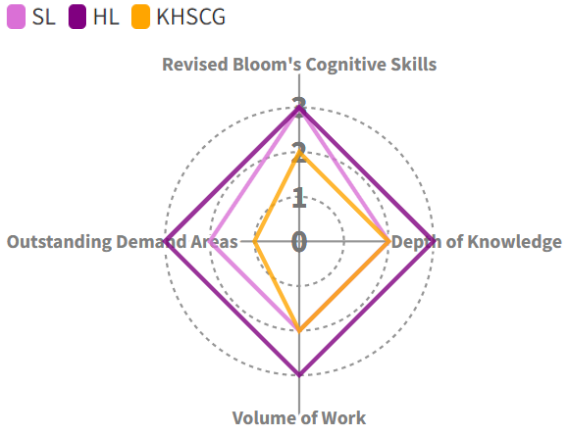
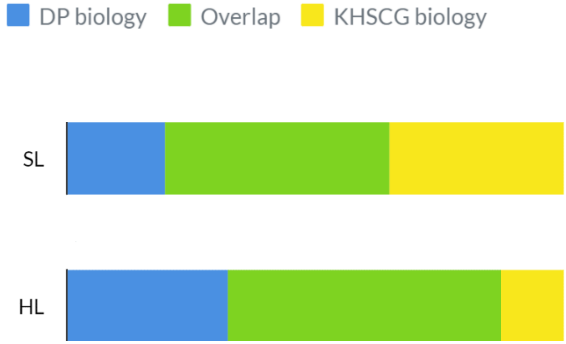
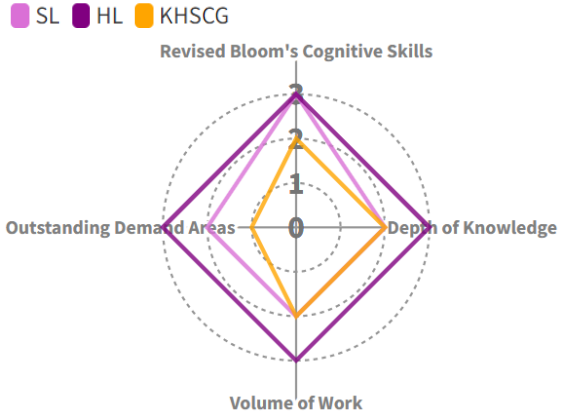
The findings from the subject-level analysis are summarised in the tables below:

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

*Key:*

| Subject name | Learning outcomes alignment | Content alignment | Demand alignment |
|---|---|---|---|
| Displays the name of the comparison subject |  <br>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. |  <br>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. |  <br>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 |
|---|---|---|---|
| KHSCG mathematics pathway | Low<br>Moderate<br>**High** |  |  |
| KHSCG physics | Low<br>Moderate<br>**High** |  |  |

| Subject name | Learning outcomes alignment | Content alignment | Demand alignment |
|---|---|---|---|
| KHSCG chemistry | Low<br>Moderate<br>**High** |  |  |
| KHSCG biology | Low<br>Moderate<br>**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. Notably, because KHSCG subjects are significantly smaller in size than the DP's, the analysis and judgements were based on the combination of all relevant subjects within each subject area (i.e. for mathematics – Mathematics (common), Mathematics I, Mathematics II, Probability and Statistics, Geometry, and Calculus.; for physics – Physics I, and Physics II; for chemistry – Chemistry I, and Chemistry II; for biology – Biology I, and Biology II).

*Mathematics*

- **Learning outcomes alignment**: the level of alignment between both DP mathematics subjects, at both SL and HL, and the KHSCG mathematics pathway's learning outcomes is significant, as all themes extracted from the learning outcomes of the DP are present in the KHSCG curricula.

- **Content alignment**: for the KHSCG mathematics pathway, alignment with AA is generally stronger than with AI, for both SL and HL. Nearly all AA SL content, and a good proportion of AI SL content, can be found in KHSCG, though the pathway exceeds the breadth and depth of DP SL by featuring a significant amount of additional content. Most of this content can, however, be identified in DP HL, resulting in considerable alignment with AA HL and reasonable alignment with AI HL. Generally, the DP HL subjects have a slightly higher volume of content than this pathway. However, it can be noted that the amount of overlapping content is dependent on the KHSCG electives chosen – in practice, students have a great degree of flexibility regarding the breadth and depth of their mathematics study.

- **Demand alignment**: the KHSCG mathematics pathway is more similar in demand to DP SL than DP HL. Though it scores similarly to DP HL for Bloom's cognitive skills and depth of knowledge, the pathway scores the same as SL for outstanding areas of demand and significantly less than both DP subjects for 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 KHSCG science subjects is significant, with all themes extracted from the DP learning outcomes being present in the KHSCG's learning outcomes.

- **Content alignment**: the level of content alignment between KHSCG and the DP science subjects varies significantly per subject:
    - Physics: there is limited content alignment between DP and KHSCG physics. The overlapping content KHSCG has with the DP comprises of around half of the SL sub-topics and a small number of HL sub-topics. Furthermore, these

alignments tend to be 'partial' rather than 'full', due to the KHSCG describing the content in far lesser detail than the DP. In the absence of a significant amount of DP sub-topics, or other content, the KHSCG appears to have less breadth and depth than both SL and HL physics.

- Chemistry: there is a significant amount of content overlap between DP and KHSCG chemistry. Aside from a few sub-topics, most of the DP SL and HL content, including features of the experimental programme, can be found in the KHSCG curricula. That said, it can be noted that some of these alignments are only 'partial' due to KHSCG not covering the sub-topics in the same level of detail as the DP. Overall, KHSCG has similar breadth and depth to the DP HL, though the latter is larger in content size.
- Biology: there is a reasonable amount of overlapping content between DP and KHSCG biology. Nearly all SL sub-topics are present in the KHSCG, with most having 'full' rather than 'partial' alignments. Furthermore, most additional higher level (AHL) sub-topics are in KHSCG, though these tend to be 'partial' rather than 'full' alignments due to lesser details covered in the KHSCG. Moreover, features of the DP's experimental programme can be identified in KHSCG biology. Overall, KHSCG biology has similar breadth to the DP and surpasses the content of SL, though does not match the depth and overall content size of HL.

- **Demand alignment**: the demand level of the KHSCG science subjects is more closely aligned with that of the DP SL, with the former scoring the same for depth of knowledge and volume of work, though slightly less for Bloom's cognitive skills and outstanding areas of demand. The level of alignment of the KHSCG with DP HL subjects is lower, as the HL subjects score higher in all demand categories.

### Summary

The programme-level features of the DP and KHSCG are moderately aligned. The two programmes observe similar philosophical underpinnings and share similarities in their assessment objectives and question types, though they differ in programme structure and student learning pathways. At subject-level, alignment between the KHSCG and DP varies across subjects. For mathematics, alignment levels are relatively high when comparing the DP against the KHSCG mathematics pathway. As for science, there was varying alignment, with KHSCG physics judged to be weakly to moderately aligned with DP physics, and both KHSCG chemistry and biology considered to be moderately to highly aligned with DP chemistry and DP biology, respectively.

# 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'.[3]

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.[4] 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 upper secondary programme of education in South Korea. As agreed with the IB, this report focuses specifically on the South Korean High School Certificate of Graduation (KHSCG) programme.

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

[4] 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:

### South Korea Research Questions

*Table 1: South Korea research questions*

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

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

2.1: Philosophical underpinnings
- Objectives
- Principles
- Values.

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

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

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

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

**RQ3:** To what degree do the subjects[5] align with regard to:

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

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

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

*Table 2: Subject areas for comparison of the DP and the KHSCG*

| **DP subject (group)** | **KHSCG subjects** | |
|---|---|---|
| *SCIENCES* | | |
| biology SL and HL | Biology I, Biology II | Integrated Science, |

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

| | | |
|---|---|---|
| chemistry SL and HL | Chemistry I, Chemistry II | Scientific Investigation (common courses) |
| physics SL and HL | Physics I, Physics II | |
| *MATHEMATICS* | | |
| mathematics: analysis and approaches (AA) SL and HL | Pathway:<br>Mathematics, Mathematics I, Mathematics II, Probability and Statistics, Geometry, and Calculus.<br><br>Other electives:<br>Mathematical Inquiry Task, Economic Mathematics, and Artificial Intelligence Mathematics. | |
| mathematics: applications and interpretation (AI) SL and HL | | |

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

## 2.3 Report Structure

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

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

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

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

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

# 3. Methodology

## 3.1 Document Selection and Identification of Comparison Points

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

### IB Documentation

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

### South Korea Documentation

- Ministry of Education (MOE) – *The National Curriculum for Primary and Secondary Schools*[6] and Ministry of Education – *Education in Korea,*[7] both including information about the education system, philosophical underpinnings and pedagogy
- Ministry of Education – *Mathematics Curriculum*[8] and Ministry of Education – *Science Curriculum*,[9] each including the syllabi for the comparison subjects used in this study.

### 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 KHSCG*

| **Documentation containing philosophical underpinnings** | |
|---|---|
| **DP** | **KHSCG** |
| 'What is an IB Education', particularly the following sections:<br>○ IB learner profile<br>○ International-mindedness<br>○ Approaches to teaching and approaches to learning (ATL).[10] | The Korean Ministry of Education's, 'The National Curriculum for the Primary and Secondary Schools', particularly the following sections:<br>○ Vision of an Educated Person<br>○ Principles of Curriculum Design |

[6] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools.* Available from: NCIC National Curriculum Infomation Center (kice.re.kr)
[7] MOE, Republic of Korea. (2018). *Education in Korea*. Available from: http://english.moe.go.kr/boardCnts/viewRenewal.do?boardID=282&boardSeq=80324&lev=0&searchType=null&statusYN=W&page=1&s=english&m=0502&opType=N
[8] MOE, Republic of Korea. (2020). *Maths Curriculum.*
[9] MOE, Republic of Korea. (2015). *Science Curriculum.*
[10] International Baccalaureate. (2017). *What is an IB Education?*

| | |
|---|---|
| | ○ Educational Goals for Elementary and Secondary Schools.[11] |

The document '*What is an IB Education?*' provides detailed information about the IB's educational philosophy. For the KHSCG, the philosophy and pedagogy of the curriculum are articulated in the 'Vision of an Educated Person', 'Principles of Curriculum Design' and 'Educational Goals for Elementary and Secondary Schools' sections of the Ministry of Education's '*The National Curriculum for the Primary and Secondary Schools*' document.[12]

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

### Learning Outcomes Comparison

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

*Table 4: Learning outcomes for comparison of the DP and the KHSCG*

| **DP subject (group)** | **Categories utilised as learning outcomes** |
|---|---|
| *SCIENCES* | |
| biology | DP sciences subject group – aims and assessment objectives |
| chemistry | |
| physics | |
| *MATHEMATICS* | |
| mathematics: analysis and approaches | DP mathematics subject group – aims and assessment objectives |
| mathematics: applications and interpretation | |
| **Korean subjects** | **Documentation and sections** |
| *SCIENCES* | |
| biology I, biology II | subject introductions (titled 'Character') objectives |
| chemistry I, chemistry II | subject introductions (titled 'Character') objectives |
| physics I, physics II | subject introductions (titled 'Character') objectives |
| *MATHEMATICS* | |
| mathematics pathway | subject introductions (titled 'Character') objectives |

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

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

## 3.2 Measuring Alignment (Similarities and Differences)

Alignment is a key concept for this series of studies. The aim of this study is to unpick the level of alignment between the DP and the KHSCG. Although Ecctis has sought to represent the

[11] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools.*
[12] Ibid.

alignment findings as straightforwardly as possible in this report, alignment is not a simple concept, so it is important to establish Ecctis' approach in this regard.

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

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

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

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

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

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

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 KHSCG, 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 KHSCG (the comparison programme) so that a mapping process can be undertaken.

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

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

## 3.2.1 Method: Programme-Level Comparison

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

### Philosophical Underpinnings

In the DP, the ATL, the learner profile, and the framework of international-mindedness were used to represent the philosophical underpinnings, while the 'Vision of an Educated Person',[13] 'Principles of Curriculum Design'[14] and 'Educational Goals'[15] sections were used for the KHSCG.

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<br>• Grounded in real world contexts<br>• Principled and community-oriented<br>• Independence/self-management, critical inquiry, and reasoning<br>• Communicative and collaborative competency<br>• Conceptual thought and understanding. |

[13] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools. Vision of an Educated Person.*
[14] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools. Principles of curriculum design.*
[15] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools. Educational goals for elementary and secondary schools.*

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

### Structure

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

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

### Requirements and Associated Outcomes

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

### Student Learning Pathways

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

### Assessment Methods

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

A simple table has been used, followed by a short textual description of the key similarities and differences. Where possible, the types/numbers of assessment used in the programme are a source of comparison, and the subjects analysed in the subject-level alignment analysis in each report have been used as examples to consider assessment in more detail (i.e. question types and marking approaches, where this information is available).

## 3.2.2 Method: Subject-Level Comparison

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

### Learning Outcomes

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

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

### Content

To compare the content of the DP subject and the comparison KHSCG 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 KHSCG 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 KHSCG subject and on KHSCG subject content topics not found to have alignment points in the DP subject.

### Demand

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

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

*Demand Profile – Subject-level Judgement*

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

matched with the curriculum in question. The categories which comprise the Demand Profile are as follows:

- **Revised Bloom's Cognitive Skills** score (0-3): this is an overall score of course demand, based entirely on a review of learning outcomes. Levels have been defined based on increasing emphasis of higher order cognitive skills taken from Bloom's Revised Taxonomy.[16]

- **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.[17]

- **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.[18]
  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'.

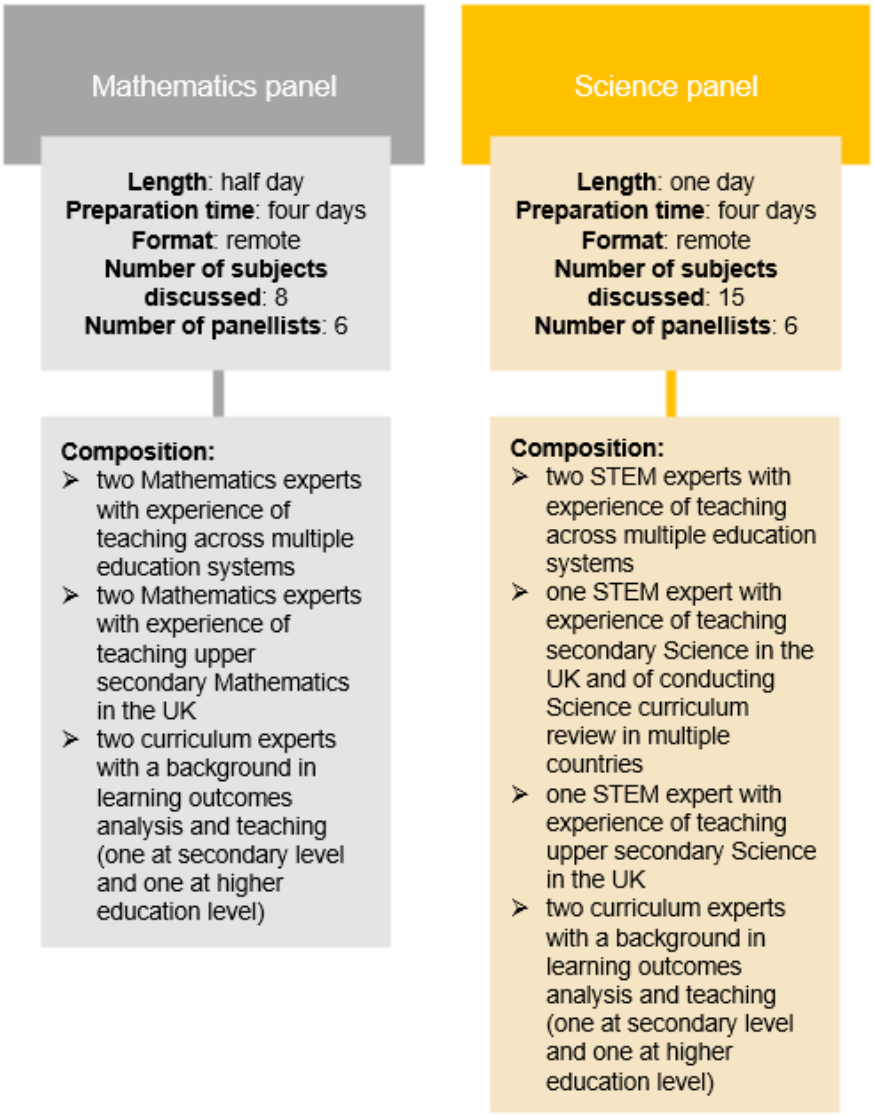
*Demand Panel: Expert Judgement Procedure*

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.[19]

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

[16] 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
[17] Webb, N. L. (2002). *Depth-of-knowledge levels for four content areas*. Language Arts. Available from: Microsoft Word - Webb DOK all content.doc (pbworks.com)
[18] Note: 'depth of content' primarily describes what is on the curriculum (i.e. the level of detail comprised in each topic), whereas 'depth of knowledge' describes what the students need to be able to do (i.e. how complex and extensive the thinking processes involved are).
[19] To minimise potential biases and subjectivity, Ecctis' recruitment procedure excluded candidates with experience of teaching any of the comparison qualifications in this study.

*Figure 1: Demand panels details*




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

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

The experts were also provided with a document containing:

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

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

All judgements resulted in scores from 0-3 for each demand criterion mentioned above, with each score for each criterion being pulled into each course's demand profile. The panel approach was used to debate the findings and scores reached by each member of the panel and arrive at an evidence-based consensus on every demand score for every subject.[20]

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.

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

# 4. Programme-Level Alignment

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

*Table 6: Research question 2*

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

It starts by offering top-level overviews of both the DP and the KHSCG, 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.[21]

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

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

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

- The arts.[22]

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

All subjects are studied concurrently over the two-year duration of the programme and most subjects can be taken at either HL or SL. In terms of teaching hours, the DP's documentation recommends 150 teaching hours for individual subjects at SL and 240 teaching hours are at HL.[23]

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.[24] The extended essay is a self-directed piece of research which results in a 4000-word essay.[25] 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.[26] Together, these three components comprise the DP 'core'.

To achieve the IB Diploma a student must take at least three HL subjects.[27] 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.[28]

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.

[22] International Baccalaureate. (2021). *Curriculum*. Available from: https://www.ibo.org/programmes/diploma-programme/curriculum/
[23] Ibid.
[24] International Baccalaureate. (2021). *Theory of knowledge*. Available from: https://www.ibo.org/programmes/diploma-programme/curriculum/theory-of-knowledge/
[25] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 2.
[26] International Baccalaureate. (2021). *CAS projects.* Available from: https://www.ibo.org/programmes/diploma-programme/curriculum/creativity-activity-and-service/cas-projects/
[27] International Baccalaureate. (2021). *Curriculum*.
[28] International Baccalaureate. (2015). *Diploma Programme: From principles into practice*. p. 6.

*Figure 2: IB Diploma Programme curriculum model*[29]


Both internal and external assessment methods are used in the DP. In most subjects, students take written examinations at the end of the programme that are marked by external IB examiners. Internally assessed tasks normally comprise between 20-30% of the total mark in each subject.[30,31]

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.[32] Coursework forms part of the assessment for areas of the DP such as the extended essay and TOK.[33] 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.[34] 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.[35]

Each DP subject, whether taken at SL or HL, is graded from 1-7 (with 7 representing the highest achievement level).[36] If a student has taken enough subjects at the correct level to be

[29] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 2.
[30] International Baccalaureate. (2021). *Understanding DP assessment*. Available from: https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/understanding-ib-assessment/
[31] International Baccalaureate. (2014). *Diploma Programme: A guide to assessment*. p. 3.
[32] International Baccalaureate. (2021). *Assessment and Exams*. https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/
[33] International Baccalaureate. (2021). *Understanding DP assessment*.
[34] Ibid.
[35] International Baccalaureate. (2021). *Assessment and Exams*.
[36] 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.[37]

Additionally, 42 total points are available from the combination of the grades for six subjects and a further three points are available to students for successful completion of the core elements of TOK, the extended essay, and CAS. The TOK and extended essay components of the DP are each marked on an A-E scale, where an A grade is the highest award, and an E grade the lowest.[38] Their combined results can contribute up to three additional numerical points to the overall DP score (see Table  below). CAS does not constitute a graded part of the DP, although its completion is mandatory to be awarded the Diploma.

HL and SL subjects are assessed against the same grade descriptors;[39] however, HL candidates are expected to demonstrate the various elements of the grade descriptors across a greater range of knowledge, skills, and understanding.

A bilingual Diploma is awarded to students who achieve:

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

Certificates are awarded to students that have taken individual subjects but not enrolled on the full Diploma, or DP candidates who do not complete the full DP.[40] 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*[41]

| | | 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.[42] However, the IB recommends consulting the subject guides prior to enrolment to ensure an adequate understanding of programme expectations.[43]

[37] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 4.
[38] Ibid.
[39] International Baccalaureate. (2021). *Understanding DP assessment*.
[40] International Baccalaureate. (2016). *Guide to the International Baccalaureate Diploma Programme*. p. 4.
[41] International Baccalaureate. (2017). *Assessment principles and practices: Quality assessments in a digital age*. p. 220.
[42] International Baccalaureate. (2015). *Diploma Programme: From principles into practice*. p. 22.
[43] Ibid.

### 4.1.2 South Korean High School Certificate of Graduation (KHSCG)

The school system in South Korea is overseen by the Ministry of Education (MOE – 교육부).[44]

It is divided into primary school (grades 1-6, typically from ages 6 to 12), middle school or lower secondary school (grades 7-9, typically from ages 12 to 15), and high school or upper secondary education (grades 10-12, typically from ages 15-18).[45]

High school education is offered by several different types of schools, including:

- General high schools
- Vocational high schools
- Special purpose high schools
- Autonomous high schools.[46]

The focus of this report is on the curriculum offered by general high schools and leading to the High School Certificate of Graduation (KHSCG); other routes will not be discussed in depth.

#### Structure

The KHSCG curriculum spans the three years of South Korea's upper secondary education. Beginning in grade 10, students select courses which earn them units towards the KHSCG, which is intended to grant access to higher education upon successful completion.

Courses in the KHSCG are divided into four subject areas: Foundation, Inquiry, Physical Education and Arts, Life and Liberal Arts. Each of these areas, in turn, includes 'subject clusters', as follows:

- The Foundation group includes Korean Language, Mathematics, English, and Korean History courses
- The Inquiry group includes Social Studies (including History / Moral Education) and Science courses
- The Physical Education and Arts includes Physical Education and Arts courses; and
- The Life / Liberal Arts group includes courses in Technology, Home Economics, Second Foreign Language, Classical Chinese and Liberal Arts.

As well as being categorised by subject area, courses in the KHSCG are also categorised based on whether they constitute common courses or elective courses.

Common courses are mandatory courses studied by all students. All students completing a KHSCG must study the common courses in: Korean Language, Mathematics, English, Korean History, Integrated Social Studies, Integrated Science, Scientific Investigation, and courses in Physical Education, Arts, and Life/Liberal Arts (i.e. Technology, Home Economics, Second Foreign Language, Classical Chinese or Liberal Arts).

Elective courses are non-compulsory courses selected by students according to their aptitudes and career plans. They are divided into general electives and career-related

[44] MOE, Republic of Korea. (2018). *Education in Korea*.
[45] Ibid.
[46] MOE, Republic of Korea. (2022). *Secondary Education.* Available from: english.moe.go.kr/sub/infoRenewal.do?m=0303&page=0303&s=english

electives. Whereas the common courses cover broader subject areas (e.g. Integrated Science), the general electives provide opportunity for specific subjects to be studied (e.g. physics, economics, music, and French). Career-related electives, in turn, have a wide range of functions – some extend the knowledge of general electives, promoting in-depth and inter-subject learning, whereas others may focus on a particular career (e.g. agriculture), or offer a focus on practical applications to everyday life (e.g. Practical Mathematics).[47] Elective courses are available across all the same subject areas listed above for common courses. Schools are encouraged to guide students to study more than three career-related elective courses.[48]

In addition to common courses and elective courses, those studying towards the KHSCG are also required to undertake what is referred to as 'creative experiential activities' (CEA), consisting of 'discretionary activities, club activities, community services, and career-related activities'.[49]

Although all general high schools are required to organise the curriculum primarily around the general and elective courses mentioned above, schools may also offer the option for students to study certain specialised courses in science, physical education, art, foreign languages, international studies, and a list of vocational disciplines.[50] If taken, such specialised subjects would be taken in place, or in addition to, some of the elective courses.

### Unit Requirements

The KHSCG programme splits the curriculum into units. Each unit in the KHSCG is equivalent to 17 lessons of 50 minutes each.[51] To successfully complete the KHSCG, students must study a minimum of 204 units (i.e. 2,890 hours) over the course of three years, of which:

- 180 units (i.e. 2,550 hours) are typically earned through successful completion of common courses and elective courses and/or specialised courses combined. Notably, all units studied from the 'Foundation' subject group may not exceed the 50% of the total number of units in the programme.[52]
- At least 24 units (i.e. 340 hours) must be earned through the completion of CEA.

The following table provides a summary of the unit allocation per subject cluster:

[47] Kwak, Y. (2022). *Exploration of High School Science Teachers' Perceptions on Instruction and Assessment of Science II Elective Courses in the 2015 Revised Curriculum.* Journal of the Korean earth science society. Vol.43 No.4. pp.557-566
[48] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*.
[49] Ibid.
[50] Additional specialised subjects offered may include courses in: management/finance, public health/public welfare, design/cultural contents, beauty treatment/tourism/leisure, cooking, construction, machinery, materials, chemical engineering, textile/clothing, electric/electronics, information/communications, processing, printing/publishing crafts, environment/safety, agriculture fisheries & maritime, and ship operations.
[51] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*. p. 20
[52] Ibid.

*Table 8: Unit requirements of the KHSCG*

| **Subject areas** | **Subject clusters** | **Minimum required units per subject cluster** (including units for the common courses in each cluster) | **Electives and/or specialised courses** |
|---|---|---|---|
| Foundation | Korean Language | **10** (8 units from Korean language common course + electives) | Selected subjects from general electives, career electives, or specialised subjects* |
| | Mathematics | **10** (8 units from mathematics common course + electives) | |
| | English | **10** (8 units from English common course + electives) | |
| | Korean History | **6** (6 units from Korean history) | |
| Inquiry | Social Studies (including History/ Moral Education) | **10** (8 units from integrated social studies common course + electives) | |
| | Science | **12** (8 units from integrated science common course, 2 units from scientific investigation common course + electives) | |
| Physical Education/ Arts | Physical Education | **10** | |
| | Arts | **10** | |
| Life/Liberal Arts | Life/Liberal Arts (i.e. Technology/ Home Economics/ Second Foreign Language/ Classical Chinese/Liberal Arts) | **16** | |
| **Sub-total** | | **94** | **86** |
| **Creative experiential activities (CEA)** | | | |
| Discretionary activities, club activities, community services, and career-related activities | | | **24** |
| **Total** | | | **204** |
| ***The full list of elective subjects is provided in Appendix D.** *NB: Units assigned to common courses can be reduced up to two units, except for Korean History, where the full 6 units are required.*[53] | | | |

[53] Ibid. p.19.

### Assessment

*School-based Assessment*

Although assessment in South Korea is carried out at school and national levels,[54] all assessment within the KHSCG is internal (i.e. school-based), varying by educational establishment.

Schools in South Korea set up their own assessment plans at the beginning of each year, with each one having oversight over the testing methodology, frequency of testing, and performance assessment, as well as grading methodology;[55] though all students receive an individual grade for their specific performance in each subject.

Even though schools enjoy wide discretion when it comes to setting up their internal assessments, the National Curriculum does provide top-level principles and guidance which each educational provider should follow when designing their assessments. For example, schools are advised:

- To 'Guide students to reflect upon and improve learning by providing constructive feedback on assessment results and offering necessary follow-up instruction'
- Not to 'assess contents and skills that have not been taught in the classrooms'
- To 'Assess both the results and process of learning, ensuring that all students have achieved the educational objectives'
- To 'Administer balanced assessments of students' cognitive and emotional skills'.[56]

In terms of assessment methods, despite the large degree of freedom provided to schools in choosing the types of assessments and questions to be used in internal assessments, the National Curriculum does provide some top-level considerations for schools, asking them to:

- 'Make use of short-answer questions, essay questions, and performance assessments to a greater extent.'
- 'Use valid assessment criteria and scales in subject areas that put emphasis on emotional, functional, and creative skills.'
- 'Develop and make use of a detailed rubric based on the nature of subject area in assessing performances and experiments.'
- 'Develop and make use of school-based assessment standards, considering the contents and characteristics of creative experiential activities.'[57]

Notably, as can be seen in the points above, schools are asked to use assessment as a means to evaluate both students' cognitive skills and their emotional skills, as well as evaluate both the results and process of learning. How to do so, however, is left at the discretion of each individual education provider, as the latter enjoy a very large degree of flexibility to decide on the types, frequency and methods of assessment for each of the subjects offered.

*National Assessment*

[54] Ra, et al. (2019). *Developing national student assessment systems for quality education: lessons from the Republic of Korea.* Asian Development Bank.
[55] Ibid.
[56] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*. p. 54
[57] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*. p. 54

National-level assessment refers to evaluation conducted by the government for all students nationwide. There are two national-level assessment systems in place: the National Assessment of Educational Achievement (NAEA)[58] and the College Scholastic Ability Test (CSAT).[59]

NAEA's high school tests are conducted in grades 10 and 11.[60] These function primarily as a quality assurance instrument, keeping track of student achievement results over the years – the grades obtained in these tests do not count towards the completion of the KHSCG or higher education access.

The CSAT is designed to measure student achievement and academic aptitude according to the National Curriculum standards for college education. The CSAT is developed and managed by the Korea Institute for Curriculum and Evaluation (KICE) and commissioned by the Ministry of Education. The CSAT consists of six tests in total that aim to assess higher-order thinking skills in the following areas:

- Korean History (mandatory)
- Language Arts
- Mathematics
- English
- Inquiry (Social Studies, Science, or Vocational Education)
- Foreign Language/Classical Chinese.[61]

Candidates must sit Korean History in order to be considered for the test, but may choose to take only one or some of the tests in the remaining subject areas. Though the results from the CSAT do not directly contribute towards successful completion of the KHSCG, they are considered for the purposes of higher education access, alongside students' high school transcripts and, at times, university entrance examinations.

### Alternative Award to the KHSCG: *Vocational High School Certificate of Graduation*

As mentioned in the introduction to this section, there are vocational upper secondary routes offered to students who do not wish to pursue the general upper secondary route considered in this report. Instead of studying the KHSCG curriculum, students may choose to study in schools that offer the Vocational High School Certificate of Graduation, a vocational qualification that allows further specialisation in the student's chosen field of study.[62]

### Curriculum Design Principles

South Korea's national curriculum is based on the 'educational ideal and vision of an educated person'.[63] It focuses on nurturing a creative and integrative learner with moral character by

[58] KICE. (2005). *The national assessment of educational achievement in 2003.* Available from: https://www.kdevelopedia.org/Resources/view/04201507090138964.do [accessed 14/09/22].
[59] KICE. (2021). *College Scholastic Ability Test*. Available from: https://www.kice.re.kr/sub/info.do?m=0205&s=english [accessed 14/09/22].
[60] KICE. (2005). *The national assessment of educational achievement in 2003.* Available from: https://www.kdevelopedia.org/Resources/view/04201507090138964.do [accessed 14/09/22].
[61] KICE. (2021). *College Scholastic Ability Test.*
[62] Ibid.
[63] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*.

developing key competencies necessary in future South Korean society. The principles of curriculum design are:

- 'To develop basic literacies in the humanities, society, science and technology, and to facilitate customized learning geared to individual students' aptitudes and career plans.
- To improve the quality of learning by organizing learning content around big ideas in subject areas and providing an optimized amount of content to learn.
- To encourage students to develop self-directed learning skills and experience the joy of learning by utilizing a variety of participatory teaching methods suited to the characteristics of subject areas.
- To help students reflect upon their learning by reinforcing assessment that places emphasis on the process of learning and to improve the quality of teaching and learning by making use of assessment results.
- To enhance the coherence of educational objectives, educational contents, instructional methods, and evaluation.
- For Vocational High Schools and High Schools Customized to Industrial Needs to follow the National Competency Standards (NCS)[64] to develop basic abilities and job-related skills needed in industrial sectors'. [65]

*Educational Goals for High School (Learning Outcomes)*

High school education emphasises students' 'active exploration of career plans suitable for their aptitudes and talents', as well as promoting the 'qualities of a democratic citizen connected with the world'. Through their upper secondary education in South Korea, students are expected to:

- 'Acquire a matured self-identity and moral character, gain knowledge and skills suitable for career plans, and develop foundational dispositions to be lifelong learners.
- Solve problems creatively by integrating knowledge and experiences from various fields and develop abilities to actively cope with new situations.
- Develop qualities and attitudes for being capable of contributing to the creation of new cultures based on literacies in the humanities, society, science and technology, and an understanding of diverse cultures.
- Develop qualities and attitudes of a democratic citizen connected to the global society and fulfil the ethics of caring and sharing based upon a sense of responsibility to the national community'.[66]

This approach is well illustrated by the above-mentioned KHSCG curriculum's focus on CEA, requiring students to engage in 'club activities, community services, and career-related

[64] NCS competency units are course standards outlined for content areas and schools should develop grade-level and semester level plans for subjects based on the course standards for content areas. For General High Schools, these apply to practical courses. For a discussion of the NCS, see Younsin, K. (2014). *Study on Development of National Competency Standards (NCS) of Pattern 패턴 분야의 국가직무능력표준 개발에 관한 연구*, Journal of Fashion Business, Vol. 18, 5. p. 144-158. Available from: koreascience.or.kr/article/JAKO201402755362561.page [accessed 14/09/22]

[65] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*.

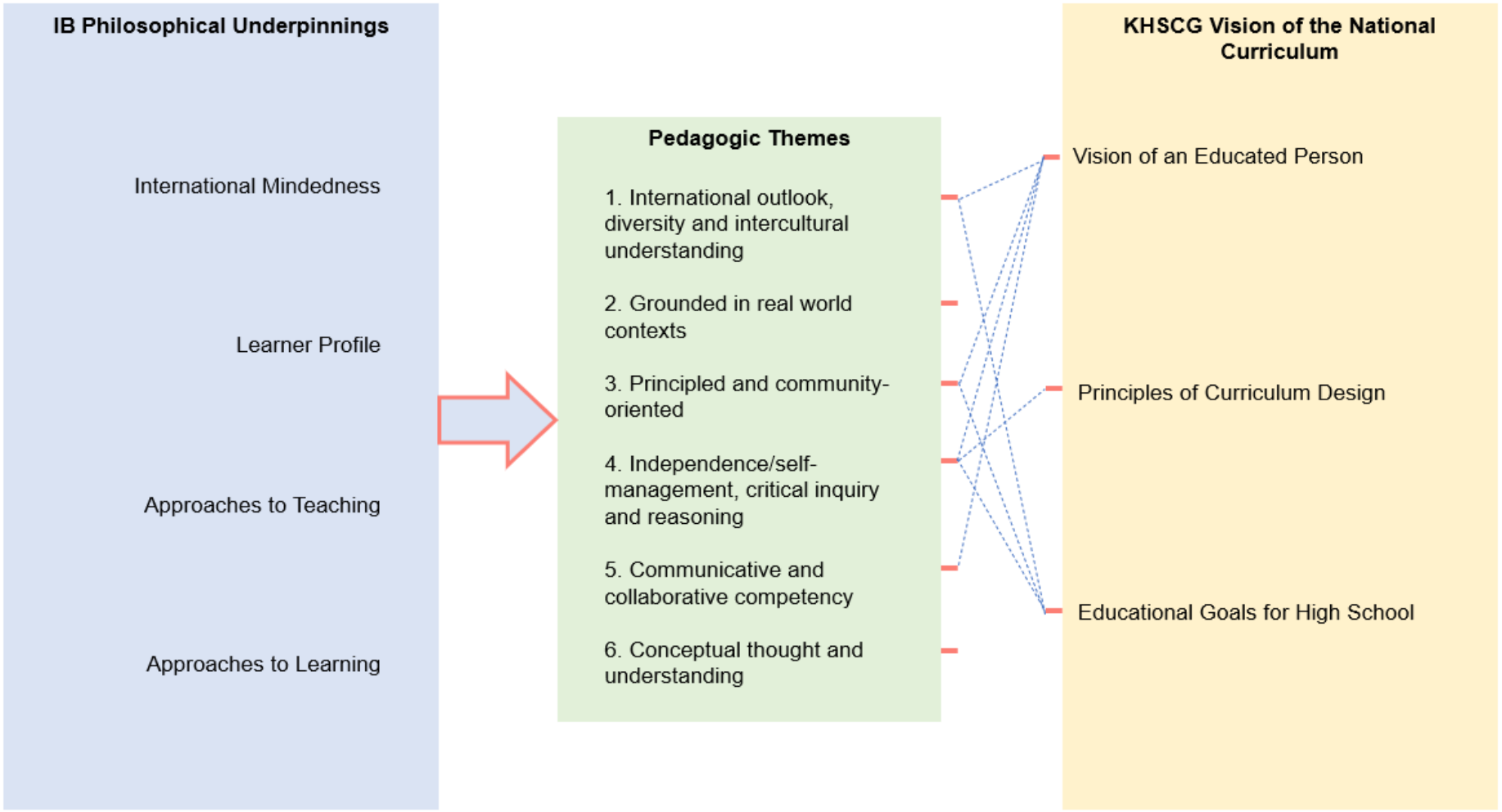
[66] Ibid.

activities'[67] that enhance not only their understanding of their subject area of interest, but also their civic competency.

[67] Ibid.

## 4.2 Philosophical Underpinnings

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



The IB learner profile, which is used across all IB programmes including the DP, outlines 10 attributes that all students should strive towards.[68] 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 KHSCG, the project team mapped the philosophical underpinnings of the KHSCG against six themes extracted from the DP's philosophical underpinnings.

*Table 8: Philosophical underpinning themes*

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

When mapping the six DP themes onto South Korea's Vision for the National Curriculum,[69] it is apparent that most of the DP themes can be identified. Generally, themes are identified in the Vision of an Educated Person[70] and the Educational Goals.[71] Themes which are strongly present are that of 'independence/self-management, critical inquiry, and reasoning', 'principled and community-orientated', and 'international outlook, diversity, and intercultural understanding'.

As with the DP, South Korean students are encouraged to be self-directed learners, developing the competency of self-management, confidence, and other skills which will enable them to pursue their aspirations and become lifelong learners. Furthermore, the curriculum envisages that students will be creative people who can integrate knowledge form various experiences to solve problems, deal with new scenarios, and discover novel ideas.

South Korean students become community orientated through living in harmony with others, caring and sharing, and being connected to the community. Their civic competency is to be developed throughout education, so that they will 'actively participate in improving the

[68] International Baccalaureate. (2017). *What is an IB education?*
[69] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools.*
[70] Ibid. *Vision of an Educated Person.*
[71] Ibid. *Educational Goals for Elementary and Secondary Schools.*

community'[72] – including local, national, and global communities. They will also develop 'a matured self-identity and moral character'.[73]

Education in South Korea aims to create citizens who benefit humankind and who support the idea of shared prosperity. In this spirit, South Korean students: 'develop qualities and attitudes of a democratic citizen connected to the global society'; have 'empathetic understanding of others and cultural sensitives'; and have values and attitudes required to be a member of global communities.

Still present, but less strongly, is the theme of 'communicative and collaborative competency'. The Vision of an Educated Person promotes communication skills, which include being able to express oneself in a variety of contexts, as well as respectfully listening to others' ideas. However, collaboration is not a skill explicitly described in the vision, which may reflect that importance is not placed on students working collaboratively as much as it is in the DP.

Also not explicitly present are the themes of 'grounded in real-world contexts', and 'conceptual thought and understanding', as the Vision components do not describe using real-world contexts for learning, exploring local and global problems, developing conceptual understanding, or making connections during learning. That said, the ability to integrate learning from various areas to solve problems and transfer knowledge to new situations is often referred to, which implies that conceptual understanding is developed. Moreover, although not explicitly mentioned at the programme level, a strong emphasis on making linkages to real world contexts is present in the sciences and mathematics subjects analysed in this study, indicating that the principle is well evidenced at least in these subjects.

Overall, the DP and the South Korean curriculum share many similar themes in their philosophical underpinnings. No significantly different themes to the DP's emerged in the Vision for the National Curriculum.[74]

## 4.3 Structure

There are six subject groups comprising the DP and students pursuing the Diploma award are normally required to select one subject from each of the six groups.[75] Students usually take three subjects at HL and three at SL. The DP also has three core components which are compulsory and are carried out alongside the grouped subjects. The KHSCG curriculum divides its subjects into four areas: Foundation (includes Korean Language, Mathematics, English, and Korean History courses), Inquiry (includes Social Studies (including History / Moral Education courses, as well as Science courses), Physical Education and Arts (includes Physical Education and Arts courses), and Life and Liberal Arts (includes courses in Technology, Home Economics, Second Foreign Language, Classical Chinese and Liberal

[72] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools. Vision of an Educated Person.*
[73] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools. Educational Goals for High School.*
[74] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools.*
[75] International Baccalaureate. (2021). *How the Diploma Programme Works*. Available from: https://www.ibo.org/programmes/diploma-programme/what-is-the-dp/how-the-diploma-programme-works/

Arts). In addition, subjects are also divided into 'common courses' and 'electives' – the former being compulsory and the latter being optional.

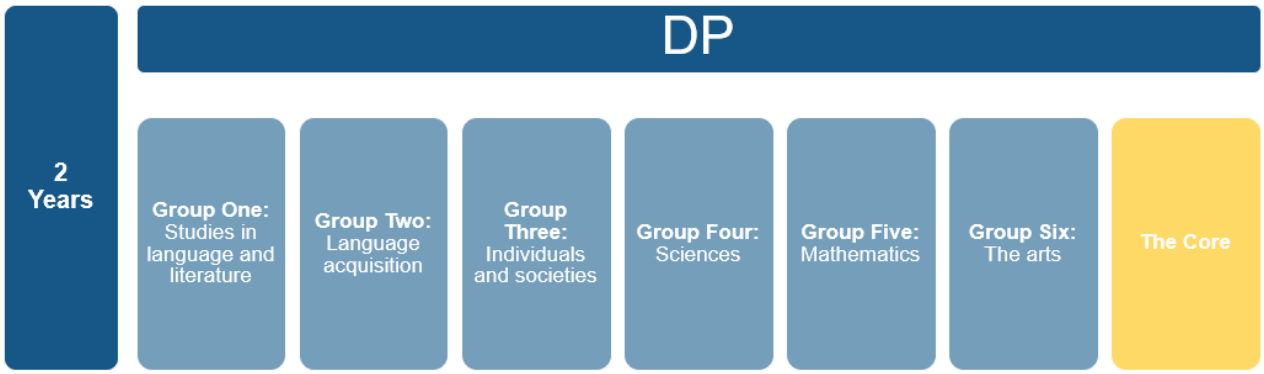
Typically, KHSCG students will study at least nine compulsory common courses (usually amounting to a total of at least 94 units) – in Korean Language (10 units), Mathematics (10 units), English (eight units), Korean History (six units), Social Studies (10 units), Science (12 units), Physical Education (10 units), and Life/Liberal Arts (16 units). These are usually studied during the student's first year of high school. During their second and final years, students are allowed to specialise by selecting general electives and/or career electives (i.e. often courses that build on general electives, promoting in-depth and inter-subject convergence learning). Electives are chosen in line with their interests and career aspirations, and typically amount to at least 86 units (i.e. typically between four and six units each), with students being encouraged to study at least three career-related elective courses.[76]

In addition to general and career electives, some schools also offer the option for students to study certain specialised courses in science, physical education, art, foreign languages, international studies, and a list of vocational disciplines.[77] If taken, such specialised subjects would be taken in place, or in addition to, some of the elective courses.

Alongside the academic curriculum, it is compulsory for students to undertake what is referred to as 'creative experiential activities' (CEA), consisting of 'discretionary activities, club activities, community services, and career-related activities'.[78] Such activities are part of the curriculum and students must study the equivalent to at least 24 units of these to obtain their KHSCG.

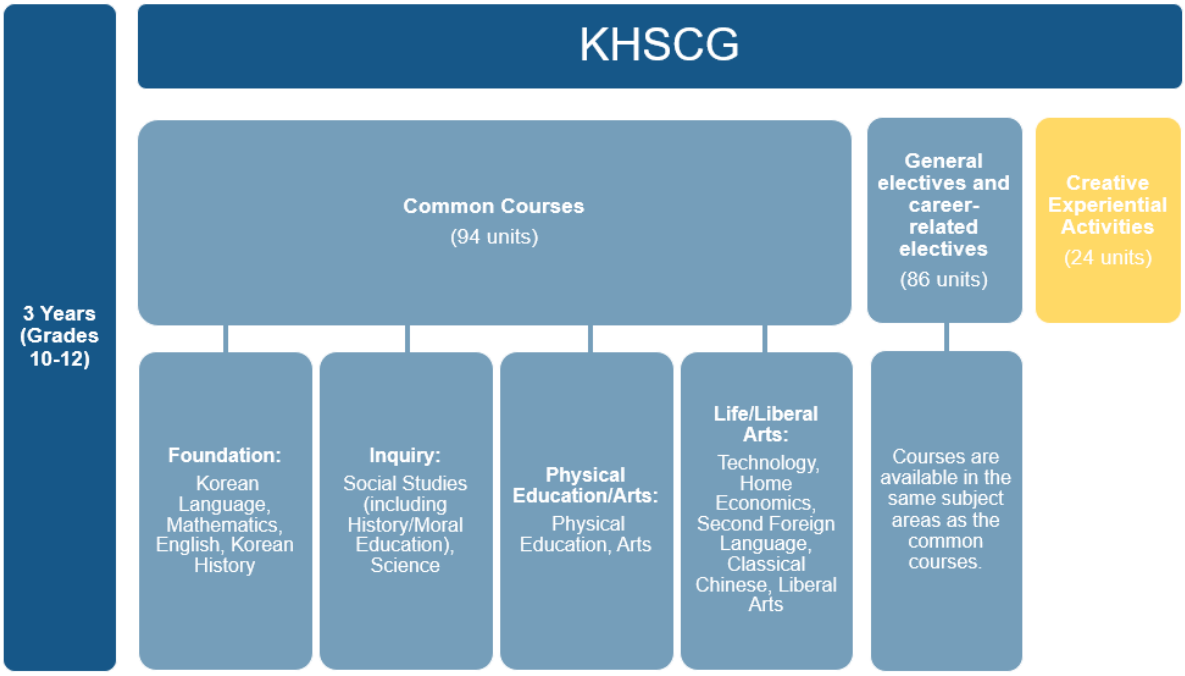
The figures below present the subject groups of the DP in comparison with the structure of the subjects in the KHSCG.

*Figure 4: Structural overview of the DP*




[76] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*.
[77] Additional specialised subjects offered may include courses in: management/finance, public health/public welfare, design/cultural contents, beauty treatment/tourism/leisure, cooking, construction, machinery, materials, chemical engineering, textile/clothing, electric/electronics, information/communications, processing, printing/publishing crafts, environment/safety, agriculture fisheries & maritime, and ship operations.
[78]MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*.

*Figure 5: Structural overview of the KHSCG*




There are some similarities in the structure and components of the DP and the KHSCG. Both programmes share a similar range of disciplines and follow a baccalaureate-style approach, requiring students to study subjects from a number of different disciplinary areas, including languages, mathematics, social sciences and humanities, sciences, and arts. The KHSCG curriculum also includes similar aspects to the DP's CAS in subjects under the physical education/arts and life/liberal arts groups, as well as CEA – which, like CAS, aim to provide practical life skills, extend the experience of learning beyond the classroom, and nurture a sense of community.

In addition to both programme structures prioritising breadth, both also include opportunities for studying subjects at different levels of depth. The DP offers its subjects at both SL and HL, with HL covering all the content and skills in SL and expanding beyond those. A somewhat similar approach is taken in the KHSCG, where elective courses are offered as both 'general electives' and 'career-related electives', with the latter often building on the knowledge and skills gained in the former. Thus, if a student chooses to study a specific subject, they have the choice to study it in more depth, through taking more electives in that area.

Despite the above similarities, the structures of the two programmes also differ in a number of ways. One evident dissimilarity is in the duration of both programmes – while the DP is studied over two years, the KHSCG is studied over three. Additionally, although both programmes divide their subjects into separate groups – each with corresponding requirements of how students choose their courses – the way in which subjects are categorised differs. The DP divides subjects according to disciplinary area (i.e. language and literature, language acquisition, individuals and societies, sciences, mathematics, and the arts). The KHSCG, on the other hand, divides subjects into four thematic groups (i.e. foundation, inquiry, physical education/arts, and life/liberal arts) that bring together subjects that would typically be classed

into different disciplinary families, such as history and mathematics, or home economics and technology.

The two programmes also differ significantly in the number of subjects that students need to study to successfully complete their qualification. In the DP, to achieve the diploma, students must, over two years, study six subjects – up to four at higher level – and achieve a minimum pass grade of 3 in all of them. The recommended teaching hours per subject, as outlined in the DP curriculum documentation, are 150 at standard level and 240 at higher level.[79] In the KHSCG, students must complete a minimum of 204 units over three years – including 94 units in common courses, 86 units in elective courses, and 24 units in CEA. Each unit is stipulated to be equivalent to approximately 14 teaching hours (i.e. 17 classes of 50 minutes), though the number of units studied per subject varies per student and school.[80] As a result, even though different students in the KHSCG can experience different numbers of subjects depending on their choices of electives, they all study a minimum of ten common courses, plus over 17 elective subjects (i.e. approximately the equivalent to 86 units) and CEA – a significantly higher number of subjects per year than those covered in the DP.

Finally, the two programmes also differ in that the TOK and the extended essay core components are only evident in the DP; the KHSCG does not feature any subjects that focus specifically on the content covered in these, instead covering elements of writing, epistemology and cross-subject linkages within the curricula of other subjects. In turn, the KHSCG includes certain subjects that are absent from the DP, such as technology and home economics, or the option offered by some schools to replace (at least some) elective courses with specialised subjects from a long list of vocational disciplines.[81]

## 4.4 Requirements and Associated Outcomes

There are no formal entrance requirements stipulated for the DP as the IB envisages numerous educational pathways leading to upper secondary education.[82] However, the IB recommends consulting the subject guides prior to enrolment to ensure an adequate understanding of programme expectations.[83] In the KHSCG, entry requirements vary per school type and location (i.e. metropolitan or provincial regions). Admission to general high school in most cities and provinces is based predominantly on successful completion of middle school academic grades and test scores achieved. In contrast, special-purpose schools, vocational high schools and autonomous high schools may, and often do, choose to use additional selection criteria, such as interviews, teacher recommendation letters, or by administering their own entrance examinations.[84]

[79] International Baccalaureate. (2021). *Curriculum*. Available from: www.ibo.org/programmes/diploma-programme/curriculum/
[80] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*.
[81] Additional specialised subjects offered may include courses in: management/finance, public health/public welfare, design/cultural contents, beauty treatment/tourism/leisure, cooking, construction, machinery, materials, chemical engineering, textile/clothing, electric/electronics, information/communications, processing, printing/publishing crafts, environment/safety, agriculture fisheries & maritime, and ship operations.
[82] International Baccalaureate. (2015). *DP: From principles into practice*. p. 22.
[83] Ibid.
[84] MOE, Republic of Korea. (2022). *Secondary Education.*

In terms of associated outcomes, both programmes aim to prepare students for higher education, employment and life-long learning. According to the DP documentation, the DP is conceived as a preparatory programme for university matriculation and higher education focusing primarily on rigorous academic study, though the programme can also prepare students for the world of work, 'lifelong learning' and 'life beyond'.[85] Similarly, the KHSCG is designed to prepare students for higher education, employment, and lifelong learning in the 21st-century's knowledge-based society.[86]

In order to be awarded a diploma in the DP, students must achieve a minimum pass grade of 3 in all subjects studied. In contrast, students are awarded the KHSCG when completing at least 204 units of study in line with the requirements outlined in the previous section. For both programmes, grades are produced for each individual subject.

Upon graduation, students receive the KHSCG (also translated as the High School Diploma). The KHSCG does not itself provide entry to university in South Korea, and all Korean high school students who intend to apply to university are typically required to pass the national College Scholastic Ability Test (CSAT), administered by the Korea Institute of Curriculum and Evaluation (KICE),[87] and sit university-specific admission examinations, which may include essays, interviews, aptitude tests, performances, or other means.[88]

## 4.5 Student Learning Pathways

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

[85] International Baccalaureate. (2017). *Diploma Programme Subject Brief.;* International Baccalaureate. (2022). *Our mission.* Available from: ibo.org/about-the-ib/mission/
[86] MOE, Republic of Korea. (2018). Education in Korea; National Curriculum Information Center (NCIC). (2022). *Education System of Korea*. Available from: ncic.re.kr/english.inf.ivi.index.do
[87] KICE. (2021). *College Scholastic Ability Test.*
[88] MOE, Republic of Korea. (2022). *Higher Education.* Available from: english.moe.go.kr/sub/infoRenewal.do?m=0305&page=0305&s=english

*Figure 6: DP imagined pathway for a student wishing to study physics at university*

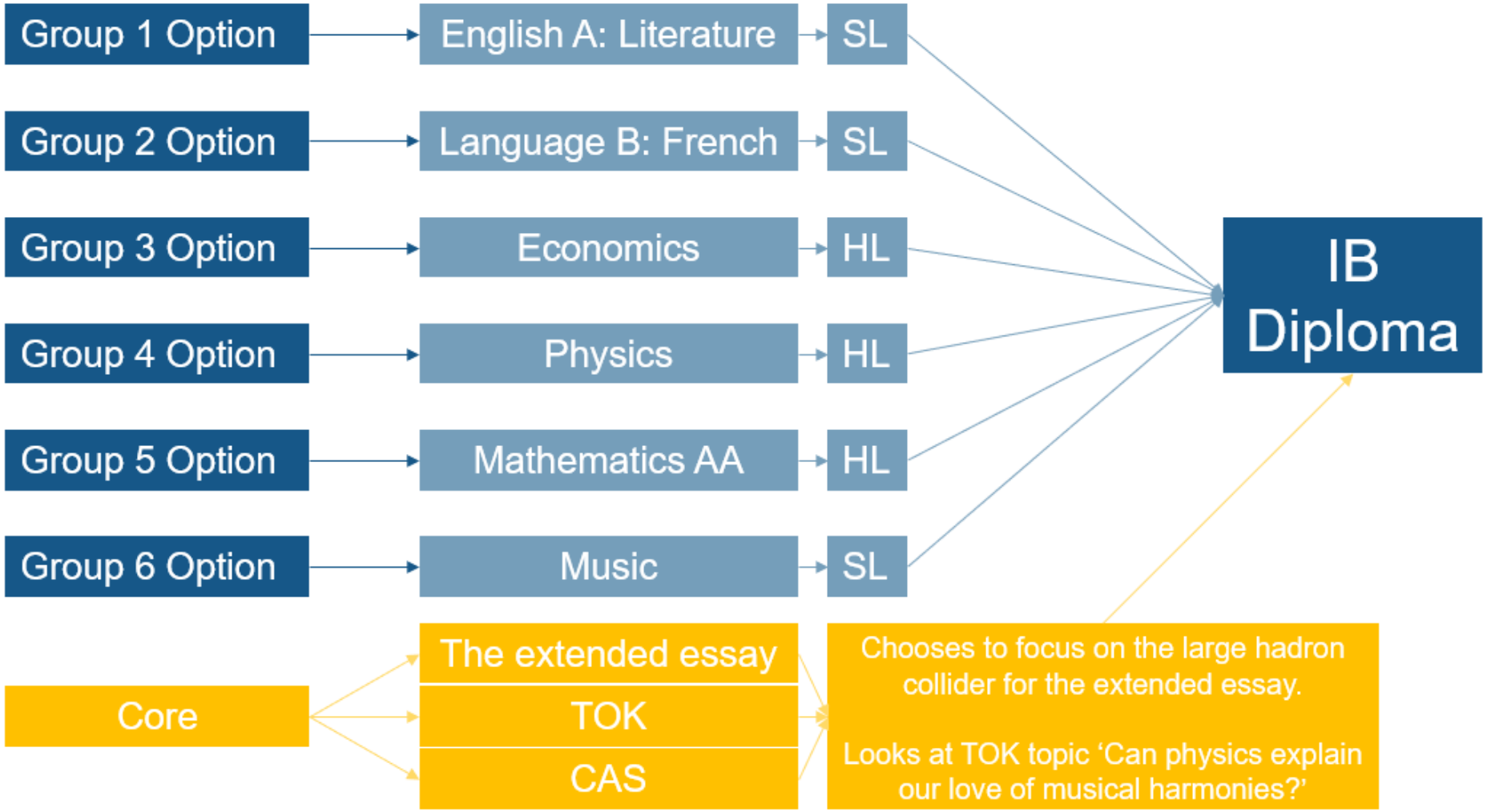
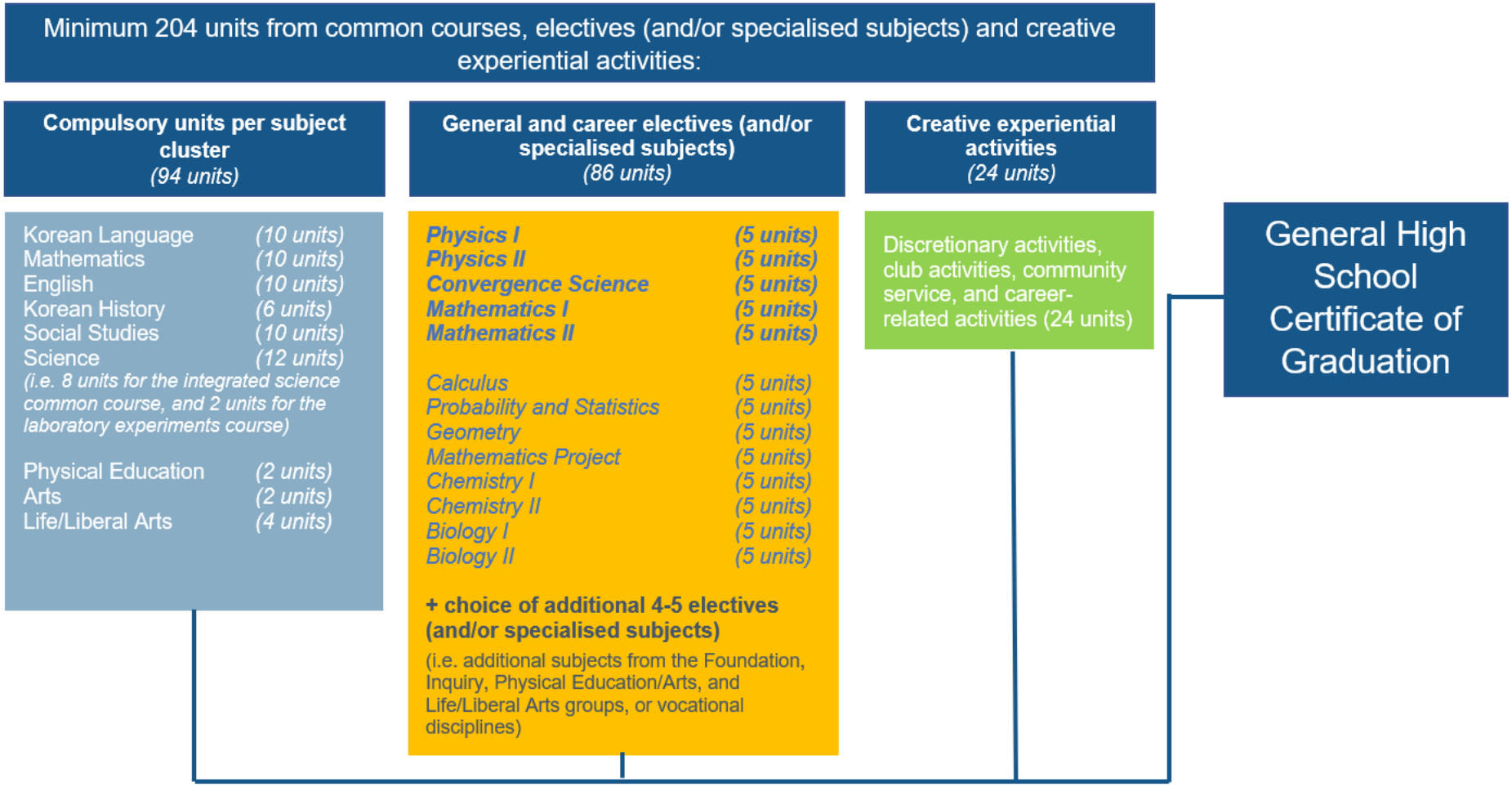


*Figure 7: KHSCG imagined pathway for a student wishing to study physics at university*



As can be seen from the diagram above, in the KHSCG, students will experience a much higher number of subjects than in the DP, with the former requiring students to study subjects from ten subject clusters, plus elective subjects and the CAE, compared to only six subjects plus the core in the DP. As a result, the KHSCG has greater breadth than the DP, requiring students to cover a larger number of areas.

Some degree of specialisation in a broad subject area is enabled in the KHSCG, however. Students who wish to pursue a somewhat specialised pathway may do so – for example, a student that would like to study physics at university and is mostly interested in science, technology, engineering and mathematics (STEM), although still required to take a number of compulsory credits from humanities and arts subjects, can choose to complete most of their elective studies in science subjects – e.g. Physics I, Physics II, Convergence Science, Mathematics I, Mathematics II, Calculus, Probability and Statistics, Geometry, Mathematics Inquiry Task (Mathematics Project), Chemistry I, Chemistry II, Biology I, and Biology II.

If a student studies the common courses and electives (both general and career-related) in these subjects, this would amount to a total of approximately 1,177h of STEM instruction over three years (≈213h for Integrated Science, Scientific Investigation; and Convergence Science and; ≈142h for Physics I and II; ≈538h for mathematics; ≈142h for Biology I and II; and ≈142h for Chemistry I and II) – allowing for a relatively high level of specialisation. In this sense, although the South Korean curriculum undoubtedly prioritises breadth, it also allows for considerable depth.

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

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

## 4.6 Assessment Methods

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

*Table 10: Top level assessment comparisons*

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

As the table above shows, the two programmes have markedly different overall approaches to assessment methods. The DP prioritises external assessment in the form of exams, whilst

internal assessment only accounts for 20-30% of the final mark in each subject.[89] In contrast, all assessment within the KHSCG relies entirely on flexible methods of internal assessment, in all subjects. Each school in South Korea has oversight over the testing methodology, frequency of testing, and performance assessment, as well as grading methodology;[90] though there is a requirement that individual grades must be awarded for each subject. Providers of the KHSCG are advised to 'guide students to reflect upon and improve learning by providing constructive feedback on assessment results and offering necessary follow-up instruction' – suggesting that the use of both formative and summative assessment is encouraged.

Despite the flexibility implied by the South Korean National Curriculum, assessment in the KHSCG is still intended to centre around broad subject-specific educational objectives and competences outlined in the National Curriculum document: 'assess both the results and process of learning, ensuring that all students have achieved *the educational objectives*'.[91] For this reason, there is a likelihood that there could be reasonable alignment with the DP subjects in terms of assessment types used. Indeed, there are similarities between internal assessment methods in the DP and those alluded to in the KHSCG. These include laboratory work in sciences, oral work in languages and performances in the arts subjects.[92] However, the level of alignment is hard to conclusively judge due to the high level of flexibility within the KHSCG approach to assessment.

As KHSCG subject assessment is based on internal assessment, comparisons with the question types and other aspects of the assessment structure of the DP are challenging. The KHSCG documentation places overall curricular emphasis on the 'use *of short-answer questions*, *essay questions*, and *performance assessments* to a greater extent',[93] but the extent to which these are used will vary depending on the educational provider. Moreover, whilst the DP uses clear assessment objectives to demonstrate the nature and proportional importance of the skills assessed, the KHSCG merely makes suggestions as to some key subject-related skills and competences that should be assessed as part of the school-based assessment standards designed by each local curriculum.

Although the specifics of the assessment objectives and curriculum design are to be decided by KHSCG education providers, some information about assessment is provided in the KHSCG under the 'objectives' section of each subject.

[89] International Baccalaureate. (2021). *Understanding DP Assessment*. Available from: https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/understanding-ib-assessment/
[90] Ibid.
[91] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*. p. 54
[92] MOE, Republic of Korea. (2020). *The Maths Curriculum; MOE, Republic of Korea. (2020). The Sciences Curriculum;* MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*. p. 54.
[93] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*. p. 54

*Table 11: Comparison of DP assessment objectives and KHSCG 'objectives' sections*[94]

| DP subject | DP assessment objectives | KHSCG mathematics subjects |
|---|---|---|
| DP mathematics subjects | AO1 – knowledge and understanding | '…understanding the concepts, principles and laws of mathematics, and mastering mathematical skills' |
| | AO2 – problem solving | '…solving problems rationally and creatively' |
| | AO3 – communication and interpretation | '…to cultivate mathematical…communication' |
| | AO4 – technology | x |
| | AO5 – reasoning | '…to cultivate mathematical reasoning';<br>'To reason and communicate mathematically' |
| | AO6 – inquiry approaches | '…understand social and natural phenomena mathematically based on creative and convergence thinking and information processing ability' |
| **DP subject** | **DP assessment objectives** | **KHSCG science subjects** |
| DP science subjects | AO1 – demonstrate knowledge | 'To recognise the interrelationship between science, technology and society as a basis for knowledge'<br>'…understanding and exploring the core concepts of science' |
| | AO2 – understanding and application | 'To understand the core concepts of science by exploring natural phenomena.';<br>'…understanding and exploring the core concepts of science.' |
| | AO3 – analyse, evaluate, and synthesize | 'To develop the ability to scientifically explore natural phenomena and problems of daily life.'; 'to cultivate the scientific literacy of solving personal and social problems scientifically and creatively' |
| | AO4 – investigation skills | '…to cultivate the scientific literacy of solving personal and social problems scientifically and creatively'<br>'…cultivating the ability to inquire.' |

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

This being said, it should be noted that the South Korean National Curriculum also states that assessment should be used not only as a means to assess subject-specific cognitive skills, but also students' *emotional skills*: 'make use of valid assessment criteria and scales in subject areas that put emphasis on *emotional*, functional, and creative skills'.[95] Although the specific methods to be used for this are unspecified and left at the discretion of each school, the fact that assessment of emotional skills is encouraged in the KHSCG constitutes a key difference between the two programmes when it comes to their approaches to assessment, given that the DP's assessment objectives do not mention emotional competency.

[94] MOE, Republic of Korea. (2020). *The Maths Curriculum; MOE, Republic of Korea. (2020). The Sciences Curriculum.*
[95] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*. p. 54

Another key difference between the DP and KHSCG, as already identified, is the absence of external assessment requirements in the KHSCG. Although not a compulsory component of KHSCG, many students complete their studies with the standardised, externally marked, CSAT to demonstrate knowledge acquired and become eligible for access to higher education. The examination includes six tests covering the areas of: Korean History, Language Arts, Mathematics, English, Inquiry (Social Studies, Science, or Vocational Education) and Foreign Language/Classical Chinese.[96] All tests are optional apart from Korean History, which must be completed in order to sit the overall examination. Unlike the final DP examinations, the matriculation examination is separate from KHSCG, yet there are similarities between the structure of the subject groups of the matriculation exam and the six subject groups that form part of the DP; notably, the focus on language arts, additional languages, mathematics, humanities and sciences. [97]

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

[96] KICE. (2021). *College Scholastic Ability Test.*
[97]KICE. (2021). *College Scholastic Ability Test.*

# 5. Subject-Level Alignment

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

*Table 9: Research question 3*

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

For each subject area, there is a brief introduction to the subjects being compared, followed by an overview of the findings from the comparative analysis between the DP subjects and the KHSCG 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**[98]
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**[99]
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.

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

**Common course: Mathematics**[100]

Mathematics is a common course in the South Korean high school curriculum and thus is required to be taken by all students. Worth eight units, this course is taken in the first grade of high school and directly follows the mathematical learning of the last grade in middle school. The aim of the common course is to provide a foundation for further study of general electives, career-related electives, specialised mathematics subjects, and other disciplines. Furthermore, the course aims to develop skills and competences which will enable students to effectively participate in society. The minimum requirement of mathematics units to complete over three years of high school is ten, therefore students will need to take at least one elective following the common course. Electives are separated into general and career-related.

**General electives**[101]

For students wishing to build on the content of the common course and study mathematics at a higher level, the following general electives may be chosen:

- **Mathematics I** – focuses on functions and sequences.
- **Probability and Statistics** – focuses on number of cases, probability, and statistics.
- **Mathematics II** – introduces calculus and concepts of limits and continuity of functions.
- **Calculus** – this elective can be chosen following study of Mathematics I and Mathematics II. It focuses on limits of a sequence, differentiation methods, and integration methods.

**Career-related electives**[102]

For students who want to build on content learnt in the common course and study mathematics that may be relevant to a future career path, the career-related electives offer the following options:

- **Geometry** – focuses on the quadratic curve, plane vectors, and spatial figure and spatial coordinates.
- **Economic Mathematics** – focuses on number and economy, sequences and finance, functions and economics, and differentiation and economics.
- **Artificial Intelligence Mathematics** – focuses on how mathematics is used in artificial intelligence and learning processes of classifying data and using it to make predictions.
- **Mathematical Inquiry Task** – focuses on developing inquiry skills and gives opportunity for students to independently explore an area of mathematics or problem and present their findings.

**KHSCG mathematics pathway**[103]

For content and demand, the analysis will focus on comparing the DP subjects to a pathway in the KHSCG mathematics curriculum – consisting of Mathematics, Mathematics I, Mathematics II, Probability and Statistics, Calculus, and Geometry. The electives have been selected from the South Korean curriculum on the basis that they are the topic areas assessed

[100] MOE, Republic of Korea. (2020). *Mathematics Curriculum.*
[101] Ibid.
[102] Ibid.
[103] Kim.J, Lee. J, Park. M, Han.I. (2012). *Mathematics Education In Korea - Vol. 1: Curricular And Teaching And Learning Practices.* p. 290-294.

in the 'Swuri-Ka' section of the CSAT[104] and also because of their similarity to the main topics in the DP.

### 5.1.1 Learning Outcomes – Mathematics

For its mathematics learning outcomes, the DP sets out aims and assessment objectives for all subjects within the mathematics subject group – hence the extracted themes are the same for mathematics: analysis and approaches and mathematics: applications and interpretation. Similarly, the South Korean curriculum sets out its learning outcomes in the form of objectives, which are mostly identical for the common course and electives, only slightly differing in their references to the content that the subject/elective focuses on. The objectives include six mathematical competencies, which are problem-solving, reasoning, creativity and convergent thinking, communication, information processing, and attitudes and practices. These competencies are described in the 'character' section of each syllabus; thus these sections were also used to assess the presence of DP themes.

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

*Table 10: Presence of the DP mathematics subject group learning outcome themes in KHSCG curricula*

| Themes extracted from the learning outcomes in the DP mathematics subject group | Presence in KHSCG | |
|---|---|---|
| 1. Being aware of, and engaging with, mathematics in its wider context | | Somewhat present. The desired result of the competencies and objectives is that students will be effective members of society. |
| 2. Developing learning skills; having a positive and resilient attitude, working both independently and collaboratively, being reflective and evaluating work | | Present in the third objective and the 'attitudes and practice' competency. |
| 3. Using inquiry-based approaches | | Somewhat present in the 'information processing' competency. |
| 4. Understanding the concepts, principles and nature of mathematics and applying concepts and procedures to a range of contexts | | Present in the first objective. |
| 5. Making links and generalisations | | Present in the 'creative and convergent' competency. |

[104] There are two options offered to students in the mathematics section of the CSAT, 'Swuri-Na' and 'Swuri-Ka'. The latter is more advanced and assesses a broader range of mathematical areas.

| | | |
|---|---|---|
| 6. Developing critical/creative thinking skills e.g. problem-solving and reasoning | | Present in 'problem-solving', 'creative and convergent thinking', and 'reasoning', competencies. |
| 7. Communicating mathematics clearly and in various forms | | Present in the second objective and the 'communication' competency. |
| 8. Knowing how technology and math influence each other and using technology to develop ideas and solve problems | | Somewhat present in the 'information processing' competency. |

Key:

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

*Presence of the DP's Learning Outcome Themes*

All of the extracted themes from the DP's learning outcomes are identifiable in the South Korean curriculum, with five of them being strongly present. Most strongly evidenced is the DP's theme of critical and creative thinking. Indeed, three out of the six mathematical competencies are dedicated to this theme, namely the problem-solving, reasoning, and creative and convergent thinking competencies. These describe skills such as exploring solution strategies, analysing facts, and justifying ideas. Furthermore, the creative and convergent thinking competency also aligns with another of the DP's themes – making links and generalisations. This competency states that students should be able to create new knowledge and solve problems by linking together mathematical concepts and skills and drawing upon information from experiences and other subjects.

Also well-evidenced is the DP's theme of learning skills, as the competency of attitudes and practices describes students having confidence and curiosity, as well as being independent learners. Although collaboration is not explicitly mentioned, there are references to 'understanding others` ideas' in the competency of communication. Communication as a theme generally is present, as this competency details expressing results, ideas, and problem-processes in various formats, such as words, text, pictures, and mathematical notation.

Turning to themes which are present in a weaker sense, some inquiry-based approaches are detailed, such as collecting, organising, and analysing data, however, these are within a different context of information processing, rather than inquiry. Therefore, elements of inquiry, such as making conjectures and testing the reliability of results, are not present in South Korean outcomes, though it can be noted that inquiry-based learning is mentioned in the teaching and learning section of the curriculum. In addition, 'information processing' only describes 'selecting and using appropriate tools', hence the theme of technology is present, but to a lesser extent than in the DP, which describes using technology to solve problems and explore new ideas.

Finally, there are elements in the South Korean outcomes which speak to the wider contexts of maths, as the curriculum intends that students will be able to use their mathematical

knowledge and competencies to engage effectively in society. However, the learning outcomes do not explicitly detail that students will be able to understand global issues and historic perspectives or think critically about the implications of mathematics.

*Other Themes in the KHSCG*

There are no significant themes in the South Korean mathematics syllabi which are not present in the DP. Differences are usually in wording, rather than intended outcomes. For example, as previously mentioned, South Korea describes a competency regarding information processing, which, whilst not explicitly described in the DP, shares similarities with the DP's outcome of using inquiry-based approaches. Another example is South Korea's reference to convergent thinking, which, whilst not a term used in the DP, is strongly present in its outcomes involving problem-solving, reasoning, critical reflection, and consideration of mathematical implications. Lastly, South Korea perhaps has more explicit detail around making mathematical connections and creating new ideas.

*Summary*

Overall, there is considerable alignment between the learning outcomes of the DP's mathematics subjects and South Korea's. Most of the DP's themes are present and similarly emphasised, especially critical and creative thinking, understanding and application, communication, and making links and generalisations. However, it can be noted that wider contexts, inquiry-based approaches, and technology, though present, had less emphasis in the KHSCG curriculum. There are no significant themes which are unique to the KHSCG.

### 5.1.2 Content – Mathematics

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

*Figure 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: KHSCG mathematics content visualiser*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Common Subject** | Mathematics | Algebra<br>- Polynomials<br>- Equations and inequalities | Geometry<br>- Equations of figures | Numbers and arithmetic operations<br>- Sets and propositions | Functions<br>- Functions and graphs | Probability and statistics<br>- Number of cases | |
| **General electives** | Mathematics I | Exponential and logarithmic functions | Trigonometric functions | Sequences | | | |
| | Mathematics II | Limits and continuity of functions | Differentiation | Integral calculus | | | |
| | Calculus | Limit of a sequence | Differentiation | Integration | | | |
| | Probability and statistics | Number of cases | Probability | Statistics | | | |
| **Career-related electives** | Geometry | Quadratic curves | Plane vectors | Spatial figures and coordinates | | | |
| | Practical Mathematics | Geometry: rules | Geometry: spaces | Statistics: Data | | | |
| | Economic Mathematics | Numbers and daily economics | Sequences and finance | Functions and economics | Differentiation and economics | | |
| | Mathematical Inquiry Task | Understanding of inquiry task | Inquiry task and evaluation | | | | |
| | Basic Mathematics | Number of cases | Polynomials | Equations and inequalities | Sets | Functions and graphs | Equation of figure |
| | Artificial Intelligence Mathematics | Artificial intelligence and mathematics | Representation of materials | Classification and prediction | Optimisation | | |

*Structure*

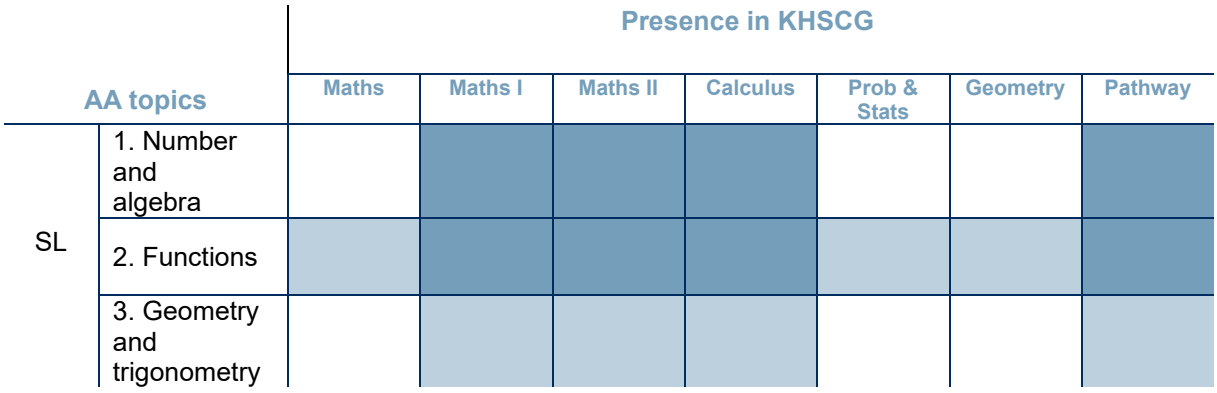
Mathematics content in the DP is separated by focus, AA and AI, and level, SL and HL. DP HL includes the content of SL, as well as additional higher level (AHL) content. For high school, the mathematics content in the South Korean curriculum is structured into the common course, general electives, and career-related electives. General electives are Mathematics I, Mathematics II, Probability and Statistics, and Calculus. Career-related electives are Geometry, Practical Mathematics, Economic Mathematics, Mathematical Task Inquiry, Basic Mathematics, and Artificial Intelligence Mathematics. Each elective usually focuses on a few areas of one main topic – unlike DP mathematics subjects which integrate content from five main topic areas. Students can choose the electives that they take, therefore there is a greater degree of flexibility than there is in the DP. Furthermore, content is not separated into levels like SL and HL in the DP; however, a few of the electives require more pre-requisite knowledge than others.

Similarly to AA and AI in the DP, the electives offer opportunities to focus on pure mathematics and applied mathematics. For example, Calculus offers more pure-focused content, whereas Economic Mathematics offers more applied-focused content. Furthermore, the Mathematical Inquiry Task elective is similar to the mathematical exploration offered in the DP, though it is not compulsory. However, the South Korean content structure has a stronger focus on careers than the DP and offers electives which have a more specific focus on certain fields, such as Economic Mathematics and Artificial Intelligence Mathematics. Furthermore, the electives also cater for those who need further time with basic concepts (Basic Mathematics) and for those who wish to focus on solving real-world problems from everyday life (Practical Mathematics). Altogether, the South Korean curriculum caters to a wider range of mathematical abilities than the DP and allows students to choose a more specific focus in their studies, based on their interests and future plans for education and careers.

*Content Alignment*

The figures below show a simplified summary of the extent to which KHSCG mathematics aligns with the main topics of the DP's subjects. The analysis in this section will first be split into AA and AI. For both AA and AI, the analysis will review how the content of each KHSCG common course/elective affects the alignment with DP subjects, before combining this information to compare a pathway to DP SL/HL mathematics. Following this, several other electives which are offered in the KHSCG and not included in the 'pathway', will be reviewed for their similarities and differences in content to the DP curriculum.

*Figure 11: Summary of the content alignment KHSCG has with the main topics in AA*



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 4. Statistics and probability | | | | | | | |
| | 5. Calculus | | | | | | | |
| AHL | 1. Number and algebra | | | | | | | |
| | 2. Functions | | | | | | | |
| | 3. Geometry and trigonometry | | | | | | | |
| | 4. Statistics and probability | | | | | | | |
| | 5. Calculus | | | | | | | |

*Figure 12: Summary of the content alignment the KHSCG has with the main topics in AI*

| | | Presence in KHSCG | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | AI topics | Maths | Maths I | Maths II | Calculus | Prob & Stats | Geometry | Pathway |
| 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 KHSCG.* | | *Partial presence of this topic in the KHSCG.* | | *Little or no presence of this topic in the KHSCG.* | N/A | *This topic does not exist at the respective level.* |
|---|---|---|---|---|---|---|---|

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

The table below summaries KHSCG content that is in neither DP mathematics subject or only one of them.

*Table 11: KHSCG mathematics content which is not covered in the DP**

| **Significant content not in AA (only)** | **Significant content not in AI (only)** |
|---|---|
| • Some financial applications (e.g. annuities). *(Economic Mathematics).* | • Limits of functions. *(Mathematics II).*<br>• Continuity and differentiability *(Mathematics II).*<br>• Combinatorics. *(Probability and Statistics).* |
| **Significant content not in either DP mathematics subject** | |
| • Additional content regarding economic applications of mathematics. *(Economic Mathematics).*<br>• Applications to artificial intelligence. *(Artificial Intelligence Mathematics).*<br>• Further detail regarding convergence and divergence of functions and limits of sequences. *(Calculus).*<br>• Parabolas, ellipses, and hyperbolas. *(Geometry).* | |

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

**Mathematics: analysis and approaches**

*Mathematics*

The mapping of content shows that the common subject Mathematics has partial alignment with a few of the main topic areas in AA. Namely, these are SL 'Functions' and AHL 'Number and algebra'. Mathematics partially aligns with SL 'Functions' content as it covers concepts of functions, quadratic and rational functions, and composite and inverse functions. However, exponential and logarithmic functions, transformations, and some analytical solutions are not included in this subject. Although Mathematics does not align with SL 'Number and algebra' content, partial alignment was found with the AHL content in this topic. Indeed, Mathematics covers counting principles, proof by induction, and some coverage of complex numbers. Overall, Mathematics on its own has very limited alignment with SL or AHL content of AA.

*Mathematics I*

Mathematics I follows Mathematics, therefore previously mentioned alignments still apply. The mapping of content shows that Mathematics I has alignment with some, but not all, of the main topics of AA SL. Topics which Mathematics I has the strongest alignment with are, at SL, 'Number and algebra' and 'Functions'. Of 'Number and algebra' content, Mathematics I covers sequences and series, simple proof, and laws of exponents and logarithms. Of 'Functions' content, Mathematics I builds on content from Mathematics to include exponential and logarithmic functions and some reference to analytical solutions, thus strengthening the alignment with SL content in this topic. Furthermore, Mathematics I incorporates trigonometric functions and radians, which gives partial alignment with 'Geometry and trigonometry' SL content. However, there is limited detail for this topic, such as for solving trigonometric

equations, and no reference to trigonometric identities or transformations. There are a few sub-topic alignments with 'Statistics and probability' from prior learning, however, not enough to be significant. No 'Calculus' content is covered in Mathematics I.

In summary, Mathematics I has good alignment with 'Number and algebra', and SL 'Functions'. There is also partial alignment with SL 'Geometry and trigonometry' content. Overall, Mathematics I has less breadth and depth than the content of AA SL.

*Probability and Statistics*

Probability and Statistics can be taken following the common subject Mathematics, therefore the alignments mentioned in relation to the common subject still apply. As expected, Probability and Statistics mostly impacts alignment with the AA topic on the same theme. Probability and Statistics includes probability, discrete random variables, and the binomial and normal distributions. Other SL sub-topics regarding presenting data and measures of central tendency and dispersion are covered in middle school. Therefore, there is good alignment with 'Statistics and probability' SL content, though it can be noted that linear regression is not covered. For students who are also taking Mathematics II, Probability and Statistics includes some coverage of continuous random variables, therefore there is partial alignment with AHL content in this case. Finally, this elective contains the binomial theorem and counting principles, hence, when taken with Mathematics I, there is strong alignment with 'Number and algebra' SL content.

*Geometry*

Geometry can be taken following the common subject Mathematics, therefore alignments mentioned in relation to the common subject still apply. In general, Geometry has little impact on the extent of alignment with AA SL content, though it does slightly increase the number of AHL sub-topics alignments in 'Geometry and trigonometry'. This is due to some coverage of vectors, including an introduction to vectors, the scalar product, and vector equations of lines. However, other AA AHL sub-topics are not covered, such as the cross product, equations of planes, reciprocal trigonometric ratios, and further trigonometric identities. Therefore, there is only weak alignment with AHL content in this topic overall. Aside from vectors, the Geometry career-elective focuses on other topics which are less, or not, present in AA. For example, Geometry focuses on parabolas, ellipses, and hyperbolas, as well going into more depth in coordinate geometry in its section named 'Spatial figures and coordinates'.

*Mathematics II*

Mathematics II would usually be taken following Mathematics I, therefore previous alignments mentioned for the latter still apply. Mathematics II focuses on limits and continuity of functions, differentiation, and integration, therefore alignment with AA only changes with regard to the topic of Calculus and the alignment with other topics remain the same as for Mathematics I.
The mapping of content shows that Mathematics II has considerable alignment with the SL content of AA Calculus. Indeed, the elective includes concepts of limits, increasing and decreasing functions, graphs, differentiation of polynomials, equations of tangents, maxima and minima problems, and integration. Furthermore, continuity and differentiability of functions is also covered, which is an AHL sub-topic in AA. Within this are some concepts not explicitly mention in the AA syllabus, such as the mean value theorem, Rolle's theorem, and the interval theorem. Overall, Mathematics II has similar depth in the topic of calculus as AA SL, but not AA HL.

*Calculus*

Calculus can be studied following Mathematics I and Mathematics II, therefore previous alignments with those electives also apply. The Calculus elective requires the most pre-requisite study and therefore can be considered the most advanced elective to be chosen. As expected, the Calculus elective only significantly impacts the alignment of the main topic of the same name in AA. Calculus builds on the learning in Mathematics II and includes several AHL sub-topics and further SL topics. These are the second derivative, further derivatives, indefinite integrals, optimisation problems, evaluation of limits, implicit differentiation, integration methods, and finding area and volume. However, the elective does not include first order differential equations or Maclaurin series.

The Calculus elective also explores convergence and divergence of sequences and series and finding the limits of sequences. Overall, the elective has greater depth in the topic of calculus than AA SL, and similar depth to AA AHL.

*Pathway*

This section will consider the alignment between a particular pathway in KHSCG mathematics, consisting of the subject/electives above, and DP AA content.

In summary, for AA SL content, the pathway has strong alignment with ‘Number and algebra’, ‘Functions’, ‘Statistics and probability’, and ‘Calculus’. There is also partial alignment with SL ‘Geometry and trigonometry’. For AHL content, there is strong alignment with ‘Calculus’ and partial alignment with ‘Number and algebra’ and ‘Statistics and probability’. There are also some sub-topic alignments within the area of vectors. Most of the content in the electives is present in AA, with the exception of some different geometry coverage and some additional coverage of continuity, differentiability, limits and sequences.

Altogether, these electives have comparable breadth to DP subjects and greater depth in content than AA SL, though slightly less depth than HL. Specifically, there is less depth in vectors, complex numbers, and trigonometry.

**Mathematics: applications and interpretation**

*Mathematics*

The mapping of content shows that Mathematics has some limited alignment with a few of the main topic areas in AI. Namely, these are SL ‘Functions’ and ‘Geometry and trigonometry’. Mathematics partially aligns with SL ‘Functions’ content as it covers concepts of functions and graphing of functions, however, modelling with functions is not a focus in this subject. Furthermore, sub-topic alignments in SL ‘Geometry and trigonometry’ include volume and area, Pythagoras, and circles, however, these are studied in middle school, prior to Mathematics. It can be noted that there are some sub-topics in ‘Statistics and probability’ which are also covered in middle school. Mathematics also includes solving equations with complex roots, however, there are no other alignments with ‘Number and algebra’. Mathematics covers some sub-topics which are not present in AI but are present in AA. These include proof, rational and polynomial functions, and counting principles. Overall, Mathematics on its own has very limited alignment with SL or AHL content of AI.

*Mathematics I*

Mathematics I can be taken following Mathematics, therefore previously mentioned alignments still apply. The mapping of content shows that Mathematics I has alignment with some, but not all, of the main topics of AI SL. Topics which Mathematics I has alignment with, at SL, are 'Number and algebra', 'Functions', and 'Geometry and trigonometry'. Of 'Number and algebra' content, Mathematics I covers sequences and series, exponents and logarithms, and some of complex numbers – thus there is partial alignment with AHL content also in this topic. Regarding 'Functions' content, Mathematics I builds on content from Mathematics to include exponential and logarithmic functions – modelling of which is referenced. However, there is limited detail with regard to modelling and fewer functions are used to model than in AI.

Furthermore, Mathematics I incorporates trigonometric functions and radians, which creates some sub-topic alignment with 'Geometry and trigonometry' AHL content, though not a significant amount. Alignment with SL content remains the same, as Voronoi diagrams are not present. Moreover, there are a few sub-topic alignments with 'Statistics and probability', however, not enough to be significant. No Calculus content is covered in Mathematics I.

In summary, Mathematics I has some alignment with 'Number and algebra', SL 'Functions' and 'Geometry and trigonometry'. Overall, Mathematics I has less breadth and depth than the content of AI SL.

*Probability and Statistics*

Probability and Statistics can be taken following the common subject Mathematics, therefore the alignments mentioned in relation to the common subject still apply.

As expected, Probability and Statistics mostly impacts alignment with the AI topic on the same theme. Probability and Statistics includes probability, discrete random variables, and the binomial and normal distributions. Other SL sub-topics regarding presenting data and measures of central tendency and dispersion are covered in middle school. Therefore, there is partial alignment with 'Statistics and probability' SL content, noting that linear regression, Spearman's rank, and hypothesis testing are not covered. Regarding AHL content, there are a couple of sub-topic alignments with the central limit theorem and confidence intervals. For students who are also taking Mathematics II, it includes some coverage of continuous random variables, which is not present in AI. In addition, this elective contains the binomial theorem and counting principles, which are also not sub-topics that are present within AI.

In summary, this elective has reasonable alignment with AI SL 'Statistics and probability' but is missing some of the key sub-topics such as regression and hypothesis testing.

*Geometry*

Geometry can be taken following the common subject Mathematics, therefore alignments mentioned in relation to the common subject still apply. It is likely that students taking Geometry will also at least take Mathematics I. In general, Geometry has little impact on the alignment of AI SL content, though it does slightly increase the number of AHL sub-topics alignments in 'Geometry and trigonometry'. This is due to some coverage of vectors, including an introduction to vectors, the scalar product, and vector equations of lines. Therefore, when taken with Mathematics I, there is partial alignment with AHL content in this topic. However,

other AI AHL sub-topics are not covered, such as the cross product, matrix transformations, graph theory, and decision mathematics. Aside from vectors, the Geometry career-elective focuses on other topics which are less, or not, present in AI. For example, Geometry focuses on parabolas, ellipses, and hyperbolas, as well going into more depth in coordinate geometry through its section named 'Spatial figures and coordinates'.

*Mathematics II*

Mathematics II is usually taken following Mathematics I, therefore previous alignments mentioned for the latter still apply. Mathematics II focuses on limits and continuity of functions, differentiation, and integration, therefore alignment with AA only changes with regard to the topic of 'Calculus' and the alignment with other topics remain the same as for Mathematics I. The mapping of content shows that Mathematics II has considerable alignment with the SL content of AI 'Calculus'. Indeed, the elective includes concepts of limits, increasing and decreasing functions, graphs, differentiation of polynomials, equations of tangents, maxima and minima problems, and integration. Furthermore, continuity and differentiability of functions is also covered, which is an AHL sub-topic in AA. Within this are some concepts not included in the AI syllabus, such as the concepts of continuity and differentiability, the mean value theorem, Rolle's theorem, and the interval theorem.

Overall, Mathematics II has similar depth and detail in the topic of calculus as AI SL, but not AI HL.

*Calculus*

Calculus can be studied following Mathematics I and Mathematics II, therefore previous alignments with those electives also apply. This elective requires the most pre-requisite study and therefore can be considered the most advanced elective to be chosen. As expected, the Calculus elective only significantly impacts the alignment of the main topic of the same name in AI. Calculus builds on the learning in Mathematics II and includes further SL sub-topics and several AHL sub-topics from the DP. These are differentiation methods, the second derivative, further derivatives, optimisation problems, integration methods, and finding area and volume. However, the elective does not include first order differential equations, slope fields, Euler's method and numerical solutions, phase portraits, or second order differential equations.

The Calculus elective also explores convergence and divergence of sequences and series and finding the limits of sequences. It also contains other areas which are not part of AI, such as implicit integration and further derivatives.

Overall, the Calculus elective has greater depth in the topic of calculus than AI SL, and similar depth to AI AHL, though with different coverage of the topic.

*Pathway*

This section will consider the alignment between a particular pathway in KHSCG mathematics, consisting of the subject/electives above, and DP AI content.

In summary, for AI SL content this pathway has strong alignment with 'Calculus' and 'Geometry and trigonometry'. There is also partial alignment with 'Number and algebra', 'Functions', and 'Statistics and probability'. For AHL content, there is partial alignment with 'Number and algebra', 'Geometry and trigonometry', and 'Calculus'. There are several areas

covered in this pathway which are not present in AI, these included certain functions content, proof, continuous random variables, continuity and differentiability, limits of sequences, and different geometry coverage. Altogether, these electives have greater depth in content than AI SL, but have slightly less depth than HL. Furthermore, it can be noted that this pathway is slightly more aligned with AA than AI.

**Other Electives**

*Mathematical Inquiry Task*

This is a career elective which can be taken following the study of the common subject, Mathematics. This elective has strong similarities with the exploration component of DP mathematics, as it aims to develop skills of inquiry. Like with the DP, this elective allocates time to both learning and understanding inquiry techniques and then executing an independent exploration. The content describes how students will, supported by examples, learn the necessity of exploring maths, the procedures involved with inquiry, and recognise the importance of research ethics. The exploration itself has many similar components to the DP's. Indeed, students taking this elective will select an area based on their interests, plan their inquiry, collaborate, use research methods (e.g. literature review, case study, and data collection), organise and present findings, use correct referencing where appropriate, and conduct self-evaluation and peer-evaluation. Furthermore, teachers are also expected to support students throughout the process, offering frequent guidance and feedback. However, there are some differences to the DP which are worth noting. Firstly, this elective is not compulsory, thus not all students will be assessed on their ability to carry out and present the findings of an independent exploration of a mathematical area. Assessment is also different, as teachers' evaluation is not based solely on the final product, but also the process, with teachers encouraged to conduct various types of evaluation throughout the inquiry such as interview and observation. Furthermore, the South Korean curriculum does not state at what level the mathematics within the inquiry needs to be, whereas the DP states that the mathematics used should be commensurate with the level of the course, SL or HL. Since this elective can be taken following the common subject Mathematics, this may mean that students taking this elective are able to use mathematics that is below the level of DP SL/HL.

The career electives also contain other options that are of a similar level but focus on areas of mathematics that are not prominent in the DP curriculum. Namely, these are the Economic Mathematics and Artificial Intelligence Mathematics. Below are summaries of these electives and how they compare to the DP.

*Economic Mathematics*

This elective contains four areas 'Numbers and daily economics', 'Sequences and finance', 'Functions and economics', and 'Differentiation and economics'. As can be seen by these areas, Economic Mathematics incorporates topics that can be found within the DP, such as number, sequences, functions, and calculus, but differs by having a stronger focus on their application to economics. Regardless, there are some sub-topic alignments with the DP, such as with arithmetic and geometric sequences and their financial applications, some functions and graphs, concept of a limit, differentiation, and optimisation. Due to its applied nature, Economic Mathematics has more instances of overlap with AI than AA, indeed it especially aligns with AI SL Calculus – with the exception that integration is not covered. Overall, many of the fundamental concepts of Economic Mathematics can be identified within the DP

curriculum, though it has additional economic-specific content, such as further economic indicators and use of functions in economics (demand and supply curve, utility functions, and equilibrium price).

*Artificial Intelligence Mathematics*

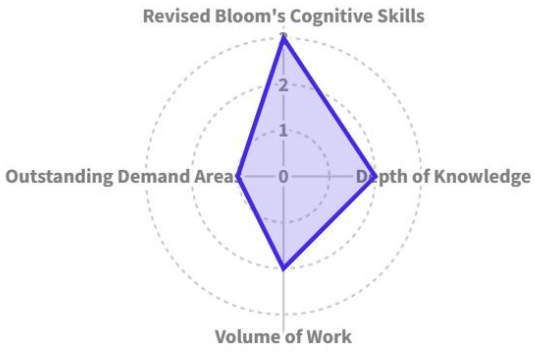
This elective is divided into four main concepts – 'Artificial Intelligence and Mathematics', 'Data Representation', 'Classification and Prediction', and 'Optimisation'. This elective diverges from the DP curriculum, though does contain similar concepts such as organising and analysing data, identifying trends, conditional probability, limits, differentiating quadratic functions, and optimisation. Differently to the DP, this elective has a strong focus on artificial intelligence, with each of the four main topics looking at a different area of this. 'Artificial Intelligence and Mathematics' explores the history of mathematics in artificial intelligence and deals with logic, truth tables and flowcharts; 'Data Representation' looks at representation of text and image data; 'Classification and Prediction' deals with classifying image data and using data for prediction; and 'Optimisation' deals with finding the maximum and minimum of functions and using optimisation methods to solve problems and decision making. Like with AI, this elective has a strong focus on technology, with reference to the use of engineering tools in most topics.

### 5.1.3 Demand – Mathematics

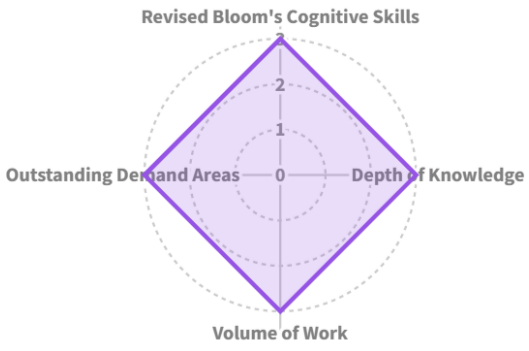
The DP and KHSCG curricula were analysed using the same demand tool in order to create a demand profile for AA (SL and HL), AI (SL and HL), and a pathway from the South Korean curriculum, comprising Mathematics, Mathematics I, Mathematics II, Calculus, Probability and Statistics, and Geometry. These demand profiles are presented below in the form of radar diagrams, with the last two diagrams showing the two DP mathematics subjects superimposed with the KHSCG pathway, enabling immediate visual comparison.

*Figure 13: Visual representations of subject demand*

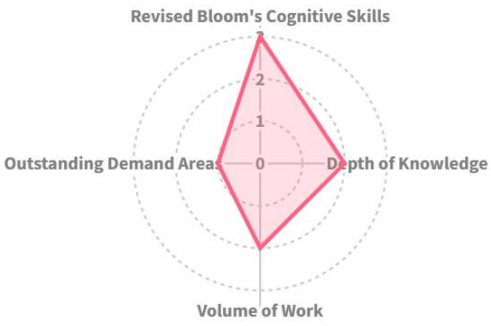
**DP mathematics: analysis and approaches SL**



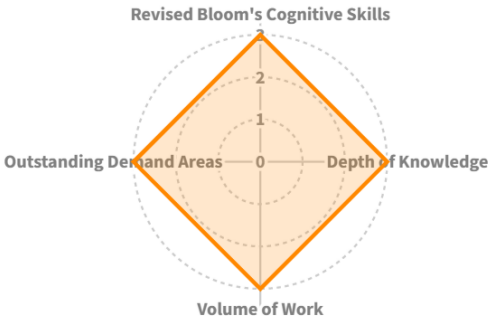

**DP mathematics: analysis and approaches HL**



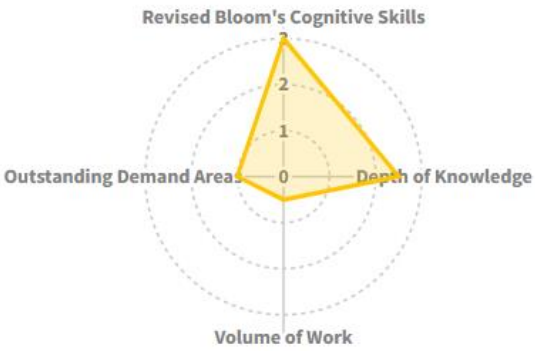

**DP mathematics: applications and interpretation SL**



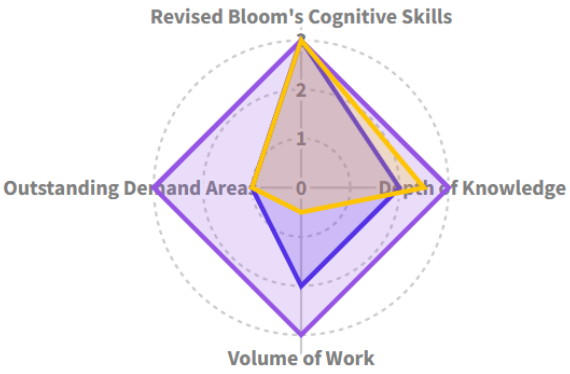

**DP mathematics: applications and interpretation HL**



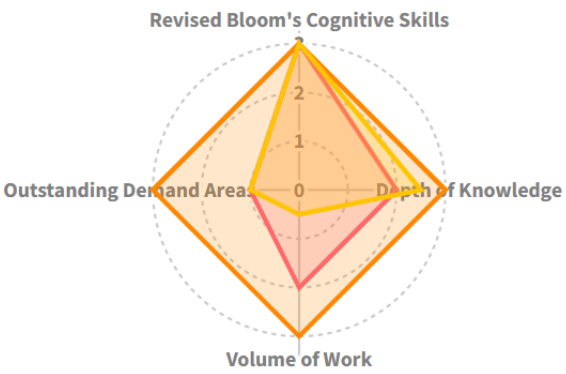

**KHSCG mathematics (pathway)**



**DP AA SL/HL and KHSCG pathway**




**DP AI SL/HL and KHSCG pathway**




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

- Regarding the scores for **Bloom's Cognitive Skills**:
  - The DP mathematics subject group learning outcomes apply to all subjects hence the scores are the same for AA (SL and HL) and AI (SL and HL). These outcomes were given a score of 3 on the basis that they strongly evidenced the development of critical and creative thinking skills through their focus on reasoning, inquiry-based approaches, reflection, generalisation, unfamiliar contexts, and consideration of wider implications.
  - Similarly, the KHSCG's learning outcomes are mostly the same for the common course and the electives, hence all received the same score of 3. The KHSCG learning outcomes evidenced creativity through their 'creative and convergent thinking' competency, which described producing and refining new ideas. Analysis, evaluation and reflection were also evidenced by their 'reasoning' and 'information processing' competencies.

- Regarding the scores for **Depth of Knowledge**:
  - Both DP mathematics subjects at SL were given a score of 2. Both subjects were judged to cover the topics of 'Number and algebra', 'Functions', 'Geometry and trigonometry', 'Statistics and probability', and 'Calculus' in considerable detail, building in complexity and requiring a substantial amount of pre-requisite knowledge. At HL, both DP mathematics subjects were awarded a score of 3 for depth of knowledge. The subjects were judged to cover topics in a high level of detail, with many sub-topics having high complexity and requiring a large amount of pre-requisite knowledge.
  - For the KHSCG, the pathway was given a score of 2.5 for depth. All electives require pre-requisite knowledge from the common course and Calculus requires substantial pre-requisite knowledge from Mathematics I and Mathematics II. Furthermore, most topics were covered in a high level of detail – though slightly less than what can be observed in the DP HL, hence a 2.5 rather than a 3 was awarded.

- Regarding the scores for **Volume of Work**:
  - Both DP mathematics subjects at SL were deemed to comprise of a moderate-heavy volume of work and were given a score of 2. The panel concluded that the teaching time allotted to cover the different concepts was short (150 hours) but acknowledged that some sub-topics contained basic concepts and recapped prior learning, hence 2 was deemed an appropriate score. For HL, both DP mathematics subjects were considered to have a heavy volume of work, due to the short amount of time allocated (240 hours) and the level of complexity of the content, which combined merited a score of 3.
  - For the KHSCG, each unit is equivalent to approximately 14 hours of teaching time. The mathematics common subject is eight units and each elective is five units, therefore this pathway has a total of 33 units and a combined teaching time of 462 hours. This amount of time was deemed a generous amount of time to cover the number of topics in the syllabus, thus it received a score of 0.

- Regarding the scores for **Outstanding Areas of Subject Demand**:
  - Both DP mathematics subjects at SL and contained one area of demand, which was the 'mathematical exploration'. This element of the SL subjects was considered to apply skills typically needed in higher education, such as extended writing and presentation of mathematical concepts, student-led exploration, and academic writing skills. Therefore, a score of 1 was awarded to both SL subjects for the inclusion of this element. In addition to this, both subjects at HL had further areas of outstanding demand. For mathematics: analysis and approaches, some of the identified outstanding areas of demand were proof by induction, complex numbers (De Moivre's theorem), vectors (cross product, equations of planes and intersections), continuous random variables (probability density functions), and Maclaurin series. For mathematics: applications and interpretation, some identified areas of outstanding demand were eigenvalues and eigenvectors, nonlinear regression, Markov chains, second order differential equations, slope fields, Euler's method, and phase portraits. Overall, there was a high number of outstanding areas of demand and a score of 3 was awarded to both HL subjects.
  - For the KHSCG, the low level of detail in the documented content meant that areas of outstanding subject demand were somewhat difficult to identify. However, a limited number of outstanding areas were found in the Calculus elective, with regard to limits of sequences and applications, and in the Mathematics I elective, with regard to mathematical induction, thus a score of 1 was deemed appropriate for this category.

## 5.2 Physics

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

**DP physics**[105]
Physics is a subject option from the DP sciences subject group, offered at both SL and HL. This subject has content that is common to both SL and HL, as well as AHL content that is featured only at HL. Thus, HL has greater breadth and depth than SL. This subject is intended to prepare students for university courses such as engineering, physics, and others requiring a strong science background. HL is suitable for those intending to pursue further study in an area requiring a strong background in physics.

**KHSCG Integrated Science**[106]
Integrated Science is taken by all students in the KHSCG, and has, therefore, been considered in this report as complementary to other science subjects. It has a strong emphasis on scientific inquiry and problem-solving skills through the study of various aspects of physics, chemistry and biology. Earth and space, the characteristics of matter, life and the environment make up some of the topics within the curriculum. Integrated Science also contains a lot of investigation and experiments through which students can gather results and apply their understanding. Collecting data, analysing and evaluating this data and then communicating it to others is a large part of this subject.

**KHSCG Scientific Investigation**[107]
As well as Integrated Science, students in the first year of high school will also take the common subject of Scientific Investigation. This subject looks at past experiments and discoveries, research methods and ethics, and the process of scientific inquiry. There is an aim for students' interest and curiosity to be developed as they learn how science is linked to sport, art and culture, technology, and the development of products. During this subject, students will plan and conduct their own scientific inquiries, inspired by problems that they themselves have discovered.

**KHSCG physics**[108]
The physics subject consists of Physics I and Physics II and aims to provide essential understanding of the natural world. Physics I provides a foundation level of understanding as to how physics can be applied to the 21st century; providing students with the ability to research, think, and solve problems scientifically. Logical reasoning and using evidence to formulate an argument are strong themes within Physics I so that students become better communicators and lifelong learners. Physics II contains more content and goes to a slightly deeper level, but still emphasises the importance of using investigative skills and evidence to solve scientific problems.

[105] International Baccalaureate. (2023). *Physics guide*.
[106] MOE, Republic of Korea. (2015). *Science Curriculum.*
[107] Ibid.
[108] Ibid.

### 5.2.1 Learning Outcomes – Physics

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

The learning outcome themes for physics were extracted from the aims and assessment objectives of the DP sciences subject group, hence the themes are the same for physics, chemistry and biology. For the purposes of mapping and comparisons with the DP, the learning outcomes for KHSCG physics were extracted from the 'character' and 'objectives' sections of the Physics I and Physics II electives.

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 KHSCG physics curricula.

*Table 12: Presence of the DP sciences subject group learning outcome themes in the KHSCG physics curricula*

| Themes extracted from the learning outcomes of the DP sciences subject group | Presence in the KHSCG | |
|---|---|---|
| 1. Conceptual understanding and making connections | | Present in both the 'character' and 'objectives' sections. KHSCG discusses the links between multiple aspects of its curriculum and mentions the comprehensive nature of physics around the world. |
| 2. Use and application of knowledge, methods, tools, and techniques that characterize science | | Present in the 'character' section. Students are expected to understand that scientific knowledge is based on logical reasoning and discovery through observation and exploration. |
| 3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis) | | Present in both the 'objectives' and 'character' sections. There is reference throughout these sections to problem solving and critical consideration. |
| 4. Skills for scientific inquiry | | Present in both the 'character' and 'objectives' sections which discuss the collection of data, research activities and selecting and organising data. |
| 5. Development of technological skills | | Present in both the 'character' and 'objectives' sections. Computers, the use of various media and information technology is referred to throughout the KHSCG outcomes. |
| 6. Effective collaboration and communication | | Present in both the 'character' and 'objectives' sections through mention of students' ability to advocate their own ideas, understand others and use various forms of communication to express scientific information. |
| 7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science | | Present in both the 'character' and 'objectives' sections through mention of students participating in society and understanding the causal relationship of human activity. |

Key:

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

*Presence of the DP's Learning Outcome Themes*

As can be seen from the table above, all learning outcome themes extracted from the DP are present in one or more areas of the KHSCG curriculum. Conceptual understanding is evident in statements such as 'understand the core concepts of physics quantitatively by exploring natural phenomena' in the objectives for Physics I, or 'understanding the concepts and inquiry methods' in the 'character' section of Physics II. Making connections between subjects, too, is present in statements such 'understand and apply…concepts of physics, focusing on…related subjects', and 'recognise the interrelationship between science, technology and society as a basis for knowledge as a democratic citizen'.

The use and application of methods, tools and techniques that characterise science is evident throughout all areas. For example, the 'character' section of Physics II evidences this in statements such as 'using in-depth physical concepts and various inquiry methods' and 'ability of scientific inquiry […] includes a scientific world view and view of nature, scientific knowledge and methods'. In the same section of Physics I, this is present in statements like 'ability to collect, interpret, and evaluate evidence through various methods such as experiments, investigations, and discussions' and 'ability to make reasonable and logical inferences based on […] scientific knowledge and methods'. Similar statements are dotted throughout the curriculum, illustrating that this theme is of great focus in the KHSCG curriculum.

Within the creativity and critical thinking theme, problem solving is referenced throughout the curriculum and is reflected in statements such as 'develop an attitude towards solving problems scientifically' and 'scientific problem-solving skills'. The creativity aspect is also prominent in the curriculum, in statements such as 'cultivate the scientific literacy of solving individual and social problems scientifically and creatively'.

The application of skills to carry out insightful and ethical investigations is also strongly evident throughout all areas of the curriculum. Statements such as 'collect, interpret, and evaluate evidence through various methods such as experiments, investigations, and discussions in order to solve scientific problems and obtain new scientific knowledge or construct meaning', 'scientific inquiry skills and knowledge, and scientific thinking' all demonstrate the prominence of this theme in the KHSCG curriculum.

Technology is another major focus throughout the KHSCG curriculum and is repeatedly referred to in all subjects, in statements such as 'recognise the interrelationship between science, technology and society' and 'understand and express scientific and technical information through various media such as computers and audio-visual equipment'.

Communication and collaboration, too, are repeatedly mentioned in both the character and the objectives sections of the Physics I and Physics II curriculum. Examples of instances where this is explicitly mentioned include: 'scientific communication ability, scientific participation', 'the ability to advocate one's own ideas, understand others' ideas, and adjust them in order to share and develop the process and results of solving scientific problems within the community'. Various means of communication are even explicitly mentioned: 'various forms of communication such as speech, words, pictures and symbols, the ability to understand and express scientific and technical information through various media'.

Finally, the awareness of local and global problems is also strongly evident throughout all areas of the curriculum and an understanding of the impact of science for society is clearly a priority concept for students to grasp. This is nicely illustrated by the following quotes: 'the ability to keep learning as a member of the community in order to act reasonably and responsibly, pay attention to social issues of science and technology, participate in the decision-making process, and adapt to new scientific and technological environments'; 'recognise the interrelationship between science, technology and society as a basis for knowledge as a democratic citizen'; and 'develop the ability to scientifically explore problems of nature and daily life'.

There are no main learning outcomes in the KHSCG curriculum that are not present in, or unrelated to, the DP themes.

*Summary*
There is a strong level of alignment between the learning outcomes of DP physics and those of KHSCG physics, with all themes extracted from the DP being strongly evidenced in the KSHCG. The South Korean physics curriculum aims to create well-rounded, curious students who have an appreciation for science as a whole and its place in the world. This aligns well with the DP's intentions of developing learners who are 'curious…and show enthusiasm about the world around them', as well as students who care for the environment and act to 'improve the lives of others'.

### 5.2.2 Content – Physics

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

*Figure 14: DP physics content visualiser*[109]

| | | | | | |
|---|---|---|---|---|---|
| **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 | | |

[109] '(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 15: KHSCG science/physics content visualiser*

| | | | | | |
|---|---|---|---|---|---|
| **Common Subject** | Integrated Science | Substance and regularity | Regularity and Combination of Substances | Components of Environment | |
| | | System and interaction | Dynamic systems | Earth systems | Life systems |
| | | Change and diversity | Chemical changes | Biodiversity and sustainability | |
| | | Environment and division energy | Ecosystem and environment | Development of renewable energy | |
| | Scientific Investigation | Scientific experiments in history | Nature of science | Research methods | |
| | | Scientific experiments in daily life | Approach to scientific experiments | Scientific inquiry process | |
| | | High-tech scientific experiments | Application of science | | |
| **General elective** | Physics I | Force and motion | Time, space, and motion | Force | Mechanical energy |
| | | Electricity and magnetism | Electricity | Magnetism | |
| | | Heat and energy | Conversion of energy | | |
| | | Waves | Properties of waves | | |
| | | Modern physics | Duality of light and matter | | |
| **Career - related elective** | Physics II | Force and motion | Time, space, and motion | Force | |
| | | Electricity and magnetism | Electricity | Magnetism | |
| | | Heat and energy | Energy conversion | | |
| | | Waves | Properties of waves | | |
| | | Modern physics | Duality of light and matter | Motion in microcosm | |

*Structure*

While the DP physics is taught over two years, the physics curriculum in the KHSCG is designed to be completed in three years. The high school national curriculum is referred to as 'electives-centred' and runs from the first grade to the third grade.[110] Science is a 'common subject' in the curriculum; thus, all students must take the common courses of 'Integrated Science' and 'Scientific Investigation'. The number of required science units is 12, with the common courses making up 10 of these units. Following the common courses, students are offered electives to choose from. The elective courses are divided into two categories: general electives (Physics I, Chemistry I, Biology I and Earth Science I) and career-related electives (Physics II, Chemistry II, Biology II, Earth Science II, Science and History, Life and Science, and Convergence Science). For reference, the KHSCG curriculum states that schools should 'guide all students to take more than three career-related elective courses',[111] and that they should organise a school curriculum 'appropriate for their circumstances and based on national guidelines'.[112]

As to the structure of the physics curriculum in particular, the DP splits it into five overarching themes; A. Space, time and motion; B. The particulate nature of matter; C. Wave behaviour; D. Fields; E. Nuclear and quantum physics – with each covering four to five topics. Similarly, each KHSCG physics elective splits into five overarching themes that have some visible parallels with the DP's subject: 'Force and motion', 'Electricity and magnetism', 'Heat and energy', 'Waves', 'Modern physics'. As can be seen in the figure above, each of these overarching themes covers between one and three topics.

*Content Alignment*

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

*Figure 16: Summary of the content alignment between the DP physics topics and the KHSCG*

| DP physics topics | SL presence in KHSCG | AHL presence in KHSCG |
|---|---|---|
| **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 | | |

[110] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools.* p.7
[111] Ibid. p.44
[112] Ibid. p.50

| | | |
|---|---|---|
| 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 | Within the 'Scientific Investigation' course | |

Key:

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

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

Unlike the DP, the KHSCG physics curriculum does not dedicate a section to setting out the mathematical requirements for the course, nor do the content descriptions frequently include the equations to be used. Therefore, the level and range of mathematics used in KHSCG physics is unclear. The absence of mathematics in the documentation may suggest that there is lesser emphasis on this than in the DP.

This being said, as can be observed in the figure above, there is some, though limited, alignment between the KHSCG physics and DP topic coverage. SL content is present in the KHSCG across all main topic areas, with alignment being particularly strong in topics A.2 Forces and momentum and C.2 Wave model. The inclusion in the KHSCG of the wave motion equation, as well as the nature of electromagnetic and mechanical waves, results in a strong level of alignment for sub-topic C.2 Wave model. Moreover, A.3 Work, energy and power shows some alignment, though this is only partial due to a greater depth of coverage of these sub-topics in the DP. Some of the SL content in topic E. Nuclear and quantum physics is also present in the KHSCG physics, though the vast majority of content within topic B. The particulate nature of matter is absent – the exception being B.5 Current and circuits, which is partially touched on.

There is some coverage of AHL content within the KHSCG curriculum, but this is limited – the few sub-topics that are included are not covered in the same depth. Sub-topic C.3 Wave phenomena shows partial alignment due to the mention of interference and diffraction, while sub-topic D.4 Induction is partially aligned through the mention of electromagnetic fields and flux – though the associated equations are missing. E.2 Quantum physics also shows some alignment as four of the DP understandings (photoelectric effect, diffraction of particles, wave-particle duality and Compton scattering) are covered. There is partial alignment with AHL content in sub-topic topics A.4 Rigid body mechanics, but no alignment in topic B. The particulate nature of matter which consists of only one sub-topic at AHL.

The experimental programme of the DP is partially covered within Physics I and Physics II through references to experimental research and project work. In addition to this, all students complete the 'Scientific Investigation' common course, within which students carry out an investigation from a topic of their choice; planning, obtaining and analysing results and then completing a small write-up of this. Therefore, the KHSCG's experimental programme is well aligned with that of the DP.

On the other hand, there are some topic areas in the KHSCG curriculum that cannot be found in the DP (see table below) such as atomic structure, diodes and capacitors. While atomic structure is covered extensively in DP chemistry, in the KHSCG it is also incorporated into the physics syllabus: 'using electric force that electrons are bound to atoms…Explain through spectral observation that electrons in atoms have discontinuous energy levels'.[113] Moreover, while coverage of diodes represents a fairly small portion of the curriculum, capacitors are mentioned multiple times in the KHSCG curriculum, constituting a notable difference.

*Table 13: KHSCG physics content which is not covered in the DP*

| Significant KHSCG curriculum content which is not included in DP physics* |
|---|
| • Atomic structure (covered in DP chemistry)<br>• Capacitors<br>• Diodes |

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

In addition to the above differences in topic coverage, the KHSCG also features a predominant focus on the importance of physics in 'everyday life' or 'real life' – an aspect that is not as prominent in the DP. For example, one of the learning outcomes in Physics I is to: 'understand the relationship between impulse and momentum and find and explain examples of reducing its impact in daily life',[114] and the curriculum features repeated references to problem solving in everyday life.

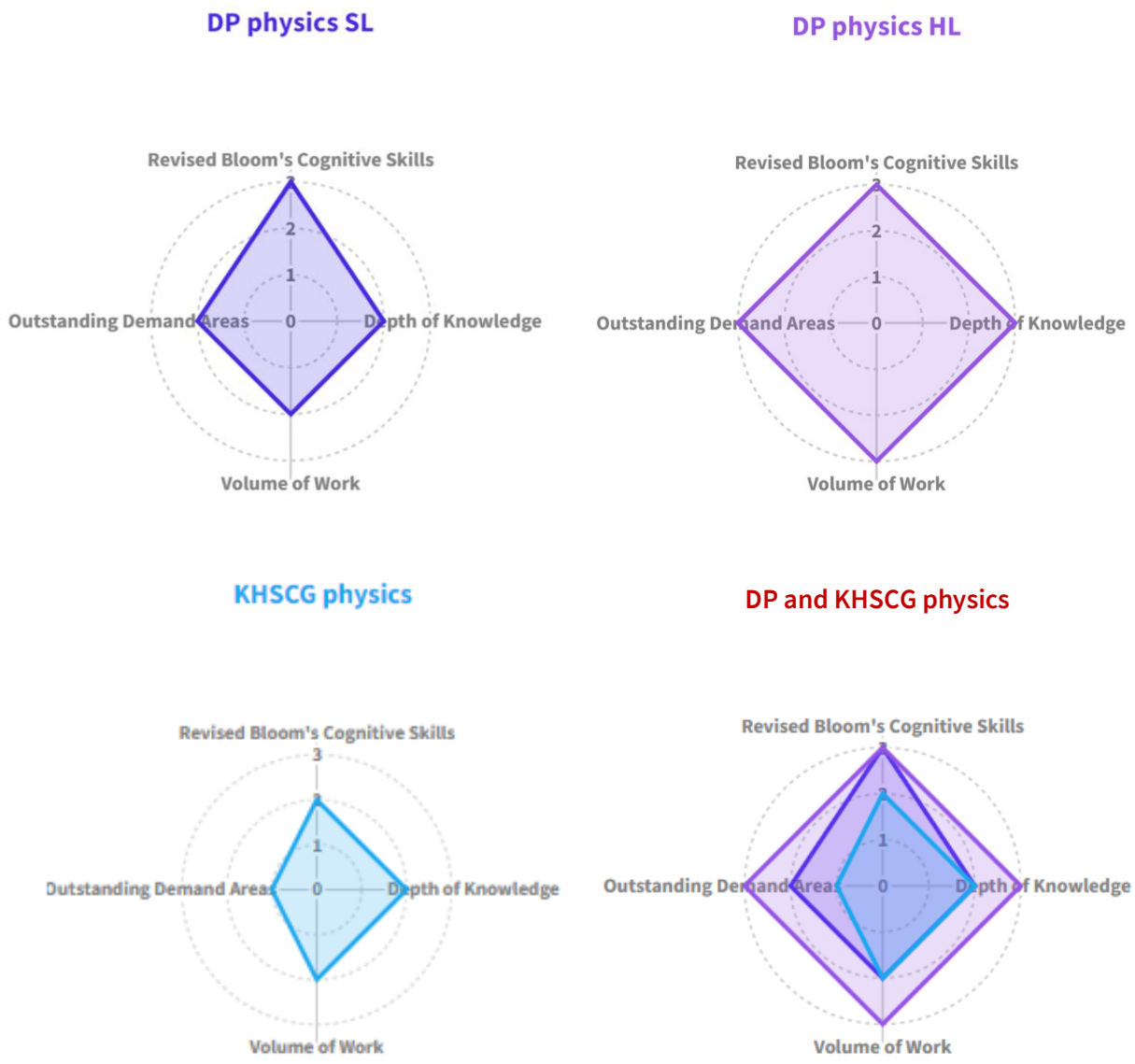
Overall, given the above-mentioned differences in the focus and topic coverage and depth of the KHSCG physics curriculum and those of the DP physics, both at SL and HL, there is a low level of alignment between the two comparison subjects.

### 5.2.3 Demand – Physics

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

[113] MOE, Republic of Korea. (2015). *Science Curriculum. Physics I.*
[114] Ibid.

*Figure 17: 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.
  - A score of 2 was given to the KHSCG physics curriculum due to the presence of higher order thinking skills in the learning outcomes, such as 'problem solve,

analyse and develop original ideas'. However, the focus is not predominantly on these aspects, hence the judgement of 2.

- Regarding the score for **Depth of Knowledge**:
  - DP physics SL was deemed to merit a score of 2 due to the mathematical pre-requisite skills and competences required to access the course, as well as the moderate to high level of cognitive complexity of the knowledge that students are expected to acquire. As to the HL course, the greater depth and additional opportunities provided for extended thinking in the additional higher level option topics pushed the score to a 3.
  - The KHSCG physics' received a score of 2 due to the strong emphasis on inquiry, and the linking across multiple topics and subjects. The threshold for a score of 3 was judged not to be met as the inquiry and linking processes do not appear to be complexly drawn out over a long period of time.

- 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.
  - A score of 2 was given to KHSCG physics as the amount of content covered and time allocation per theme are relatively standard, and most themes are covered in considerable detail, going beyond basic conceptual depth.

- 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.
  - No specific subject content areas within KHSCG physics were regarded as outstanding in terms of demand. However, the consistent theme of scientific inquiry and the linking of multiple concepts provides significant opportunity for stretching students' understanding in general across the physics curriculum, hence the score of 1.

## 5.3 Chemistry

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

**DP chemistry**[115]
Chemistry is a subject option offered within the DP sciences subject group, at both SL and HL. This subject has content that is common to both SL and HL, as well as AHL content that is featured only in the HL. Thus, the HL has greater breadth and depth than SL. This subject is designed to prepare students for university courses such as medicine, biological science and environmental science. HL is suitable for those intending to pursue further study in an area requiring a strong background in chemistry.

**KHSCG Integrated Science**[116]
Integrated Science is taken by all students in the KHSCG and has, therefore, been considered in this report as complementary to other science subjects. It has a strong emphasis on scientific inquiry and problem-solving skills through the study of various aspects of physics, chemistry and biology. Earth and space, the characteristics of matter, life and the environment make up some of the topics within the curriculum. Integrated Science also contains a lot of investigation and experiments through which students can gather results and apply their understanding. Collecting data, analysing and evaluating this data and then communicating it to others is a large part of this subject.

**KHSCG Scientific Investigation**[117]
As well as Integrated Science, students in the first year of high school will also take the common course of Scientific Investigation. This subject looks at past experiments and discoveries, research methods and ethics, and the process of scientific inquiry. Students' interest and curiosity will be developed as they learn how science is linked to sport, art and culture, technology, and the development of products. During this subject, students will plan and conduct their own scientific inquiries, inspired by problems that they themselves have discovered.

**KHSCG chemistry**[118]
The chemistry subject consists of Chemistry I and Chemistry II and aims to provide essential understanding of chemical reactions, particles and the usefulness of chemistry in the real world. Chemistry I provides a foundation level of understanding as to how chemistry can be applied to the 21st century; providing students with the ability to research, think, and solve problems scientifically. Logical reasoning and using evidence to formulate an argument are strong themes within Chemistry I so that students become better communicators and lifelong learners. Chemistry II contains more content and goes to a slightly deeper level, but still emphasises the importance of using investigative skills and evidence to solve scientific problems.

[115] International Baccalaureate. (2023). *Chemistry guide*.
[116] MOE, Republic of Korea. (2015). *Science Curriculum*
[117] Ibid.
[118] Ibid.

### 5.3.1 Learning Outcomes – Chemistry

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

The learning outcome themes for chemistry were extracted from the aims and assessment objectives of the DP sciences subject group, hence the themes are the same for chemistry, physics and biology. For the purposes of mapping and comparisons with the DP, the learning outcomes for KHSCG chemistry were extracted from the 'character' and 'objectives' sections of the Chemistry I and Chemistry II subjects.

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 KHSCG chemistry curricula.

*Table 14: Presence of the DP sciences subject group learning outcome themes in the KHSCG chemistry curricula*

| Themes extracted from the learning outcomes of the DP sciences subject group | Presence in the KHSCG | |
|---|---|---|
| 1. Conceptual understanding and making connections | | Present in both the 'character' and 'objectives' sections. The KHSCG discusses the links between multiple aspects of its curriculum and how the contents of chemistry have close connections with other subjects. |
| 2. Use and application of knowledge, methods, tools, and techniques that characterize science | | Present in both the 'character' section. Students are expected to understand that scientific knowledge is based on logical reasoning and discovery through observation and exploration. |
| 3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis) | | Present in both the 'objectives' and 'character' sections. There is reference throughout these to problem solving and critical consideration. |
| 4. Skills for scientific inquiry | | Present in both the 'character' and 'objectives' sections which discuss the collection of data, research activities and selecting and organising data. |
| 5. Development of technological skills | | Present in both the 'character' and 'objectives' sections. Computers, the use of various media and information technology is referred to throughout the KHSCG curriculum. |
| 6. Effective collaboration and communication | | Present in both the 'character' and 'objectives' sections through mention of students' ability to advocate their own ideas, understand others and use various forms of communication to express scientific information. |
| 7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science | | Present in both the 'character' and 'objectives' sections. The KHSCG encourages students to become lifelong learners and pay attention to social issues of science and technology. |

Key:

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

*Presence of the DP's Learning Outcome Themes*

As can be seen from the table above, all learning outcome themes extracted from the DP are present in one or more areas of the KHSCG curriculum. Conceptual understanding is evident in statements such as 'understand the core concepts of chemistry by exploring natural phenomena in daily life' in the objectives for Chemistry I, or 'enjoying learning advanced chemistry concepts and inquiry methods' in the 'character' section of Chemistry II. Making connections between subjects, too, is present in statements such as 'recognise the interrelationship between science, technology and society as a basis for knowledge as a democratic citizen' and the fact that the content composition of 'Chemistry II' is closely related to the chemistry concepts contained in 'Integrated Science', 'Scientific Investigation' and 'Chemistry I', implying linkages within the sciences and chemistry subjects.

The use and application of methods, tools and techniques that characterise science is evident throughout all areas, in statements such as 'ability to collect, interpret, and evaluate evidence through various methods', 'enjoying learning advanced chemistry concepts and inquiry methods' and 'ability of scientific inquiry…includes a scientific world view and view of nature, scientific knowledge and methods' in the 'character' section of Chemistry II, or 'enjoying learning chemistry concepts and exploring methods through natural phenomena or situations related to daily experience' in the 'character' section of Chemistry I. Similar statements are dotted throughout the curriculum, illustrating that this theme is of great focus in the KHSCG curriculum.

Within the creativity and critical thinking theme, problem solving is referenced throughout the curriculum and is reflected in statements such as 'cultivate science and core abilities such as…scientific problem-solving ability', 'use scientific knowledge and scientific thinking to solve personal or public problems' and 'solve scientific problems and obtain new scientific knowledge or construct meaning'. The 'creativity' aspect is also prominent in the curriculum, in statements such as 'cultivate the scientific literacy of solving individual and social problems scientifically and creatively'.

The application of skills to carry out insightful and ethical investigations is also strongly evident throughout all areas of the curriculum. Statements such as 'collect, interpret, and evaluate evidence through various methods such as experiments, investigations, and discussions in order to solve scientific problems and obtain new scientific knowledge or construct meaning', 'scientific inquiry skills and knowledge, and scientific thinking' all demonstrate the prominence of this theme in the KHSCG curriculum.

Technology is another major focus throughout the KHSCG curriculum and is repeatedly referred to in all subjects, in statements such as 'recognise the interrelationship between science, technology and society'; 'understand and express scientific and technical information through various media such as computers and audio-visual equipment'.

Communication and collaboration, too, are repeatedly mentioned in both the character and the objectives sections of the Chemistry I and Chemistry II curriculum. Examples of instances where this is explicitly mentioned include: 'scientific communication ability, scientific participation', 'the ability to collect, interpret, and evaluate evidence through…discussions' and 'the ability to advocate one's own ideas, understand others' ideas, and adjust them in order to share and develop the process and results of solving scientific problems within the

community'. Several means of communication are even explicitly mentioned: 'various forms of communication such as speech, words, pictures and symbols, the ability to understand and express scientific and technical information through various media'.

Finally, the awareness of local and global problems is also strongly evident throughout all areas of the curriculum and an understanding of the impact of science for society is clearly a priority concept for students to grasp. This is nicely illustrated by the following quotes: 'the ability to keep learning as a member of the community in order to act reasonably and responsibly, pay attention to social issues of science and technology, participate in the decision-making process, and adapt to new scientific and technological environments'; 'recognise the interrelationship between science, technology and society as a basis for knowledge as a democratic citizen', and 'explore the role of chemistry in contributing to future society'.

*Other Themes in the KHSCG*

There are no main learning outcomes in the KHSCG curriculum that are not present or related to the DP themes.

*Summary*

There is a strong level of alignment between the learning outcomes of the DP chemistry and those of KHSCG chemistry, with all themes extracted from the DP being strongly evidenced in the KSHCG. The Korean chemistry curriculum aims to create well-rounded, curious students who have an appreciation for science as a whole and its place in the world. This aligns well with the DP's intentions of developing learners who are 'curious…and show enthusiasm about the world around them',[119] as well as students who care for the environment and act to 'improve the lives of others'.[120]

### 5.3.2 Content – Chemistry

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

[119] International Baccalaureate. (2023). *Chemistry guide*. p. 12
[120] International Baccalaureate. (2023). *Chemistry guide*. p. 13

*Figure 18: DP chemistry content visualiser*[121]

| | | | | | | |
|---|---|---|---|---|---|---|
| **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 | | | |

[121] '(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 19: KHSCG science/chemistry content visualiser*

| | | | | | |
|---|---|---|---|---|---|
| **Common Subject** | Integrated Science | Substance and regularity | Regularity and Combination of Substances | Components of Environment | |
| | | System and interaction | Dynamic systems | Earth systems | Life systems |
| | | Change and diversity | Chemical changes | Biodiversity and sustainability | |
| | | Environment and division energy | Ecosystem and environment | Development of renewable energy | |
| | Scientific Investigation | Scientific experiments in history | Nature of science | Research methods | |
| | | Scientific experiments in daily life | Approach to scientific experiments | Scientific inquiry process | |
| | | High-tech scientific experiments | Application of science | | |
| **General elective** | Chemistry I | Structure of matter | Components of matter | Chemical combinations | |
| | | Change of matter | Chemical reactions | Energy inflows and outflows | |
| **Career - related elective** | Chemistry II | Properties of matter | States of matter | | |
| | | Change of matter | Chemical reactions | Energy inflows and outflows | |

*Structure*

While DP chemistry is taught over two years, the chemistry curriculum in the KHSCG is designed to be completed in three years. The KHSCH curriculum is referred to as 'electives-centred' and runs from the first grade to the third grade.[122] Science is a 'common subject' in the curriculum; hence all students must take the common courses of 'Integrated Science' and 'Scientific Investigation'. The number of required science units is 12, with the common courses making up 10 of these units. Following the common courses, students are offered electives to choose from. The elective courses are divided into two categories: general electives (Physics I, Chemistry I, Biology I and Earth Science I) and career-related electives (Physics II, Chemistry II, Biology II, Earth Science II, Science and History, Life and Science, and Convergence Science). For reference, the KHSCG curriculum states that schools should 'guide all students to take more than three career-related elective courses',[123] and that they should organise a school curriculum 'appropriate for their circumstances and based on national guidelines'.[124]

As to the structure of the chemistry curriculum in particular, the DP splits it into two over-arching themes of 'Structure' and 'Reactivity', each covering three large topics. Similarly, the KHSCG splits the curricula of its chemistry electives, Chemistry I and Chemistry II, into two large overarching themes that have clear parallels with those of the DP – 'Structure of matter' and 'Change of matter' (another term for reactivity) for Chemistry I; and 'Properties of matter' and 'Change of matter' for Chemistry II. As can be seen in the figure above, each of these overarching themes covers between one and two large topics.

*Content Alignment*

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

*Figure 20: Summary of content alignment between the DP chemistry topics and the KHSCG chemistry*

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

[122] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools.* p. 7
[123] Ibid. p. 44
[124] Ibid. p. 50

| | | |
|---|---|---|
| 1.3 Energy from fuels | | N/A |
| 1.4 Entropy and spontaneity | N/A | |
| **Reactivity 2. How much, how far and how fast?** | | |
| 2.1 How much? The amount of chemical change | | N/A |
| 2.2 How fast? The rate of chemical change | | |
| 2.3 How far? The extent of chemical change | | |
| **Reactivity 3. What are the mechanisms of chemical change?** | | |
| 3.1 Proton transfer reactions | | |
| 3.2 Electron transfer reactions | | |
| 3.3 Electron sharing reactions | | N/A |
| 3.4 Electron-pair reactions | | |
| Experimental programme | Within the 'Scientific Investigation' course | |

Key:

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

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

The topic coverage of the KHSCG curriculum is strongly aligned with that of the DP chemistry, with only two of the DP's topics not being present in the KHSCG curriculum. These are Structure 3.2 – Functional groups: Classification of organic compounds and 3.4 – Electron-pair reactions. All other topics are covered to some extent by the KHSCG chemistry curriculum, mostly showing high levels of alignment, particularly with SL topics. Regarding AHL content, there are a number of areas – such as the nuclear atom, classification of elements in the periodic table, energy cycles in reactions, and proton transfers – that are covered to similar depth. However, some areas are covered only partially – such as electron configurations, the covalent model, entropy and spontaneity, and electron transfer reactions – while some are completely absent, such as classification of organic compounds and the metallic model. Thus, KHSCG surpasses the content of SL with regard to depth, though not HL. The experimental programme of the DP is partially covered within Chemistry I and Chemistry II, through references to experimental research and project work, and further alignment is found in the 'Scientific Investigation' common course. Within this, students carry out an investigation from a topic of their choice; planning, obtaining and analysing results and then completing a small write-up of this. Therefore, the DP's experimental programme is fully aligned with the KHSCG.

Notably, the KHSCG curriculum also covers some areas and concepts which are absent from the DP curriculum. The properties of water, for instance, is present in KHSCG chemistry but the DP covers this in its biology curriculum. The KHSCG also contains the concepts of half-life and first order reactions which are not found in the DP chemistry. The KHSCG chemistry also differs from the DP in that it features an underlying theme of the importance of chemistry for everyday life – while links to the real world are made in the DP curriculum, the 'everyday life' aspect is much more prominent on the KHSCG, where these links are deeply embedded in numerous content areas. For example, Chemistry I covers cases where chemistry has contributed to solving food problems, clothing problems, and housing problems – an approach that is not found in the DP.

*Table 15: KHSCG chemistry content which is not covered in the DP*

| Significant KHSCG content which is not included in DP chemistry* |
|---|
| • The properties of water & its importance in everyday life<br>• General theme of 'real life' importance: e.g. importance of buffers in vivo, fermentation in real life, examples of catalysts in life/industry, altering freezing/boiling points<br>• Half-life and first order reactions |

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

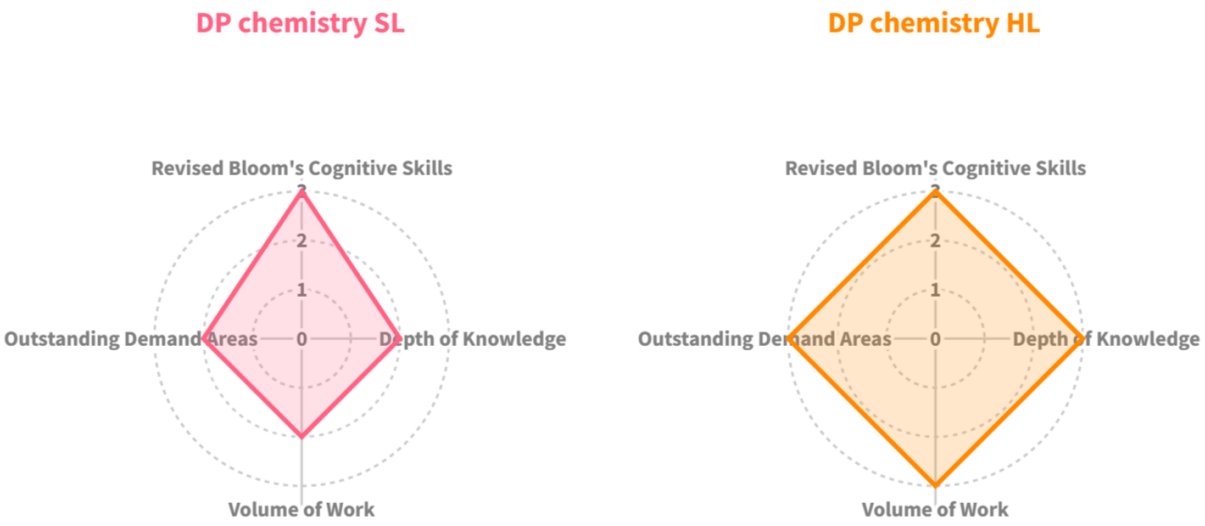
*Summary*

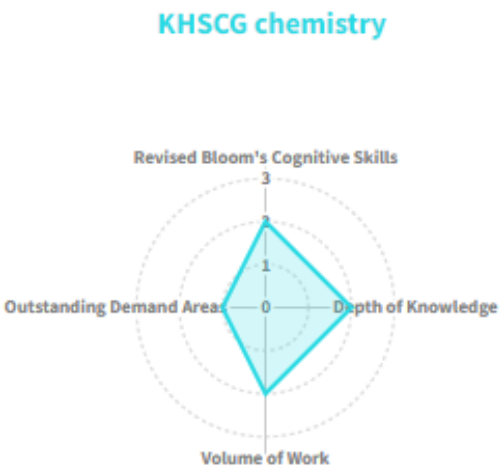
In general, the KHSCG chemistry curriculum is highly aligned with the DP, with very few topic areas in one that are not covered by the other. The KHSCG curriculum has a more limited coverage of the mechanisms of chemical change, lacking content on electron transfer and electron-pairing reactions, and classification of organic compounds. Instead, it features coverage of the properties of water, half-life and first order reactions, and an overall emphasis on the importance of chemistry in everyday life, which make up a smaller focus in the DP. Overall, the focus, breadth and depth of the curricula are similar, though the KHSCG is somewhat surpassed in content size by DP HL.

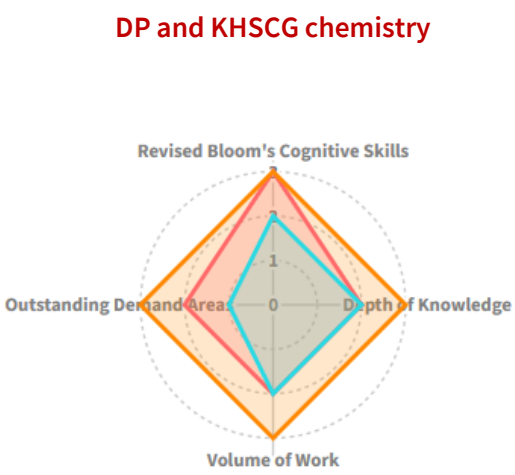
### 5.3.3 Demand – Chemistry

The DP and KHSCG curricula were analysed using the same demand tool in order to create a demand profile for DP chemistry SL, DP chemistry HL, and KHSCG 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 21: Visual representations of subject demand*






- 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.
  - The score of 2 was given to the KHSCG chemistry curriculum due to the presence of higher order thinking skills in the learning outcomes, such as 'problem solve, analyse and develop original ideas'. However, the focus is not predominantly on these aspects, hence the judgement of 2.

- Regarding the score for **Depth of Knowledge**:
  - DP chemistry SL was deemed to merit a score of 2 due to the mathematical pre-requisite skills and competences required to access the course, as well as the moderate to high level of cognitive complexity of the knowledge that students are expected to acquire. As to the HL course, the greater depth and additional opportunities provided for extended thinking in the additional higher level option topics pushed the score to a 3.
  - The KHSCG chemistry received a score of 2 due to the strong emphasis on inquiry, and the linking across multiple topics and subjects. The threshold for a score of 3 was judged not to be met as the inquiry and linking processes do not appear to be complexly drawn out over a long period of time.

- 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.

  - A score of 2 was given to KHSCG chemistry as the amount of content covered and time allocation per theme are relatively standard, and most themes are covered in considerable detail, going beyond basic conceptual depth.

- 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.
  - No specific subject content areas within KHSCG chemistry were regarded as outstanding in terms of demand. However, the consistent theme of scientific inquiry and the linking of multiple concepts provides significant opportunity for stretching students' understanding, hence the score of 1.

## 5.4 Biology

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

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

**KHSCG Integrated Science**[126]
Integrated Science is taken by all students in the KHSCG, and has, therefore, been considered in this report as complementary to other science subjects. It has a strong emphasis on scientific inquiry and problem-solving skills through the study of various aspects of physics, chemistry and biology. Earth and space, the characteristics of matter, life and the environment make up some of the topics within the curriculum. Integrated Science also contains a lot of investigation and experiments through which students can gather results and apply their understanding. Collecting data, analysing and evaluating this data and then communicating it to others is a large part of this subject.

**KHSCG Scientific Investigation**[127]
As well as Integrated Science, students in the first year of high school will also take the common course of Scientific Investigation. This subject looks at past experiments and discoveries, research methods and ethics, and the process of scientific inquiry. Students' interest and curiosity will be developed as they learn how science is linked to sport, art and culture, technology, and the development of products. During this subject, students will plan and conduct their own scientific inquiries, inspired by problems that they themselves have discovered.

**KHSCG biology**[128]
The biology subject consists of Biology I and Biology II and aims to provide essential understanding of what life is, the human body and diversity within ecosystems. It provides students with the ability to research, think and solve problems scientifically. Logical reasoning and using evidence to formulate an argument are strong themes within Biology I so that students become better communicators and lifelong learners. Biology II contains more content and goes to a slightly deeper level, but still emphasises the importance of using investigative skills and evidence to solve scientific problems.

### 5.4.1 Learning Outcomes – Biology

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

[125] International Baccalaureate. (2023). *Biology guide*.
[126] MOE, Republic of Korea. (2015). *Science Curriculum.*
[127] Ibid.
[128] Ibid.

The learning outcome themes for biology were extracted from the aims and assessment objectives of the DP sciences subject group, hence the themes are the same for biology, chemistry and physics. For the purposes of mapping and comparisons with the DP, the learning outcomes for KHSCG biology were extracted from the 'character' and 'objectives' sections of the Biology I and Biology II subjects.

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 KHSCG biology curricula.

*Table 16: Presence of the DP sciences subject group learning outcome themes in the KHSCG biology curricula*

| Themes extracted from the learning outcomes of the DP sciences subject group | Presence in the KHSCG | |
|---|---|---|
| 1. Conceptual understanding and making connections | | Present in both the 'character' and 'objectives' sections. KHSCG discusses the links between multiple aspects of its curriculum and mentions the comprehensive nature of biology around the world. |
| 2. Use and application of knowledge, methods, tools, and techniques that characterize science | | Present in both the 'character' section. Students are expected to understand that scientific knowledge is based on logical reasoning and discovery through observation and exploration. |
| 3. Creativity and critical thinking (problem-solving, analysis, evaluation, synthesis) | | Present in both the 'objectives' and 'character' sections. There is reference throughout these sections to problem solving and critical consideration. |
| 4. Skills for scientific inquiry | | Present in both the 'character' and 'objectives' sections which discuss the collection of data, research activities and selecting and organising data. |
| 5. Development of technological skills | | Present in both the 'character' and 'objectives' sections. Computers, the use of various media and information technology is referred to throughout the KHSCG outcomes. |
| 6. Effective collaboration and communication | | Present in both the 'character' and 'objectives' sections through the mention of students' ability to advocate their own ideas, understand others and use various forms of communication to express scientific information. |
| 7. Awareness of global and local problems and the environmental, ethical, cultural, and social impact of science | | Present in both the 'character' and 'objectives' sections. The KHSCG encourage students to become lifelong learners and pay attention to social issues of science and technology. |

Key:

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

*Presence of the DP's Learning Outcome Themes*

As can be seen from the table above, all learning outcome themes extracted from the DP are present in one or more areas of the KHSCG curriculum. Conceptual understanding is evident in statements such as 'explore life phenomena and understand the core concepts of biology' in the objectives for Biology I and Biology II, or 'thinking and using scientific facts, principles, concepts' in the character section of Biology II. Making connections between subjects, too, is present in statements such as 'recognise the mutual relationship between biology, technology and society, and develop knowledge as a democratic citizen based on this' and the fact that the 'content composition of 'Biology II' is closely related to the concepts of biology contained in 'Integrated Science', 'Scientific Investigation and 'Biology I', implying linkages within the sciences and biology subjects.

The use and application of methods, tools and techniques that characterise science is evident throughout all areas, in statements such as 'ability to collect, interpret, and evaluate evidence through various methods', 'scientific world view and view of nature, scientific knowledge and methods, the ability to make reasonable and logical inferences based on scientific evidence and theories', 'enjoy learning scientific knowledge and inquiry methods', and 'evaluate evidence through various methods'. Similar statements are dotted throughout the curriculum, illustrating that this theme is of great focus in the KHSCG curriculum.

Within the creativity and critical thinking theme, problem solving is referenced throughout the curriculum and is reflected in statements such as 'learning centred on multiple inquiries are used to cultivate scientific thinking ability, scientific inquiry ability, scientific problem solving ability', or 'solve scientific problems and obtain new scientific knowledge or construct meaning'. The 'creativity' aspect is also prominent in the curriculum, in statements such as 'understanding life phenomena…so as to creatively solve various problems in life', and 'solving individual and social problems scientifically and creatively'.

The application of skills to carry out insightful and ethical investigations is also strongly evident throughout all areas of the curriculum. Statements such as 'collect, interpret, and evaluate evidence through various methods such as experiments, investigations, and discussions in order to solve scientific problems and obtain new scientific knowledge or construct meaning', 'scientific inquiry skills and knowledge, and scientific thinking' all demonstrate the prominence of this theme in the KHSCG curriculum.

Technology is another major focus throughout the KHSCG curriculum and is repeatedly referred to in all subjects, in statements such as 'recognise the mutual relationship between biology, technology and society'; 'understand and express scientific and technical information through various media such as computers and audio-visual equipment'.

Communication and collaboration, too, are repeatedly mentioned in both the character and the objectives sections of the Biology I and Biology II curriculum. Examples of instances where this is explicitly mentioned include: 'scientific communication ability, scientific participation', 'the ability to collect, interpret, and evaluate evidence through…discussions' and 'the ability to advocate one's own ideas, understand others' ideas, and adjust them in order to share and develop the process and results of solving scientific problems within the community'. Various means of communication are even explicitly mentioned: 'various forms of communication such

as speech, words, pictures and symbols, the ability to understand and express scientific and technical information through various media'.

Finally, the awareness of local and global problems is also strongly evident throughout all areas of the curriculum and an understanding of the impact of science for society is clearly a priority concept for students to grasp. This is nicely illustrated by the following quotes: 'the ability to keep learning as a member of the community in order to act reasonably and responsibly, pay attention to social issues of science and technology, participate in the decision-making process, and adapt to new scientific and technological environments'; 'recognise the mutual relationship between biology, technology and society, and develop knowledge as a democratic citizen'.

*Other Themes in the KHSCG*

There are no main learning outcomes in the KHSCG curriculum that are not present or related to the DP themes.

*Summary*

There is a strong level of alignment between the learning outcomes of the DP biology and those of KHSCG biology, with all themes extracted from the DP being strongly evidenced in the KSHCG. The Korean biology curriculum aims to create well-rounded, curious students who have an appreciation for science as a whole and its place in the world. This aligns well with the DP's intentions of developing learners who are 'curious…and show enthusiasm about the world around them',[129] as well as students who care for the environment and act to 'improve the lives of others'.[130]

### 5.4.2 Content – Biology

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

[129] International Baccalaureate. (2023). *Biology guide*. p. 12
[130] International Baccalaureate. (2023). *Biology guide*. p. 13

*Figure 22: DP biology content visualiser*[131]

| | | | | |
|---|---|---|---|---|
| **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 | |

[131] '(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 23: South Korea science/biology content visualiser*

| | | | | | |
|---|---|---|---|---|---|
| **Common Subject** | Integrated Science | Substance and regularity | Regularity and Combination of Substances | Components of Environment | |
| | | System and interaction | Dynamic systems | Earth systems | Life systems |
| | | Change and diversity | Chemical changes | Biodiversity and sustainability | |
| | | Environment and division energy | Ecosystem and environment | Development of renewable energy | |
| | Scientific Investigation | Scientific experiments in history | Nature of science | Research methods | |
| | | Scientific experiments in daily life | Approach to scientific experiments | Scientific inquiry process | |
| | | High-tech scientific experiments | Application of science | | |
| **General electives** | Biology I | Biology and human life | Characteristics and the development process of biology | | |
| | | Structure and energy of living organisms | Structure and function of animals | | |
| | | Homeostasis and bodily control | Stimulation and reaction | Defense mechanisms | |
| | | Genetic inheritance | Reproduction | Heredity | Evolution and diversity |
| | | Environment and ecosystems | Ecosystem and interactions | | |
| **Career-related electives** | Biology II | Biology and human life | Characteristics and the development process of biology | Biotechnology | |
| | | Structure and energy of living organisms | Chemical basis of life | Units of life | Photosynthesis and respiration |
| | | Genetic inheritance | Reproduction | Heredity | Evolution and diversity |

*Structure*

While the DP biology is taught over two years, the biology curriculum in the KHSCG is designed to be completed in three years. The high school national curriculum is referred to as 'electives-centred' and runs from the first grade to the third grade.[132] Science is a 'common subject' in the curriculum; hence all students must take the common courses of 'Integrated Science' and 'Scientific Investigation. The number of required science units is 12, with the common courses making up 10 of these units. Following the common courses, students are offered electives to choose from. The elective courses are divided into two categories: general electives (Physics I, Chemistry I, Biology I and Earth Science I) and career-related electives (Physics II, Chemistry II, Biology II, Earth Science II, Science and History, Life and Science, and Convergence Science). For reference, The KHSCG curriculum states that schools should 'guide all students to take more than three career-related elective courses',[133] and that they should organise a school curriculum 'appropriate for their circumstances and based on national guidelines'.[134]

As to the structure of the biology curriculum in particular, the DP splits it into four over-arching themes – i.e. A. Unity and diversity; B. Form and function; C. Interaction and independence; D. Continuity and change – with each covering four large topics, namely 1. Molecules, 2. Cells, 3. Organisms and 4. Ecosystems. Somewhat differently, the KHSCG splits the curricula of its biology electives, Biology I and Biology II into five and three overarching themes, respectively. These include 'Biology and human life', 'Structure and energy of living organisms', 'Genetic inheritance' for both subjects, and the additional 'Homeostasis and bodily control' and 'Environment and ecosystems' for Biology I. As can be seen in the figure above, each of these overarching themes covers between one and three large topics.

*Content Alignment*

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

*Figure 24: Summary of content alignment between the DP biology topics and KHSCG biology*

| DP biology topics | SL presence in KHSCG | AHL presence in KHSCG |
|---|---|---|
| **A. Unity and diversity** | | |
| 1 Molecules | | |
| 2 Cells | | |
| 3 Organisms | | |
| 4 Ecosystems | | |
| **B. Form and function** | | |
| 1 Molecules | | |
| 2 Cells | | |
| 3 Organisms | | |
| 4 Ecosystems | | N/A |
| **C. Interaction and independence** | | |
| 1 Molecules | | |
| 2 Cells | | |
| 3 Organisms | | |
| 4 Ecosystems | | N/A |

[132] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools.* p.7
[133] Ibid. p.44.
[134] Ibid. p.50.

| D. Continuity and change | | |
|---|---|---|
| 1 Molecules | | |
| 2 Cells | | |
| 3 Organisms | | |
| 4 Ecosystems | | |
| Experimental programme | Within the 'Scientific Investigation' course | |

Key:

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

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

As shown in the figure above, the topic coverage in the KHSCG curriculum is similar to that of the DP biology. Most SL content is covered at least partially, with the exception of topics B3.2 Gas exchange and B3.2 Transport, and most content from B4.1 Adaptation to environment and B4.2 Ecological niches. Otherwise, the remaining topic areas within B. Form and function are covered in similar depth as the DP SL. The KHSCG aligns particularly strongly with the SL content in C. Interaction and independence and A. Unity and diversity.

Alignment with the DP is slightly lower for AHL content, however; the breadth of AHL content covered is similar, but there are only partial alignments with most sub-topics. While there is strong alignment with B1 Molecules and C1 Molecules, the remaining AHL content is not covered by the KHSCG in comparable depth, with two topics completely absent from the KHSCG curriculum. The experimental programme of the DP is partially covered within Biology I and Biology II through references to experimental research and project work. In addition to this, all students complete the 'Scientific Investigation' common course which involves students carrying out an investigation from a topic of their choice; planning, obtaining and analysing results and then completing a small write-up of this. Therefore, the DP's experimental programme is fully aligned with the KHSCG.

Notably, the KHSCG also devotes attention to some topics and areas which are absent or receive limited attention in the DP (see table below). These include: biotechnology and its application to medical and food industries; recombinant DNA technology, nuclear replacement and cell fusion; the use of stem cells, monoclonal antibodies and gene therapy; ecological, ethical, legal and social issues with biotechnology; and an overall emphasis on the importance of biology in 'everyday life' or 'real life'. For instance, KHSCG Biology I covers the investigation of 'the positive and negative effects of living modified organisms on human life and ecosystems', a topic that does not receive the same level of attention in the DP.

*Table 17: KHSCG biology content which is not covered in the DP*

| Significant KHSCG content which is not included in DP biology* |
|---|
| • Biotechnology and its importance in the medical and food industries<br>• Recombinant DNA technology, nuclear replacement and cell fusion<br>• Use of stem cells and gene therapy<br>• Ecological, ethical, legal and social issues with biotechnology<br>• Learning from science throughout history<br>• Integration of science in everyday life through decisions regarding food, make-up, architecture, transport and sports |

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

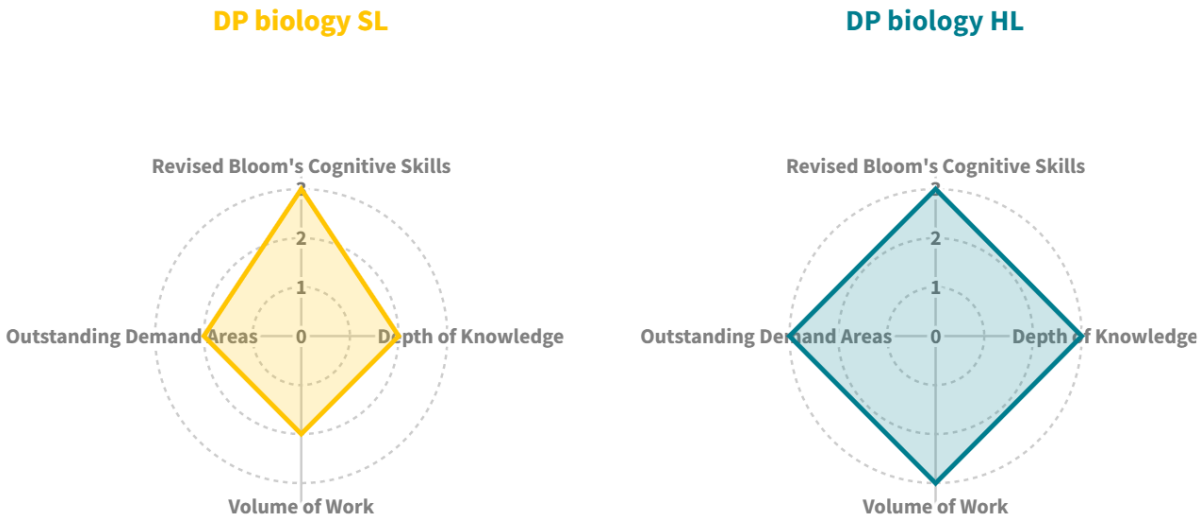
*Summary*

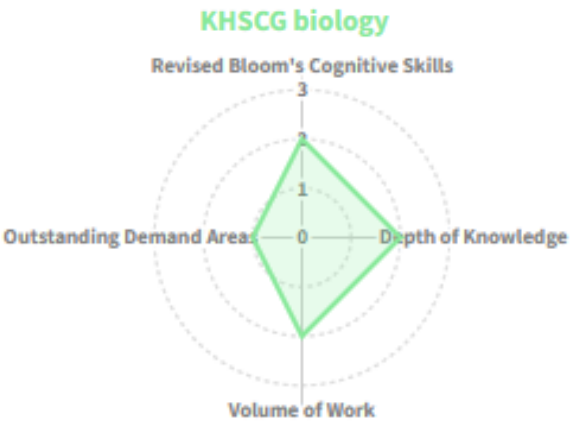
Overall, there is moderate to high alignment between KHSCG and DP biology, with higher alignment with SL topics and lower alignment with AHL topics. While there is a significant proportion of shared topic coverage between the KHSCG biology and SL, the breadth and depth of the HL coverage exceeds that of the Korean curriculum in a number of areas. Conversely, there are also some areas which receive exclusive or greater attention in the KHSCG, such as coverage of recombinant DNA technology, nuclear replacement and cell fusion and the general focus on ecological, ethical, legal and social issues of biotechnology, further reducing the level of alignment between the two curricula.

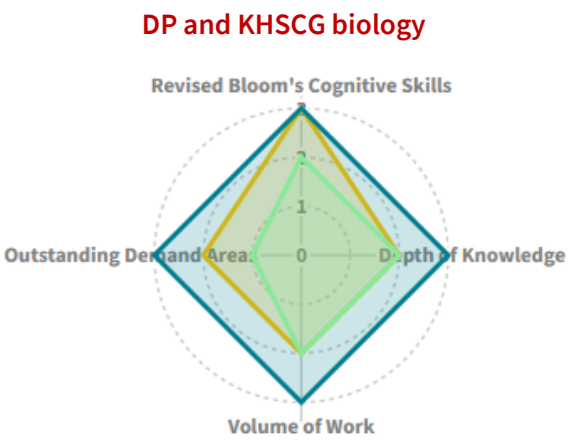
### 5.4.3 Demand – Biology

The DP and KHSCG curricula were analysed using the same demand tool in order to create a demand profile for DP biology SL, DP biology HL, and KHSCG 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 25: 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.
  - The score of 2 was given to the KHSCG biology curriculum due to the presence of higher order thinking skills in the learning outcomes, such as 'problem solve, analyse and develop original ideas'. However, the focus is not predominantly on these aspects, hence the judgement of 2.

- Regarding the score for **Depth of Knowledge**:
  - DP biology SL was deemed to merit a score of 2 due to the pre-requisite skills and competences (e.g. interpretation of graphs data, mathematics skills, some chemistry and geography links) required to access the course, as well as the moderate to high level of cognitive complexity of the knowledge that students are expected to acquire. As to the HL course, the greater depth and additional opportunities provided for extended thinking in the additional higher level option topics pushed the score to a 3.
  - The KHSCG biology's received a score of 2 due to the strong emphasis on inquiry, and the linking across multiple topics and subjects. The threshold for a score of 3 was judged not to be met as the inquiry and linking processes do not appear to be complexly drawn out over a long period of time.

- 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.

  - A score of 2 was given to KHSCG biology as the amount of content covered and time allocation per theme are relatively standard, and most themes are covered in considerable detail, going beyond basic conceptual depth.

- 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.
  - No specific subject content areas within KHSCG biology were regarded as outstanding in terms of demand. However, the consistent theme of scientific inquiry and the linking of multiple concepts provides significant opportunity for stretching students' understanding, hence the score of 1.

# 6. Key Findings

This section summarises the alignment and main similarities and differences found between the DP and the KHSCG, both at programme level and subject level.

## 6.1 Programme Level

*Philosophical Underpinnings*

Most of the key themes within the IB's learner profile, ATL, and philosophy of international-mindedness are present to at least some extent in the KHSCG's Vision of an Education Person and the Educational Goals. Although some DP themes, such as real-world linkages and conceptual thought and understanding, do not receive the same level of explicit emphasis in the KHSCG's philosophical underpinnings, they are implicitly present and evidenced in the curriculum.

*Programme Structure*

There are some similarities between the two programme structures; for example, both take a baccalaureate-style approach to encouraging breadth of study, both require students to study subjects from broadly similar subject areas, and both include curricula components that sit alongside subjects (such as community activities). Additionally, both programmes allow students to specialise in particular subjects – the DP by differentiating between SL and HL, and the KHSCG by allowing students to study both the common courses and elective courses (both general and career-related) for a specific subject.

However, there are significant structural dissimilarities that would make movement between the two programmes challenging for students in particular. The fact that the KHSCG is three years in duration compared to the DP's two years is one important factor. Moreover, the number of curriculum components in each programme is quite different. The KHSCG's 204-unit structure leads to a larger number of subjects being experienced by students, whereas the DP's six-subject structure leads to a smaller number of subjects. Finally, the two programmes also differ in that the TOK and the extended essay core components are only evident in the DP. In turn, the KHSCG includes certain subjects that are absent from the DP, such as technology and home economics, or the option offered by some schools to replace (at least some) elective courses with specialised subjects.[135]

*Entry Requirements*

The DP and the KHSCG take different approaches to entry requirements at the start of their programmes. The IB encourages students and teachers to consult subject guides around expected prior learning but does not provide fixed entry requirements. In contrast, admission to general high schools in Korea is contingent on successful completion of middle school, and often on academic grades and test scores achieved. Moreover, autonomous schools, special-purpose schools, and vocational high schools often choose to use additional selection criteria,

[135] Additional specialised subjects offered may include courses in: management/finance, public health/public welfare, design/cultural contents, beauty treatment/tourism/leisure, cooking, construction, machinery, materials, chemical engineering, textile/clothing, electric/electronics, information/communications, processing, printing/publishing crafts, environment/safety, agriculture fisheries & maritime, and ship operations.

such as interviews, teacher recommendation letters, or by administering their own entrance examinations.[136]

*Student Learning Pathways*

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

*Assessment Methods*

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

Although this would seemingly make the two programmes weakly aligned, it should be noted that the flexibility of the internal assessment in the KHSCG could result in a practical student experience that is quite similar in some respects to the DP's assessment patterns. For instance, the type of skills assessed in each programme showed broad alignment, with exception of the KHSCG's additional focus on assessment of emotional competency – an aspect that is entirely absent from the DP's assessment objectives. Moreover, what little information is available on the KHSCG's flexible assessment indicates that similar item types and methods of assessment to the DP would be likely – e.g. use of short-answer questions, essay questions, and performance assessments for the arts subjects.

*Summary*

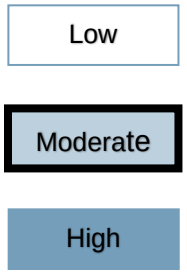
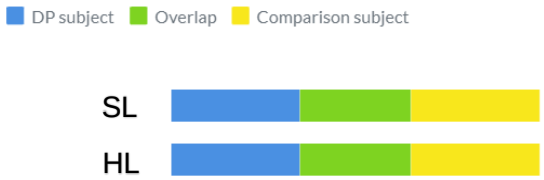
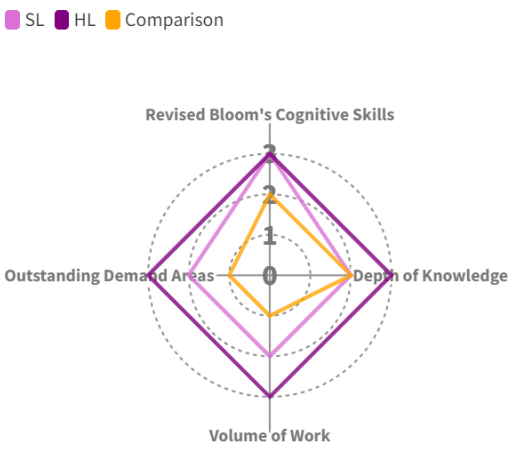
The structures of the two programmes and entry requirements are the most significant points of difference and the philosophical underpinnings are the most significant point of similarity. In all other respects, there are some notable differences, though with points of clear alignment with regard to how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

[136] MOE, Republic of Korea. (2022). *Secondary Education.*

## 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 KHSCG. The summaries include key findings on learning outcomes alignment, content alignment and demand alignment, as per the key below:

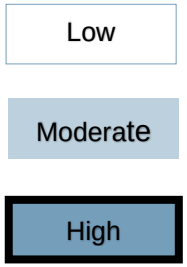
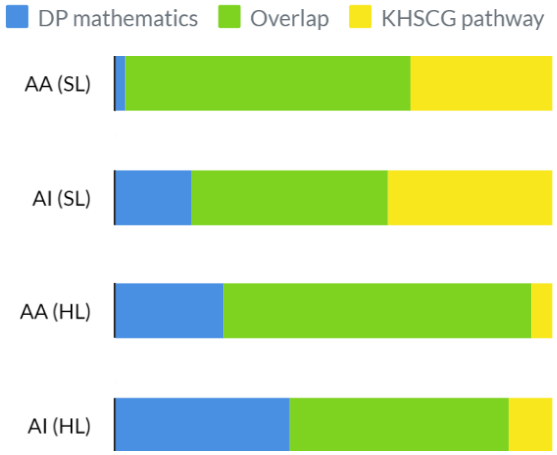
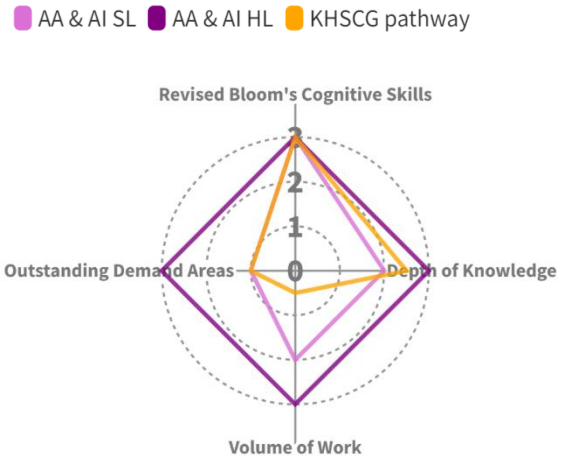
*Key:*

| Subject name | Learning outcomes alignment | Content alignment | Demand alignment |
|---|---|---|---|
| Displays the name of the comparison subject |  <br>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. |  <br>These bars represent the content alignment between the DP subject and the comparison. There is one bar showing alignment with SL content and another for HL content (inclusive of SL content). The **green** section of the bar represents the overlap of content between the subjects. The **blue** section represents content which was in the DP subject only. The **yellow** section represents content which was in the comparison subject only. Therefore, if, say, the blue section was longer than the yellow, this can be interpreted as DP subject having more content unique to itself than the comparison did. A large green bar would indicate that a substantial proportion of content overlaps between the DP and the comparison subject. |  <br>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 mathematics subjects and the KHSCG mathematics pathway is represented below:

*Figure 26: Visual representations of subject-level alignment (mathematics subjects)*

| Subject name | Learning outcomes alignment | Content alignment | Demand alignment |
|---|---|---|---|
| KHSCG mathematics pathway |   |   |   |

- **Learning outcomes alignment**: the level of alignment between both DP mathematics subjects, at both SL and HL, and the KHSCG mathematics pathway's learning outcomes is substantial, as all DP themes are present in the KHSCG curricula.

- **Content alignment**: for the KHSCG mathematics pathway, alignment with AA is generally stronger than with AI, for both SL and HL. Nearly all AA SL content, and a good proportion of AI SL content, can be found in KHSCG, though the pathway exceeds the breadth and depth of DP SL by featuring a significant amount of additional content. Most of this content can, however, be identified in DP HL, resulting in considerable alignment with AA HL and reasonable alignment with AI HL. Generally, the DP HL subjects have a slightly higher volume of content than this pathway. However, it can be noted that the amount of overlapping content is dependent on the KHSCG electives chosen – in practice, students have a great degree of flexibility regarding the breadth and depth of their mathematics study.

- **Demand alignment**: the KHSCG mathematics pathway is more similar in demand to DP SL than DP HL. Though it scores similarly to DP HL for Bloom's cognitive skills and depth of knowledge, the pathway scores the same as SL for outstanding areas of demand and significantly less than both DP subjects for volume of work.

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

- **Similarities in learning outcomes**: All eight themes extracted from the DP learning outcomes are identifiable in the KHSCG curricula, hence there is considerable alignment between the mathematics learning outcome themes of the DP and KHSCG. Five out of eight DP learning outcomes are strongly present in the KHSCG, especially with regard to critical and creative thinking skills. Both also consider the attitudes and learning skills of students and aim to develop independence, confidence, and interest. Other skills of communication, making connections, and understanding and application have similar emphasis in the KHSCG. Other DP themes such as wider contexts, technology, and inquiry-approaches are present, though with less emphasis.

- **Similarities in content**: when considering the pathway content, a large amount of the DP SL topics can be identified, as well as a considerable number of AHL topics. Therefore, this pathway exceeds the DP SL in breadth and depth of content and is more comparable to that of DP HL subjects. Furthermore, outside of this pathway, the KHSCG curriculum offers the Mathematical Inquiry Task elective, which has similarities to the mathematical exploration in the DP syllabus.

- **Similarities in demand**: DP and KHSCG both have the highest score for the presence of higher-order cognitive skills (taken from Bloom's Revised Taxonomy) and therefore have similar emphasis on analysis, evaluation, and creation in their learning outcomes. For the rest of the scores, the KHSCG mathematics pathway has higher similarity with the demand level of the DP SL than the DP HL, scoring the same for outstanding areas of demand and slightly more for depth of knowledge.

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

- **Differences in learning outcomes:** though there are considerable similarities in learning outcome themes, the KHSCG has a lot less emphasis on the wider contexts of mathematics than the DP, only referring to enabling students to participate in society. Furthermore, inquiry-based approaches, including using technology to explore, has less emphasis in the KHSCG, with no explicit reference to investigative or experimental actions except when in the context of information-processing (e.g. collecting data). Conversely, the KHSCG has some specific concepts in their learning outcomes which, though similar to the DP, are not explicitly mentioned, such as convergent thinking and information-processing.

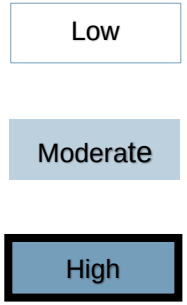
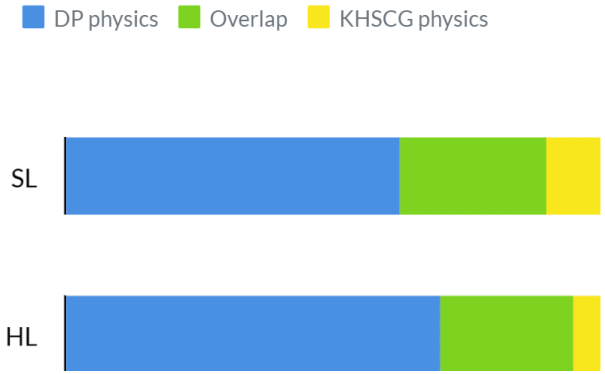
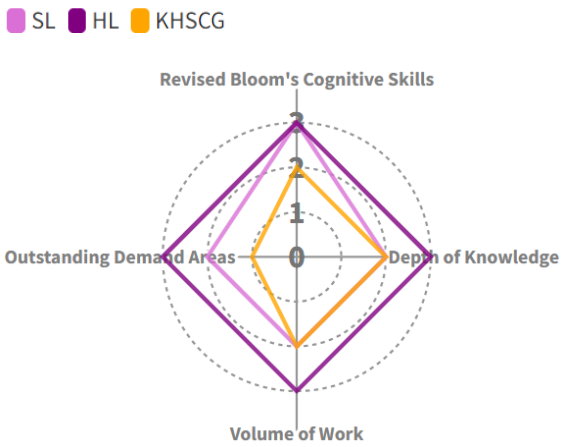
- **Differences in content:** the structure of mathematical content varies significantly between the DP and KHSCG. Whereas the DP integrates five main mathematical areas into all its courses, the KHSCG separates large content areas into stand-alone electives. Therefore, the breadth of study could vary a lot between KHSCG students, depending on the electives selected. Generally, there is a higher degree of flexibility in the KHSCG curriculum, which offers a wider range of options and allows students to study few or several electives. Hence, there is only noteworthy alignment with DP content when students take a pathway that will lead to a similar breadth and depth of content to be covered. Furthermore, the pathway more strongly aligns with AA content than AI content.

- **Differences in demand:** the most important difference in demand between the KHSCG and DP relates to volume of work. DP mathematics covers a greater number of different topics and complex concepts within the allocated teaching hours, whereas the KHSCG allocates a generous amount of teaching hours to cover a similar breadth and depth of content in the selected pathway. Furthermore, the pathway scores significantly lower than DP HL subjects for outstanding demand areas, thus the pathway has more similarity with SL than HL for demand.

### 6.2.2 Physics Alignment

The subject level alignment between the DP and KHSCG physics is represented below:[137]

*Figure 27: Visual representations of subject-level alignment (physics)*

| Subject name | Learning outcomes alignment | Content alignment | Demand alignment |
|---|---|---|---|
| KHSCG physics |  |  |  |

[137] The summary visual shows the results from the comparison between the DP (SL and HL) and KHSCG Physics I and Physics II combined.

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

- **Content alignment**: there is limited content alignment between DP and KHSCG physics. The overlapping content KHSCG has with the DP comprises of around half of the SL sub-topics and a small number of HL sub-topics. Furthermore, these alignments tend to be 'partial' rather than 'full', due to the KHSCG describing the content in far lesser detail than the DP. In the absence of a significant amount of DP sub-topics, or other content, the KHSCG appears to have less breadth and depth than both SL and HL physics. However, it can be noted that there are similarities with the DP's experimental programme, giving some further alignment in this area.

- **Demand alignment**: the demand level of KHSCG physics is more closely aligned with that of DP SL, with the former scoring the same for depth of knowledge and volume of work, though slightly less for Bloom's cognitive skills and outstanding areas of demand. The level of alignment of the KHSCG with DP HL is lower, as DP HL physics scores higher in all demand categories.

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

- **Similarities in learning outcomes:** there is a high level of alignment between the learning outcomes of DP physics and those of KHSCG physics, with all themes extracted from the DP being strongly evidenced in the KHSCG. The KHSCG curriculum similarly aims to create well-rounded, curious students who have an appreciation for science and its place in the world. Specifically, the KHSCG also aims to develop conceptual understanding, application, skills for scientific inquiry, technological skills, communication and collaboration, creativity and critical thinking, and awareness of global and local problems and the impact of science.

- **Similarities in content:** there is a small amount of overlapping content between KHSCG and DP physics. Regarding content in the SL physics, the KHSCG content demonstrates strong alignment with two topics, C.2 Wave model and A.2 Forces and momentum, and partial alignment with a number of sub-topics in each of the DP physics' five overarching topics. KHSCG physics also has some alignment with three AHL sub-topics – C.3 Wave phenomena, D.4 Induction, and E.2 Quantum physics – though these are 'partial' rather than 'full' alignments due to content being covered in less detail than the DP. As to alignment with the DP's experimental programme, this is found primarily in the common course 'Scientific Investigation', which contains similar requirements and skills.

- **Similarities in demand:** KHSCG physics scores the same as DP SL for depth of knowledge and volume of work and is generally more aligned with SL than HL for demand.

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

- **Differences in learning outcomes:** no significant differences in learning outcomes were found.

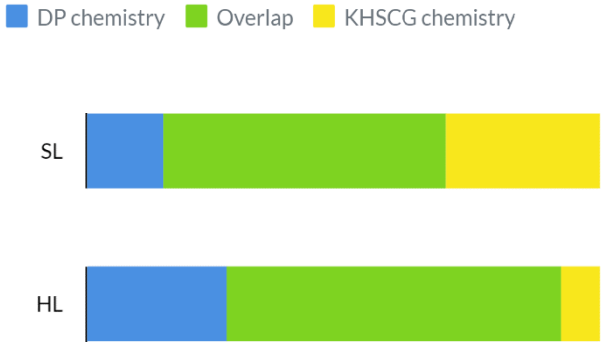
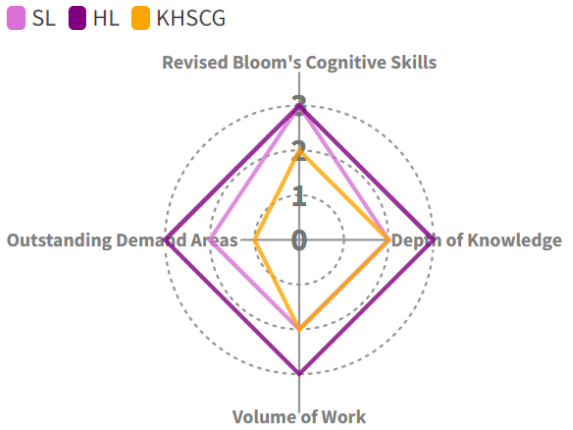
- **Differences in content:** there is a limited amount of shared physics content between the DP and KHSCG physics, with DP AHL topics being particularly less evident in the KHSCG curriculum. Furthermore, shared topics are typically only partially (rather than fully) aligned as these are often covered in lesser detail in the KHSCG than in the DP. Another notable difference is that the KHSCG curriculum does not clearly set out mathematical requirements for physics, whereas these are clearly stated in the DP and interwoven into the content descriptions. Hence, the level and range of mathematics used in KHSCG physics is unclear.

- **Differences in demand:** KHSCG physics scores lower than DP HL for all demand categories and scores less than DP SL for Bloom's cognitive skills and outstanding demand areas.

### 6.2.3 Chemistry Alignment

The subject level alignment between the DP chemistry and KHSCG chemistry is represented below: [138]

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

| Subject name | Learning outcomes alignment | Content alignment | Demand alignment |
|---|---|---|---|
| KHSCG chemistry | Low<br>Moderate<br>High |  |  |

[138] The summary visual shows the results from the comparison between the DP (SL and HL) and KHSCG Chemistry I and Chemistry II combined.

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

- **Content alignment**: there is a significant amount of content overlap between DP and KHSCG chemistry. Aside from a few sub-topics, most of the DP SL and HL content, including features of the experimental programme, can be found in the KHSCG curricula. That said, it can be noted that some of these alignments are only 'partial' due to KHSCG not covering the sub-topics in the same level of detail as the DP. Overall, there is considerable alignment between the topic coverage of KHSCG and the DP SL and HL, though HL covers a number of topics in greater depth.

- **Demand alignment**: the demand level of KHSCG chemistry is more closely aligned with that of DP SL, with the former scoring the same for depth of knowledge and volume of work, though slightly less for Bloom's cognitive skills and outstanding areas of demand. The level of alignment of the KHSCG with DP HL is lower, as DP HL chemistry scores higher in all demand categories.

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

- **Similarities in learning outcomes:** there is a high level of alignment between the learning outcomes of DP chemistry and those of KHSCG chemistry, with all themes extracted from the DP being strongly evidenced in the KHSCG. The KHSCG curriculum similarly aims to create well-rounded, curious students who have an appreciation for science and its place in the world. Specifically, the KHSCG also aims to develop conceptual understanding, application, skills for scientific inquiry, technological skills, communication and collaboration, creativity and critical thinking, and awareness of global and local problems and the impact of science.

- **Similarities in content:** there is a large amount of overlapping content between the DP and KHSCG chemistry. Most of the DP SL and HL topics, as well as features of the experimental programmes, can be identified in the KHSCG, and conversely the majority of KHSCG topics are covered by the DP. Notably, alignment levels between the KHSCG and DP are higher when comparing KHSCG against SL, and more limited when comparing against HL.

- **Similarities in demand:** KHSCG scores the same as DP SL for depth of knowledge and volume of work and is generally more aligned with SL than HL for demand.

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

- **Differences in learning outcomes:** no significant differences in learning outcomes were found.

- **Differences in content:** there are two sub-topics (Structure 3.2 – Functional groups: Organic compounds, and Reactivity 3.4 – Electron-pair reactions) with which the

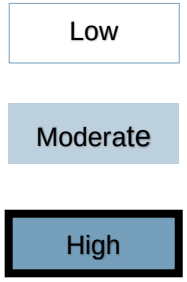
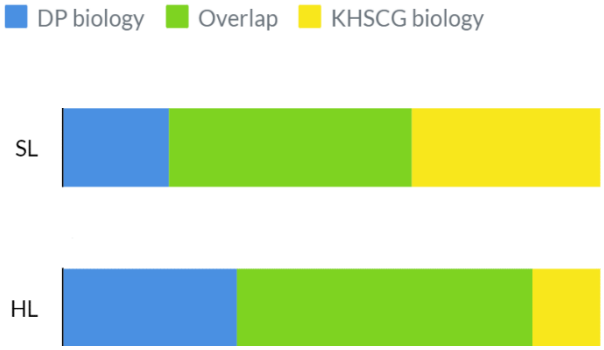
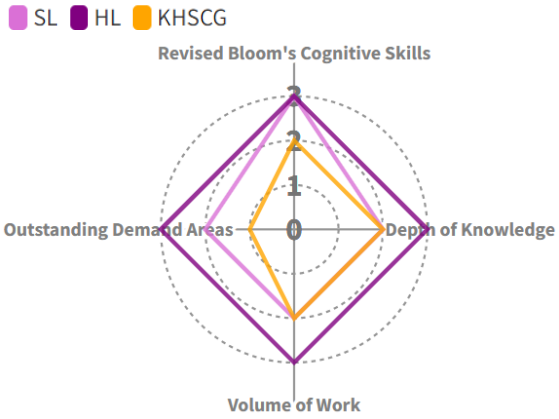
KHSCG curriculum shows no alignment at either SL or HL. Additionally, the KHSCG also shows no alignment at HL with the DP sub-topic structure 2.3 – The metallic model, despite being highly aligned at SL. Moreover, the general theme of highlighting the 'real-life' importance of chemical concepts and applications is more explicitly stated in the KHSCG syllabus with relation to the use of buffers in vitro, fermentation and catalysts in industry. Furthermore, whilst the content of KHSCG surpasses SL in breadth, it covers less content overall than DP HL chemistry.

- **Differences in demand:** KHSCG chemistry scores lower than DP HL for all demand categories and scores less than DP SL for Bloom's cognitive skills and outstanding demand areas.

### 6.2.4 Biology Alignment

The subject level alignment between the DP biology and KHSCG biology is represented below:[139]

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

| Subject name | Learning outcomes alignment | Content alignment | Demand alignment |
|---|---|---|---|
| KHSCG biology |   |   |   |

[139] The summary visual shows the results from the comparison between the DP (SL and HL) and KHSCG Biology I and Biology II combined.

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

- **Content alignment**: there is a considerable amount of overlapping content between DP and KHSCG biology. Nearly all SL sub-topics are present in the KHSCG, with most being highly, rather than 'partially', aligned. Furthermore, most additional higher level (AHL) sub-topics are in KHSCG, though the level of alignment tends to be partial due to the topics being explored in less detail in the KHSCG. Moreover, features of the DP's experimental programme can also be identified in KHSCG biology. Overall, KHSCG biology has a similar topic coverage to that of the DP and includes more content than what is included at SL, though does not match the depth of HL.

- **Demand alignment**: the demand level of KHSCG biology is more closely aligned with that of DP SL, with the former scoring the same for depth of knowledge and volume of work, though slightly less for Bloom's cognitive skills and outstanding areas of demand. The level of alignment of the KHSCG with DP HL is lower, as DP HL biology scores higher in all demand categories.

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

- **Similarities in learning outcomes:** there is a high level of alignment between the learning outcomes of DP biology and those of KHSCG biology, with all themes extracted from the DP being strongly evidenced in the KHSCG. The KHSCG curriculum similarly aims to create well-rounded, curious students who have an appreciation for science and its place in the world. Specifically, the KHSCG also aims to develop conceptual understanding, application, skills for scientific inquiry, technological skills, communication and collaboration, creativity and critical thinking, and awareness of global and local problems and the impact of science.

- **Similarities in content:** KHSCG has a large amount of overlapping content with DP biology at both SL and AHL. KHSCG shows high alignment with the majority of topics in DP SL, whereas the coverage of AHL topics is mostly partial. Within the AHL content, the KHSCG content is particularly well aligned with the 1. Molecules topics in B. Form and function and C. Interaction and independence. Generally, there is a high level of similarity between the topic coverage of the DP and that of the KHSCG, as almost all DP topics are present in the KHSCG to some extent.

- **Similarities in demand:** KHSCG scores the same for demand as DP SL for depth and knowledge and volume of work and is generally more aligned with SL than HL for demand.

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

- **Differences in learning outcomes:** no significant differences in learning outcomes were found.

- **Differences in content:** when compared to DP SL, the KHSCG does not cover some aspects of topics B3. Organisms and B4. Ecosystems and there is only partial alignment with most D. Continuity and change topics. The majority of DP AHL content is covered in the KHSCG, with the exception of topics A1. Molecules and C3. Organisms. The topic coverage of the KHSCG is, thus, well aligned with that of the DP, but the depth of the content covered differs, with many of the AHL topics being only partially covered. Furthermore, KHSCG contains some content that cannot be found in DP biology, such as the ecological, ethical, legal and social issues associated with the use of biotechnology. The KHSCG also contains a large focus on how science can be used in everyday life with regard to food, make-up, architecture and sports; an aspect that is absent from the DP.

- **Differences in demand:** KHSCG biology scores lower than DP HL for all demand categories and scores less than DP SL for Bloom's cognitive skills and outstanding demand areas.

# 7. Bibliography

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

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

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

International Baccalaureate. (2017). *Assessment principles and practices: Quality assessments in a digital age*. p. 220.

International Baccalaureate. (2017). *Diploma Programme Subject Brief.*

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*. Available from: https://www.ibo.org/programmes/diploma-programme/assessment-and-exams/

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

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

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

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

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

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

International Baccalaureate. (2022). *Our mission.* Available from: ibo.org/about-the-ib/mission/

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

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

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

KICE. (2005). *The national assessment of educational achievement in 2003.* Available from: https://www.kdevelopedia.org/Resources/view/04201507090138964.do [accessed 14/09/22].

KICE. (2005). *The national assessment of educational achievement in 2003.* Available from: https://www.kdevelopedia.org/Resources/view/04201507090138964.do [accessed 14/09/22].

KICE. (2021). *College Scholastic Ability Test*. Available from: https://www.kice.re.kr/sub/info.do?m=0205&s=english [accessed 14/09/22].

KimJ., Lee J., Park M., HanI. (2012). *Mathematics Education In Korea - Vol. 1: Curricular And Teaching And Learning Practices.* p. 290-294.

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

Kwak, Y. (2022). *Exploration of High School Science Teachers' Perceptions on Instruction and Assessment of Science II Elective Courses in the 2015 Revised Curriculum.* Journal of the Korean earth science society. Vol.43 No.4. pp.557-566.

MOE, Republic of Korea. (2022). *Secondary Education.* Available from: english.moe.go.kr/sub/infoRenewal.do?m=0303&page=0303&s=english

MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools.* Available from: NCIC National Curriculum Infomation Center (kice.re.kr)

MOE, Republic of Korea. (2022). *Higher Education.* Available from: english.moe.go.kr/sub/infoRenewal.do?m=0305&page=0305&s=english

MOE, Republic of Korea. (2015). *The Science Curriculum.*

MOE, Republic of Korea. (2018). *Education in Korea*. Available from: http://english.moe.go.kr/boardCnts/viewRenewal.do?boardID=282&boardSeq=80324&lev=0&searchType=null&statusYN=W&page=1&s=english&m=0502&opType=N

MOE, Republic of Korea. (2020). *The Maths Curriculum.*

National Curriculum Information Center (NCIC). (2022). *Education System of Korea*. Available from: ncic.re.kr/english.inf.ivi.index.do

Ra, S. et al. (2019). Asian Development Bank. *Developing national student assessment systems for quality education: lessons from the Republic of Korea.*

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

Younsin, K. (2014). '*Study on Development of National Competency Standards (NCS) of Pattern 패턴 분야의 국가직무능력표준 개발에 관한 연구*', Journal of Fashion Business, Vol. 18, 5. P144-158. Available from: koreascience.or.kr/article/JAKO201402755362561.page [accessed 14/09/22].

# 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.<br><br>**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.<br><br>**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.<br><br>**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.<br><br>**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.<br><br>**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:<br><br>**Thinking skills:** including areas such as critical thinking, creative thinking, and ethical thinking<br><br>**Research skills:** including skills such as comparing, contrasting, validating, and prioritizing information<br><br>**Communication skills:** including skills such as written and oral communication, effective listening, and formulating arguments<br><br>**Social skills:** including areas such as forming and maintaining positive relationships, listening | In all IB programmes, teaching is:<br><br>**Based on inquiry:** A strong emphasis is placed on students finding their own information and constructing their own understandings.<br><br>**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.<br><br>**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.<br><br>**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.<br><br>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.<br>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.<br><br>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.<br><br>**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.<br><br>**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.<br><br>**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<br><br>**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.<br><br>**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.<br><br>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 18: [Subject]*

| Demand Judgement | Score Descriptors (highlight the best-fit descriptor) | Judgement and Key Evidence |
|---|---|---|
| Revised Bloom's Cognitive Skills[140] | 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[141] | 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 | |

[140] Evidence pool: Learning outcomes
[141] 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[142] | 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[143] | 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) | |

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

# Appendix D

The table below lists the subject areas, subject clusters, common courses and elective courses (both general and career-related) found in the KHSCG:

| Subject areas | Subject clusters | Common courses | Elective courses | |
|---|---|---|---|---|
| | | | General electives | Career-related electives |
| Foundation | Korean Language | Korean Language | Speech and Writing, Reading, Language and Media, Literature | Practical Korean Language, Advanced Korean Language, Reading Classics |
| | Mathematics | Mathematics | Mathematics I, Mathematics II, Calculus, Probability and Statistics | Practical Mathematics, Geometry, Economic Mathematics, Mathematical Inquiry Task, Basic Mathematics, and Artificial Inquiry Mathematics |
| | English | English | English Conversation, English I, English Reading & Writing, English II | Practical English, Culture of English-Speaking Countries, Career English, Reading British and American Literature |
| | Korean History | Korean History | Korean Geography, World Geography, World History, East Asian History, Economics, Politics & Law, Society & Culture, Life & Ethics, Ethics & Thoughts | Travel Geography, Inquiry on Social Issues, Classics & Ethics |
| Inquiry | Social Studies (History/Moral Education) | Integrated Studies | Korean Geography, World Geography, World History, East Asian History, Economics, Politics & Law, Society & Culture, Life & Ethics, Ethics & Thoughts | Travel Geography, Inquiry on Social Issues, Classics & Ethics |
| | Science | Integrated Science, Scientific Investigation | Physics I, Chemistry I, Biology I, Earth Scie | Physics II, Chemistry II, Biology II, Earth Science II, Science History, Life & Science, Convergence Science |

| | | | | |
|---|---|---|---|---|
| Physical Education / Arts | Physical Education | | Physical Education, Exercise & Health | Sports & Life, Sports Inquiry |
| | Arts | | Music, Art, Drama | Music Performance, Music Appreciation & Criticism, Studio Art, Art Appreciation & Criticism |
| Life / Liberal Arts | Technology/ Home Economics | | Technology<br>Home Economics/Informatics | Agricultural Life Science, General Engineering, Creative Business Management, Maritime Culture & Technology, Home Economics Science, General Intellectual Property |
| | Foreign Language | | German I, French I, Spanish I, Chinese I, Japanese I, Russian I, Arabic I, Vietnamese I | German II, French II, Spanish II, Chinese II, Japanese II, Russian II, Arabic II, Vietnamese II |
| | Classical Chinese | | Classical Chinese I | Classical Chinese II |
| | Liberal Arts | | Philosophy, Logics, Psychology, Pedagogy, Religious Studies, Career & Occupation, Health, Environment, Practical Economics, Essay Writing | |

In addition to the above, schools may choose to offer specialised courses to their students, which they can take in place and/or in addition to their elective courses. For a list of all specialised courses offered, consult pages 24-41 of The National Curriculum for the Primary and Secondary Schools document.[144]

[144] MOE, Republic of Korea. (2015). *The National Curriculum for the Primary and Secondary Schools*.