The International Baccalaureate Diploma Programme (DP): Alignment with the Pakistan National Curriculum for Years XI and XII

Submitted to the International Baccalaureate by UK NARIC

The National Recognition Information Centre for the United Kingdom

The national agency responsible for providing information and expert opinion on qualifications and skills worldwide

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Term	Meaning
ATL	Approaches to Teaching and Learning - *IB*
CAS	Creativity, activity, service
CP	Career-related Programme
DP	Diploma Programme
FBISE	The Federal Board of Intermediate and Secondary Education
HSSC	Pakistan Higher Secondary School Certificate
IB	International Baccalaureate
MYP	Middle Years Programme
NEP	Pakistan National Education Policy (2009)
PYP	Primary Years Programme
SSC	Pakistan Secondary School Certificate
THE	Times Higher Education
TOK	Theory of Knowledge
UK NARIC	The National Recognition Information Centre for the United Kingdom

Executive Summary

The International Baccalaureate (IB) is a non-profit educational foundation that offers four programmes, including the IB Diploma Programme (DP), internationally through authorised IB world schools. In order to better understand the IB DP in the context of the Pakistani education system, the IB commissioned UK NARIC to undertake a comparative analysis to identify the similarities and differences in the content, structure, assessment and cognitive demand of the IB DP and the Pakistan Higher Secondary School Certificate (HSSC) in addition to the aims, objectives and policies that underpin the Pakistan education system, as outlined in the National Education Policy (NEP), 2009.

The study also sought to compare the recognition of the IB DP and HSSC for the purpose of undergraduate admission by reviewing published admission requirements for universities within the top 100 Times Higher Education (THE) World University Rankings for 2016.

Methodology

To complete this study, UK NARIC researched and reviewed Pakistan materials available in the public domain, including published curriculums, assessment materials, and policy documents. To inform the comparative analysis, UK NARIC reviewed four subjects: Mathematics, Biology, Chemistry and Physics, making reference to the National Curriculum (2006) in these subjects as well as syllabi and assessment materials from a secondary education board in Pakistan.

The first phase of the project examined the policies and objectives of the IB DP and compared these to the educational vision, aims and objectives, priorities and goals of the Pakistani education system as set out in the Pakistani National Education Policy (2009).

The second phase included an analysis of curriculum and assessment that focussed on comparing the IB DP content, structure, intended learning outcomes and assessment methods with the Pakistan National Curriculum (2006)[1] for Years XI and XII in the four selected subjects[2].

Thirdly, the principles, practices and standards of the IB DP were compared with the pedagogical and learning approaches for the HSSC. The subject level and overall intended learning outcomes for the HSSC were also reviewed, drawing on the findings from the above curriculum analysis, to identify the overarching level of skills expected amongst the subjects and how these compared with the IB DP.

The final phase of the project included a comparison of university admissions requirements for holders of the IB DP and the HSSC. This data came from a sample of 52 institutions from the 2016 THE Top 100 institutions that publish their admission requirements (with the

[1] Using the FBISE syllabi on a secondary basis to observe the curriculum in practice.
[2] The IB DP syllabi used included: Mathematics HL, Biology HL, Chemistry HL, and Physics HL.

relevant information needed for the study) and were based in key destination countries for Pakistani students[3].

Key Findings

The study found many similarities between the IB DP and the aims and principles of the Pakistani education system.

On a policy and objective level, both the IB and Pakistani education system (as identified in the NEP) share the following goals:

- To develop a self-reliant individual, a global citizen and an original thinker who values their individual responsibility towards their society
- To strive to deliver an education that caters for the social, political and spiritual needs of individuals and society
- To aim to adhere to justice and equity, raising students who are aware of human rights and encouraging their students to engage in service oriented activities that uphold the principles of fairness, justice and respect
- To encourage links between what is taught in the classroom and real life, with both understanding the importance of teacher professional development to ensure teachers are well placed to deliver this in practice.

In terms of recommendations for teaching and learning, both the IB DP and Pakistan National Curriculum and HSSC encourage student-centred teaching, allowing students to actively develop their own understanding from concepts. Inquiry-based teaching is also similarly supported by both programmes; the IB DP makes this integral to the framework of the programme and its curriculum and would allow a Pakistani school offering the IB to seamlessly implement the approach.

Teachers should also support students in developing key communication, analytical and critical thinking skills. Further, both recommend that collaborative work and group discussions take place, and that assessment should be formative and summative. However, the IB DP includes this and all of the above practices and approaches within and throughout its framework and policies, ensuring that these approaches are implemented within the curriculum and assessment.

The IB also prescribes additional teaching practices, to enable students to develop social and self-management skills. Overall, the IB framework emphasises six pedagogical teaching principles. Three of these are shared with the HSSC, including teamwork, inquiry-based teaching, and assessment approaches. In addition, the IB teaching is:

- Focussed on conceptual understanding
- Developed in local and global contexts
- Differentiated to meet the needs of all learners.

[3] As published by the UNESCO Institute of Statistics: UNESCO (2014). *Global Flow of Tertiary-Level Students [Pakistan – Where do students go?].*

From the curriculum comparison, the study found that all HSSC aims, objectives and standards are included, or at a minimum partially included, within the IB DP. Both programmes aim for students to become life-long learners, problem-solvers, and investigators who have experimental and communication skills. Similarly, the Pakistani standards and benchmarks were mostly identified within the IB DP. As the majority of these are set at topic level, differences were only found where the topic outlines of the IB DP and HSSC differ.

In terms of content, clear similarities could be seen in the key topics covered, although the IB DP includes a larger breadth of topics in the subjects reviewed. Differences, where identified, were often between the sub-topics within the programmes or with the level of detail provided and/or prescribed for key topics; however IB World Schools could feasibly cover the majority of the HSSC topics within the IB DP curriculum they develop.

When considering the IB DP and HSSC intended learning outcomes, both aim for students to develop: a solid knowledge of the subject, scientific/rational thinking, and an understanding of the importance of technology, the limitations of science, and cognitive, affective and psychomotor abilities.

The standards and benchmarks from the National Curriculum for the four subjects were also examined to identify the level of skills students were expected to develop. Similar to the HSSC, the IB DP expects students to have understanding, application, and analysis skills. Additionally, both include outcomes for students to evaluate, apply, explain, compare, interpret, and differentiate; however, these only make up a select few of the HSSC outcomes.

In practice (as identified in the education board's learning and teaching guidelines, together with assessment) there is more emphasis on students being able to recall, understand, and in some cases apply their knowledge, with less emphasis apparent on the higher-order thinking skills (i.e. analysis, evaluation, synthesis). In comparison, the IB DP places equal emphasis on developing conceptual understanding and the relative application and skills associated with each concept, as demonstrated in the assessments, standards, and practices.

The comparison of the assessment methods found that both the IB DP and HSSC employ external written examinations and include an element of practical assessment in the science subjects; in Mathematics, the IB DP includes an individual project in addition to the written examinations. The overall duration spent on these assessments is similar between the programmes; however the volume of assessment for the IB DP subjects is slightly higher.

Similar questions types were also identified between the programmes, with both using multi-part structured questions and multiple-choice; however the IB DP uses more multi-part structured questions than the HSSC and does not use any multiple-choice questions in the IB DP Mathematics HL programme.

From the assessment comparison of the IB DP and HSSC it was further identified that both assess knowledge, understanding and application skills. However, the HSSC includes more questions focussed solely on knowledge recall than found in the IB DP. Further, the IB DP

assessments include questions focussed on analysis and evaluation skills, which although referenced in the National Curriculum, were not observed in the HSSC papers.

In the final phase of the study, significant differences were found in the recognition of the IB DP and HSSC for the purpose of admission to top ranked universities. Out of 25 institutions within the THE Top 100, all were found to accept the IB DP for direct admission to Bachelor degree programmes, subject to achievement of the requisite grades for the institution and or degree programme in question; one additionally offers advanced standing. By contrast eight institutions were found to accept the HSSC for direct entry, with many requiring one further year of study in the form of an International Foundation Year, Year 1 of a degree programme in Pakistan, or even completion of an international secondary qualification such as the DP or A level.

In summary, the study found that whilst clear similarities can be seen between underpinning philosophies and aims of the IB and Pakistan education systems, and between the key content covered within subjects of the DP and HSSC, the IB DP assesses subjects at a higher level of cognitive demand and is designed to be of a higher academic level overall than the HSSC. This objective evaluation of the curriculum and assessment is further supported by the greater level of recognition of the IB DP in relation to the general entrance requirements of universities worldwide.

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1. Introduction

1.1 Scope and objectives of the study

UK NARIC was commissioned by the International Baccalaureate (IB) to provide a holistic comparison of the IB Diploma Programme (DP) in the context of the Pakistan education system. The IB is a non-profit educational foundation that offers four programmes, including the IB DP, internationally. Pakistan is one of many countries in which the IB programmes are delivered. As of October 2016, fifteen Pakistani schools offer IB programmes, nine of which deliver the IB DP.

About UK NARIC

UK NARIC is the designated national agency in the United Kingdom for the recognition of international qualifications and professional skills. Since 1997, it has performed this official function on behalf of the UK Government.

UK NARIC provides informed advice and guidance on vocational, academic and professional qualifications from over 190 countries worldwide. The information provided enables international and UK organisations, institutions and government agencies to develop informed opinions when considering qualifications or training systems from overseas.

With the expertise and experience developed through running the National Agency, together with a number of other programmes on behalf of the UK Government and European Union, UK NARIC has been uniquely well placed to manage and support delivery of an extensive global research portfolio for:

- Ministries of Education and other government agencies
- Universities and other higher education institutions
- Secondary exam boards and awarding bodies
- Professional bodies.

Specific areas of expertise include:

- International education systems and qualifications
- Comparative studies on curriculum and assessment
- Qualification benchmarking
- Grade comparisons
- Best practice in recognition
- Qualification framework development and/or referencing;
- Supporting the development and implementation of mutual recognition agreements.

To compare the IB and Pakistan education system, the study will focus on identifying the similarities and differences in the content, structure, assessment and cognitive demand of the IB DP and the Pakistan Higher Secondary School Certificate (HSSC) in addition to the aims, objectives and policies that underpin them. For this purpose, the IB DP will be compared with the following reference points:

- The National Education Policy (NEP), 2009
- The Pakistan HSSC for Years XI and XII in four selected subjects: Mathematics, Biology, Chemistry and Physics. The focus will be on the following sources:
  - The National Curriculum (2006)
  - A selected secondary education board in Pakistan, the Federal Board of Intermediate and Secondary Education (FBISE).

The study will also seek to compare the recognition of the IB DP and HSSC for the purpose of undergraduate admission. This will review the published admission requirements for universities within the top 100 Times Higher Education (THE) World University Rankings for 2016.

1.2 Research questions

The study is designed around the following research questions:

1) To what extent does the DP align with the 'Educational Vision', 'Aims and Objectives', 'Overarching Priorities' and goals regarding learning and development articulated by the NEP 2009?
2) How do the principles, practices and standards of the DP compare with the pedagogical and learning approaches, as well as the intended learning outcomes, for the Pakistan HSSC?
3) In what ways does the DP align with the National Curriculum for Years XI and XII? More specifically,
   a) In what ways does the content and structure of DP Mathematics HL and Sciences (Biology, Chemistry and Physics) HL compare with their Pakistan HSSC equivalents?
   b) In what ways do the DP Mathematics HL and Sciences (Biology, Chemistry and Physics) HL approaches to assessment align or differ with their Pakistan HSSC counterparts?
   c) Are there differences in the cognitive demand between DP Mathematics HL and Sciences (Biology, Chemistry and Physics) HL and their Pakistan HSSC counterparts?
4) How do the DP and Pakistan HSSC align to each other with regards to the extent of their recognition at top global universities?

1.3 Structure of the report

Section 2 includes the methodology used to complete the study.

Section 3 provides an overview of the Pakistan school education system to contextualise the comparative analysis, while **Section 4** introduces the IB and the four programmes it offers, including a detailed overview of the IB DP in line with the focus of this study.

Section 5 examines the philosophical underpinnings of the Pakistani education system and the IB, with a comparison of the IB DP framework and policies to the Pakistan NEP (2009).

Section 6 provides a detailed comparative analysis of the aims, objectives, outcomes, curriculum and assessment of the Pakistan HSSC with the IB DP in four subjects: Mathematics, Biology, Chemistry and Physics.

Section 7 compares the IB DP principles, practices, standards and *Approaches to Teaching and Learning* to the teaching and learning guidance in the Pakistan National Curriculum. Further, the IB DP is compared to the overarching learning expectations identified from the aims, objectives and benchmarks for the HSSC from Section 6.

Section 8 compares the recognition of the IB DP and HSSC by top universities around the world for the purposes of admission to undergraduate study.

Section 9 examines the key findings from the comparative analyses.

Section 10 includes a bibliography of the resources used for the study.

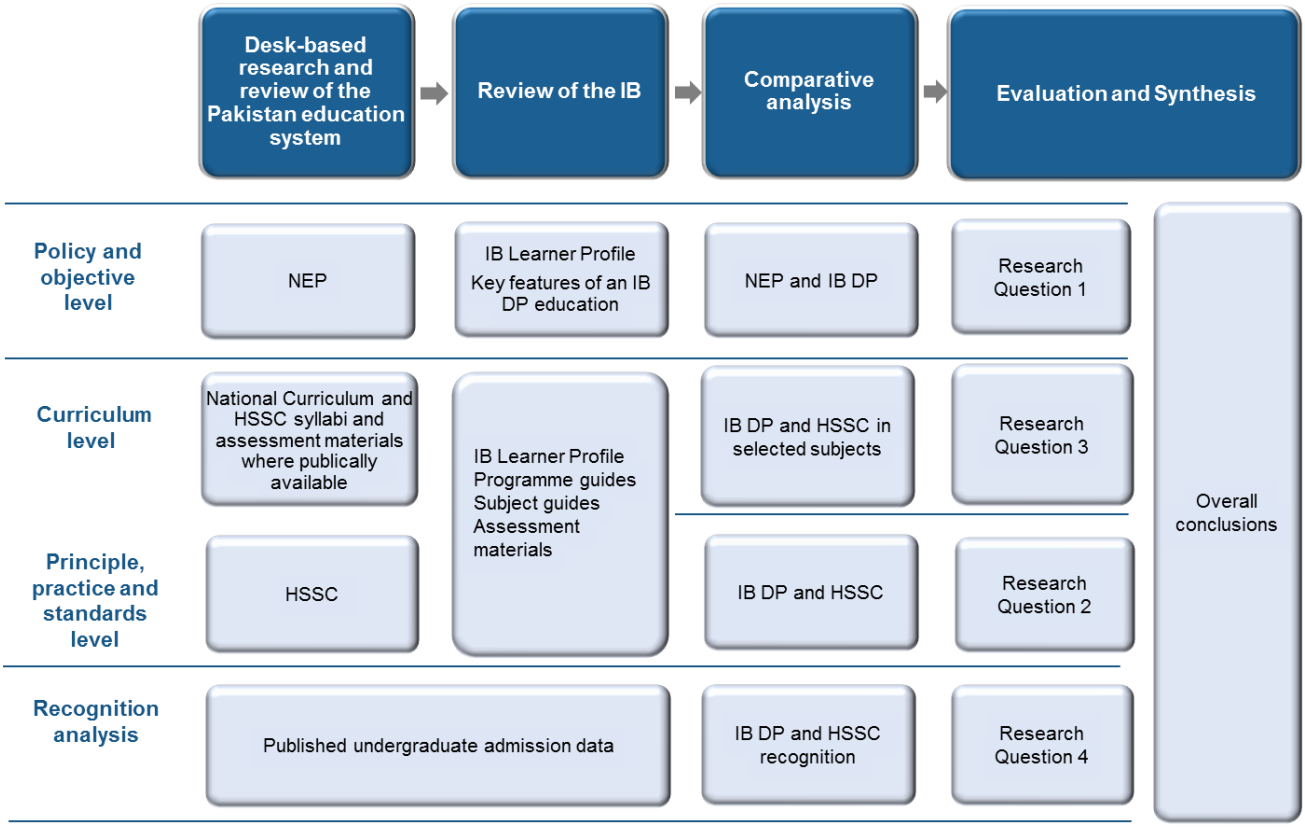
2. Methodology

To address the research questions and conduct a reliable comparison of the IB qualifications against the previously identified focal points in the Pakistani education system, the study will include three key phases as follows:

- Desk-based research and document review:
  - For the Pakistani school system
  - For the IB DP
- Comparative analysis
- Evaluation and synthesis.

The process can be illustrated as follows:

Figure 1: Methodological process



2.1 Desk-based research and document review

This stage involved firstly collating information pertaining to the IB DP, including the programme content, structure, assessment methods, learning outcomes and the educational philosophy, aims and objectives that underpin in. Similar information was also gathered on the Pakistani upper secondary school system, as available in the public domain. This included the NEP (2009); National Curriculum (2006) up to Grade 12; and curriculum (scheme of studies) and assessment materials for the HSSC for the Mathematics and Sciences (Biology, Chemistry and Physics). As there are multiple education boards in Pakistan offering the HSSC, curriculum and assessment documents were collated from the FBISE, an examination board that is under the Ministry of Education and Professional Training.

A full list of the sources can be found in Section 10.

Next, the project team conducted a review of the education policies and goals, curriculum and programmes as a whole, to contextualise the review of the IB DP and Pakistani syllabi and inform any methodological considerations. A second, comprehensive review was undertaken to discern the key principles, themes and components of the Pakistani policies and practices, curriculum and assessment in preparation for the subsequent comparative analysis.

2.2 Comparative analysis

The second stage of the project, the comparative analysis, comprised four tiers as shown in Figure 1:

- Policy and objective level analysis: comparison of the IB DP aims and underpinning philosophies and the educational vision, aims and objectives, priorities and goals of the Pakistani education system as set out in the NEP (2009)
- Curriculum level analysis: a comparison of the IB DP curriculum and assessment, in particular to:
    - Compare the IB DP content, structure and intended learning outcomes with the Pakistan National Curriculum (2006) for Years XI and XII in Mathematics, Biology, Chemistry and Physics. To observe the curriculum in practice, the syllabi from the FBISE were also referenced where appropriate.
    - Compare the IB DP assessment objectives and assessment methods with the HSSC (using syllabi and assessment materials collated from the FBISE).
- Principle, practice and standards level analysis: comparison of the IB DP principles, practices and standards with the pedagogical and learning approaches, and the intended learning outcomes for the HSSC
- Recognition and progression analysis: comparison of published university admissions requirements for holders of the IB DP and HSSC.

The focus of the first three tiers of the comparative analysis was on identifying the extent to which the salient principles and features of the Pakistani upper secondary school system and HSSC were evident within the IB DP, being mindful of inevitable variations in terminology.

2.2.1 Policy and objective level analysis [Research question 1]

As outlined above, the comparative analysis began with the policy level analysis, comparing the philosophical underpinnings of the IB and Pakistani education systems, since the principles and goals established at a national / overarching level should be reflected in the national school curriculum and assessment.

The analysis centred on the Pakistan NEP (2009) and in particular its educational vision, aims and objectives, overarching priorities and goals regarding learning and development.

Through this, the ways in which the IB DP align with the NEP could be clearly identified [Research Question 1].

2.2.2 Curriculum level analysis [Research question 3]

As outlined in the Introduction, analysis of the IB DP against the Pakistani National Curriculum for Years XI and XII centred on the four subjects chosen by the IB: Mathematics, Biology, Chemistry and Physics.

The analysis identified and compared the HSSC and IB, for each subject, in terms of aims and objectives, structure and content, assessment methods and demand. No judgement of quality is made or intended on the programmes or awarding bodies.

The findings of this comparative analysis were documented in tabular format, so that where sufficient evidence of similarity/alignment was found between the IB DP and the Pakistani system, a check mark (✓) was used. Where any aspect of the Pakistani system was not considered to be included within the IB, the cell was left blank and further explanation provided below the table. If there was evidence to show that the IB could be considered *partially* similar, a check mark with an asterisk was used (✓*). An example of the table format can be seen below:

Table 1: Example mapping table

[Reference Point in the Pakistan System]	Included in the IB
Key theme 1	✓*
Key theme 2	
Key theme 3	✓
Key theme 4	✓
Key theme 5	✓
Key theme 6	

For each table, a supporting analysis is provided to ensure transparency in the decision-making process. Any relevant key features or components of the IB which were not similarly found within the Pakistan reference points were also identified within the text, where appropriate.

The table below identifies the syllabi used as the basis for comparison.

Table 2: Syllabi reviewed

Subject	Pakistani National Curriculum	FBISE HSSC	IB DP
Mathematics	Mathematics (I-X[XI-XII])	Mathematics (XI-XII)	Mathematics HL
Biology	Biology (XI – XII)	Biology (XI–XII)	Biology HL
Chemistry	Chemistry (XI-XII)	Chemistry (XI-XII)	Chemistry HL
Physics	Physics (XI-XII)	Physics (XI-XII)	Physics HL

Content and Structure (Research question 3a)

For each subject, the number and range of topics studied were reviewed to determine and compare the general breadth and depth of the courses. The core topics studied were also compared using the mapping table (Table 1) demonstrated above.

The analysis also compared the recommended teaching hours of the course (as a proportion of the full DP/HSSC programme) where comparable data was identified.

The aims and objectives of the IB DP and HSSC were also compared in this section to inform the content and structure comparison.

The Pakistan National Curriculum was used as the principle point of reference for this comparison, with the FBISE HSSC syllabi examined as a second point of reference to observe the curriculum in practice.

Assessment methods and demand (Research question 3b and 3c)

The comparison of the IB DP and HSSC assessment first involved an overarching comparison of the assessment objectives, where stated, and overall summative assessment methods; noting where external and/or internal assessment is used and the relative weighting of external and internal assessment to the overall grade.

This was followed by a more detailed comparison of assessment materials, focussing on external HSSC assessments available in the public domain. This considered:

- The type(s) of assessment employed
- The breadth and depth of content covered within the exam(s)
- The number and type(s) of questions posed in each exam, together with the weighting of the different types of questions (mark allocation)
- The duration of the exam(s).

Comparing the cognitive demand of the assessment involved an item-level analysis, taking into consideration:

- The cognitive levels of the questions in each question – specifically whether items are testing students' knowledge recall, understanding, application, analysis or evaluation skills and, with reference to the allocation of marks, the range of and extent to which the different cognitive levels are assessed through the IB DP and HSSC
- The level of resources (or direction) given: i.e. to what extent is the information needed to answer the question given in the question / exam paper itself
- The question types, such as, the use of single- and/or multiple-part questions and the extent to which these provide students with a strategy for response or require students to create their own.

Mark schemes and guidelines were not publically available at the time of writing, nevertheless some consideration can be given to marking approaches based on the question type, mark allocation and instructions to candidates (such as whether they are expected to show their workings out in the case of mathematics papers).

2.2.3 Principle, practice and standards level analysis [Research question 2]

The comparison of the IB DP principles, practices and standards with the pedagogical and learning approaches and the intended learning outcomes for the HSSC was completed after the curriculum analysis. As the learning outcomes are typically unit and/or topic specific, this allowed for the learning outcomes to be compared on a subject level before informing the comparison of the programmes overall, identifying the overarching level of skills expected amongst the subjects.

The IB DP pedagogical and learning approaches were also reviewed on a subject and programme level with both the subject guides and the programme documents reviewed, including:

- Diploma Programme: From principles into practice
- Diploma Programme assessment: principles and practice
- Approaches to teaching and learning in the Diploma Programme
- Programme Standards and Practices.

For the HSSC, the pedagogical and learning approaches from the National Curriculum were reviewed in addition to the teacher learning outcomes and guidelines in the FBISE syllabi to understand the level of skills expected of students and the expectations for teachers.

2.2.4 Recognition analysis [Research question 4]

To compare the IB DP and HSSC for the purpose of undergraduate admission, published data was sought from THE Top 100 institutions 2016, according to the following criteria:

- The availability of published admissions requirements, detailing country and/or qualification-specific information, to ensure transparency in the analysis
- To ensure there was coverage of key destination markets for Pakistani students, according to data published by the UNESCO Institute of Statistics[4].

UNESCO data shows the following countries to be key destination countries in 2014 (the most recent data):

Table 3: Key destination countries – students from Pakistan

Rank	Country
1	UK
2	Australia
3	USA
4	Saudi Arabia
5	United Arab Emirates
6	Canada
7	Germany
8	Malaysia
9	Cuba
10	Italy
11	Sweden
12	Finland
13	Kyrgyzstan
14	Republic of Korea
15	Qatar
16	Bahrain
17	Cyprus
18	France
19	Norway
20	New Zealand
21	Oman
22	Japan

[4] UNESCO (2014). *Global Flow of Tertiary-Level Students [Pakistan – Where do students go?].* Available at: <http://www.uis.unesco.org/Education/Pages/international-student-flow-viz.aspx> [Accessed September 2016].

23	Netherlands
24	Iran
25	Ukraine
26	Denmark
27	China, Hong Kong
28	Austria
29	Spain
30	Ireland

Notes:

1. Countries receiving fewer than 100 students in 2014 have been omitted from the above list.
2. Not all of the countries listed above have institutions appearing in the Times' Top 100 rankings. Consideration has also been given to the rank of each country and the number of students studying in each. Accordingly, the institution sample includes a good number of UK and Australian universities acknowledging that these two countries were ranked the top two destinations for Pakistani students, with over 6000 students in 2014.

This found published data pertaining to one or both of the qualifications at 52 of the THE Top 100 universities, which were then reviewed first on a country-specific basis, beginning with the UK and Australia. The report compares these admission requirements in tabular format with the requirements for the IB DP and HSSC side by side for each of the selected universities. The table indicates the acceptance of qualifications as follows:

- ✔ Direct entry: Direct entry to Bachelor degree programme, and if so what grades are requested
- ✔Advanced Standing: Advanced standing (typically subject to achievement of certain grades or subject combinations, above those accepted for direct entry)
- ✔* Direct entry: In most cases, the asterisk is used to indicate restrictions in place, for example where only certain streams of the HSSC are accepted
- ✗： Further study required[5]
- **N/A:** No information given, the qualification is not included on the list of acceptable entry requirements, which it is acknowledged may not be exhaustive.

Having reviewed the acceptance of the IB DP and HSSC by country, a summary of findings for 25 highly ranked universities demonstrates the acceptance rate of each qualification. These 25 were selected by first narrowing the sample to those institutions providing information on *both* qualifications, leaving 32 universities. These were then put in order of their THE rank to select the highest 25 universities, which were as follows:

[5] In most cases this was specified as an international foundation programme, but some universities additionally specified the first year of undergraduate study in home country, or an alternative secondary school qualification.

Table 4: Institutions included in the summary of IB DP and HSSC recognition for undergraduate study

Institution	THE Rank 2016
University of Oxford	1
University of Cambridge	4
University of California Berkeley	10
University College London (UCL)	15
University of Toronto	22
The London School of Economics and Political Science (LSE)	25
University of Edinburgh	27
Ludwig-Maximilians-Universität München (LMU Munich)	30
University of Melbourne	33
University of British Columbia	36
McGill University	42
Heidelberg University	43
University of Hong Kong	43
Technical University of Munich	46
Hong Kong University of Science and Technology	49
University of Manchester	55
Humboldt University of Berlin	57
University of Sydney	60
University of Queensland	60
Boston University	64
University of Bristol	71
Free University of Berlin	75
Chinese University of Hong Kong	76
RWTH Aachen University	78
University of New South Wales	78

2.2.5 Evaluation and synthesis

The final stage of the project involved drawing together the key findings and conclusions from the review and comparative analysis. The key findings of each section are presented at the beginning of each report section.

3. Overview of the Pakistan School Education System

3.1 Oversight and administration

Both the provincial and federal governments are responsible for the education system in Pakistan. On a federal level, the education system is centrally organised by the Ministry of Federal Education and Professional Training which is responsible for the national policy and planning; supervision and maintenance of the standards curricula and textbooks for school education; funding and quality control for higher education; and direct administration of educational institutions in the Islamabad Capital Territory, Federally Administered Tribal Areas (FATAs), Azed Jammu and Kashmir. The Inter Board Committee of Chairmen (IBCC) and the Higher Education Commission (HEC) help the ministry with coordinating schools, technical schools and higher education respectively.

The Ministry of Federal Education and Professional Training also has control of the 26 provincial and federal boards of education, all of which are members of the IBCC. These boards are responsible for conducting external examinations for the Secondary School Certificate (SSC; or Matriculation Certificate) and the HSSC[6].

The provincial education departments are responsible for the implementation of the educational policy determined at the national level, the development of the school curriculum according to the federal guidelines and the conduct of the Grade 10 and 12 exit examinations.

3.1.1 The Federal Board of Intermediate and Secondary Education (FBISE)

For the purposes of this study, the external examination materials will be collated from the FBISE in Islamabad. The FBISE is responsible for the SSC and HSSC curriculum and external examinations in affiliated institutions.

The FBISE was established under the FBISE Act of 1975 and is in charge of the following jurisdictions:

- Islamabad Capital Territory
- All over Pakistan (Cantonments and Garrisons)
- Federally Administered Northern Areas
- Institutions established by Pakistan Missions or Citizens of Pakistan (overseas)[7].

Within these institutions, the FBISE is responsible for prescribing the course curriculum, ensuring adequate facilities, appointing examiners and supporting staff and conducting the external examinations that lead to the final mark in the SSC and HSSC.

[6] Sometimes also referred to as Higher Secondary Certificate (HSC) or Intermediate Certificate.

[7] Federal Board of Intermediate and Secondary Education, (n.d.). *Introduction*. [online] Available at: <https://fbise.edu.pk/introduction.php> [Accessed 9th November 2016].

3.2 National policies for education

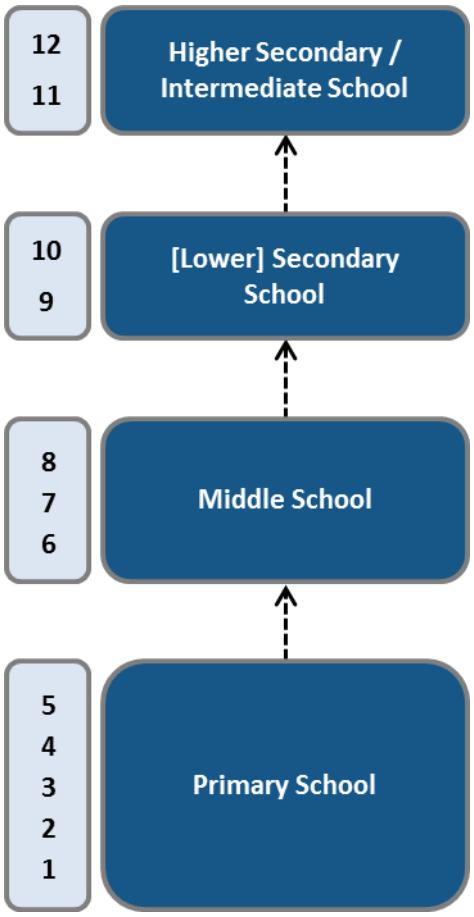
Multiple policy documents regarding the national education in Pakistan have been published since a National Education Conference convened in Pakistan in 1947. The most recent National Education Policy was published in 2009 by the Ministry of Education and sets out the aims and goals for improving education. This policy is reviewed further in Section 5 of this report.

Additionally, a National Curriculum was published in 2006 and introduced in schools in 2007. As of 2003, a review of the curriculum has been scheduled to take place every five years. Textbooks are compiled and produced for government schools based on this national curriculum by the Textbook Boards.

3.3 Structure and curriculum

Formal education in Pakistan lasts for 12 years, starting with primary school and finishing with Secondary school. The following table demonstrates the number of class years in each stage.

Figure 2: Class years in Pakistani school system



Primary school is run over five years and begins for students aged five. The medium of instruction is often Urdu[8], but regional languages may also be taught. Students will study the language of instruction, arts and crafts, mathematics, science, Pakistan studies, Islamiyat/Islamiat, or health and physical education.

After primary school, students continue to middle school which consists of three years (Grade 6-8) and includes the introduction of English and Arabic (or a different regional language) as compulsory subjects[9]. Those who successfully complete their studies continue to secondary schools for general education or to trade schools for vocational courses.

Secondary school is split into two phases: lower secondary (Grades VIIII and X) and higher secondary (Grades XI and XII). In lower secondary, there are three streams: science, humanities and technical and students study five subjects based on their chosen stream. Compulsory education ends at Grade X when students are 15-16, however enrolment rates are low at this stage of education (estimated at 29-40%)[10]. Upon successful completion of the programme and an external examination, conducted by one of the Boards of Intermediate and Secondary Education, students are awarded their first exit qualification, the SSC. Alternatively, students at technical schools or vocational institutions take examinations to receive the Skills Worker Certificate or Diploma, respectively[11]. The armed forces also administer a small number of schools within the government-funded school system for education at secondary and higher secondary level.

Higher secondary is viewed as a two-year university preparation course with students specialising in either science or arts subjects[12]. Each specialisation includes four compulsory subjects including: English, Urdu, Islamic studies/Civics (for non-Muslims) and Pakistan studies. Three or four additional subjects are studied that are related to the specialisation. Students who successfully complete their studies and pass the external examinations receive the HSSC (which as mentioned above, is also known as the Intermediate Examination Certificate). Completion of the HSSC is mandatory for progression to university.

A breakdown of the compulsory and additional subjects available to higher secondary students is demonstrated in the table below:

[8] At private school, the medium of instruction is often English.
[9] UK NARIC, n.d. *International Comparisons - Pakistan*.
[10] UK NARIC, 2016. *International Comparisons.*
[11] UK NARIC, 2016. *International Comparisons.*
[12] Including: General science, humanities, commerce, pre-medical, pre-engineering, medical technology or home economics.

Table 5: Compulsory and elective subjects in the HSSC[13]

Subject Groups	Sub-Groups and course subjects		Marks
Compulsory (500 marks)	English (Compulsory) / English (Advance)		200
	Urdu (Compulsory) / Urdu Salees In lieu of Urdu (Compulsory) / Pakistan Culture for Foreign Students Part I and Pakistan Culture Paper-II		200
	Islamic Education / Civics (for Non-Muslims)		50
	Pakistan Studies		50
Science Group (600 marks)	**Pre-Medical Group:**	Physics, Chemistry, Biology	200 for each subject
	Pre-Engineering Group:	Physics, Chemistry, Mathematics	200 for each subject
	Science General Group:	Students select one of the following combinations: 1) Physics, Mathematics, Statistics 2) Mathematics, Economics, Statistics 3) Economics, Mathematics, Computer Science 4) Physics, Mathematics, Computer Science 5) Mathematics, Statistics, Computer Science	200 for each subject
Humanities Group (600 marks)	Students select three subjects: • Arabic/Persian/French/English (Elective)/Urdu (Elective) • Economics • Fine Arts • Philosophy • Psychology • Statistics • History of Modern World/Islamic History/ History of Muslim India/ History of Pakistan • Islamic Studies • Health and Physical Education • Sindhi (Elective) • Civics • Education • Geography • Sociology • Mathematics • Computer Science • Islamic Culture		200 for each subject

[13] Federal Board of Intermediate and Secondary Education Islamabad, 2015. *Biology Syllabus- Grade XII.*

Subject Groups	Sub-Groups and course subjects		Marks
	• Library Science • Outlines of Home Economics		
Commerce Group (600 marks)	**Grade XI (four subjects required**	• Principles of Accounting • Principles of Economics • Principles of Commerce • Business Mathematics	100 75 75 50
	Grade XII (four subjects required)	• Principles of Accounting • Commercial Geography • Computer Studies / Typing / Banking • Statistics	100 75 75 50
Medical Technology Group (600 marks)	**Students select one of the following:** 1) Medical Lab Technology Group 2) Dental Hygiene Technology Group 3) Operation Theater Technology Group 4) Medical Imaging Technology Group 5) Physiotherapy Technology Group 6) Ophthalmic Technology Group		Unknown

The final mark for the HSSC is out of a total 1100 marks. Students often receive the number of marks obtained out of 1100, in addition to an associated letter grade. Other grades may be awarded depending on the examination board conducting the examinations. One of the following marks may also be awarded to students:

Table 6: Grading scales for secondary examinations – percentage and grades

Grade	Percentage Mark	Comment
A1	80% and up	Outstanding
A	70-79.9%	Excellent
B	60-60.9%	Very good
C	50-59.9%	Good
D	40-49.9%	Fair
E	30-39.9%	Satisfactory

In addition to the above school system, private schools are available to students and are run separate from the government-funded schools. Some are English language orientated and offer international qualifications, such as the British A-levels or American SATs.

Religious seminaries are also available at primary to graduate level and are known as madrassas or madaris schools. The curriculum in these schools focusses on Islamic religion, culture, arts and sciences. On completion of Class 10, students receive an award known as the *Saanavia Aama*, and after Class 12 the *Saanavia Khaasa*. These are both legally

recognised as the equivalent of the SSC and HSSC in Pakistan when passes are obtained in Urdu, English and Pakistan studies[14].

[14] UK NARIC, 2016. *International Comparisons.*

4. Overview of the International Baccalaureate

The International Baccalaureate (IB) is a non-profit educational foundation founded in 1968. The IB is run internationally by three Global Centres in The Hague, Bethesda and Singapore. A Foundation Office is located in Geneva, the Assessment Centre is in Cardiff, and a final office is in Buenos Aires.

4.1 IB Philosophy and Learner Profile

The IB programmes are developed, delivered and maintained by the IB's philosophy to focus not only on academics, but also on personal, emotional and social skills. This is further demonstrated in the IB's mission statement as follows:

> "The International Baccalaureate® aims to develop inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect.
>
> To this end the organization works with schools, governments and international organizations to develop challenging programmes of international education and rigorous assessment.
>
> These programmes encourage students across the world to become active, compassionate and lifelong learners who understand that other people, with their differences, can also be right"[15].

All of the IB programmes hold a philosophy to develop their learner's academic and non-academic attributes. These ideals and descriptors are defined in the IB Learner Profile. The profile describes the types of learner the IB intends to develop, namely:

- Inquirers
- Knowledgeable
- Thinkers
- Communicators
- Principled
- Open-minded
- Caring
- Risk-takers
- Balanced
- Reflective.

Schools offering the programmes are expected to assist students in becoming an IB Learner. The Learner Profile attributes are discussed and compared to the key themes and underpinning philosophies of the Pakistani education system in the comparative analysis[16].

[15] The International Baccalaureate (n.d.). *Mission.*

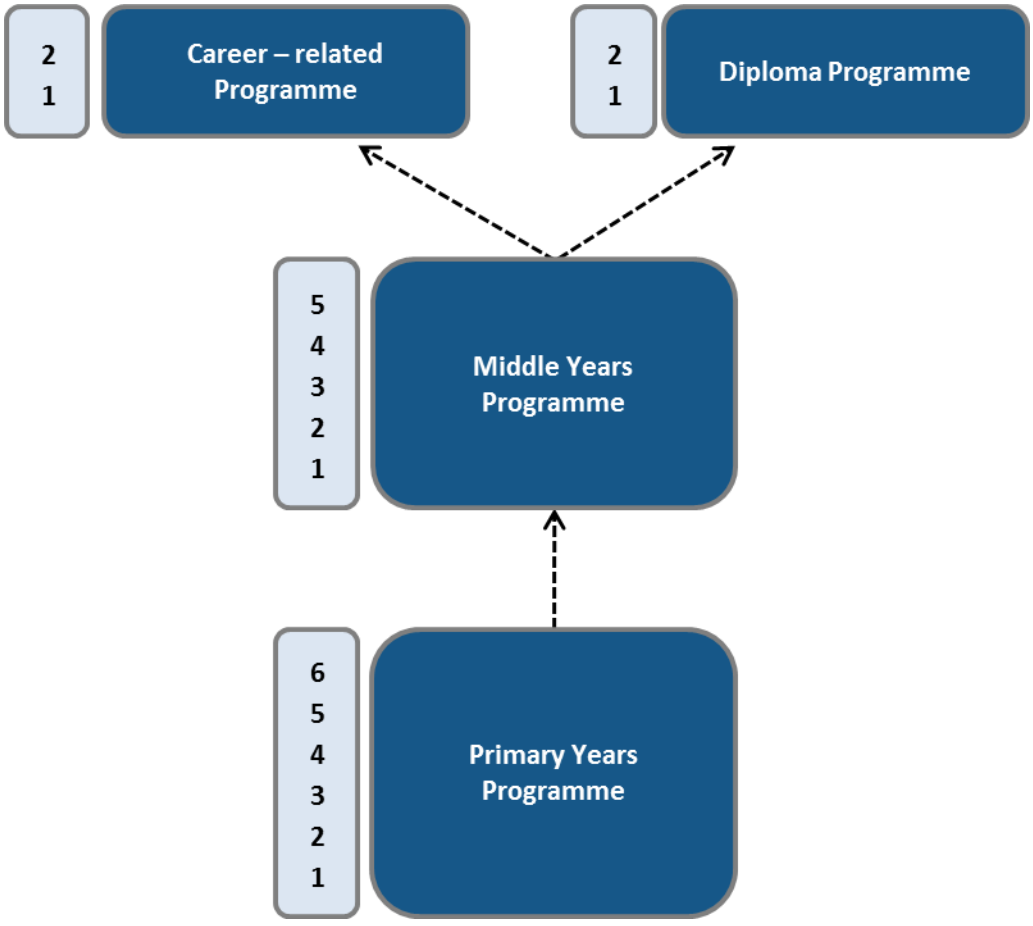
[16] For the full IB Learner Profile, please visit http://www.ibo.org/globalassets/digital-tookit/flyers-and-artworks/learner-profile-en.pdf.

4.2 Programmes

Four programmes are offered globally by the IB including the Primary Years Programme (PYP), Middle Years Programme (MYP), Diploma Programme (DP) and Career-related Programme (CP). All four programmes are delivered internationally in authorised schools, referred to as IB World Schools. The IB World Schools can deliver individual IB programmes or offer them as a continuum. Additionally, the programmes can be taught and assessed in three languages: English, French and Spanish.

In terms of duration, the IB PYP is generally run by schools as a five to six year programme[17] and the IB MYP as a two to five year programme. Both the IB DP and CP are two year programmes. The progression of the IB programmes, when taken in continuum, can be seen in the figure below. Equally, students can enter any of the below IB programmes without previous experience in an IB programme.

Figure 3: Progression of the IB programmes



[17] The PYP may be begin at age three and often concludes at grade 6 (however some schools run till grade 7).

4.2.1 IB Diploma Programme

The IB DP is a two-year programme offered to students between the ages of 16-19. In addition to the DP core[18], the programme consists of six courses chosen from the following subject groups:

Table 7: IB DP Programme subject groups

IB DP Subject Groups[19]
• Language and Literature • Language Acquisition • Individuals and Societies • Sciences • Mathematics • The arts.

Most subjects are offered at both higher level (HL) and standard level (SL), and students must take a combination of both (three or four at HL). The HL subjects are studied in greater depth and breadth than those at SL and with more teaching hours (240 hours for HL and 150 for SL).

No entry requirements are set for the IB DP, as students can come from the IB MYP and/or other qualifications or prior study. For some, but not all, students, the DP may be their first exit qualification for secondary school.

There is an option for students who are not enrolled in a full DP to take individual DP courses and assessment in order to receive a Diploma Programme Course results (DPCR). A DPCR can also be awarded to full DP students who do not meet the minimum requirements for a full DP.

All IB DP courses are assessed through a combination of external and internal assessment. The type and weightings vary for each subject and course. Students receive marks for each assessment that are combined for a final grade in each DP course. These grades range from 7 to 1 (7 is the highest score). The results of each course are combined for a total score in the DP. To receive the full DP students must achieve a minimum of 24 points in addition to successful completion of the DP core.

[18] The IB DP core is taken by all DP students and consists of the following three requirements: a theory of knowledge course (TOK) that allows for reflection on learning in all subjects, an extended essay of 4,000 words on a topic of interest, and a 'creativity, action, service' (CAS) experience.

[19] Students may opt to study an additional Science, Individuals and Societies, or languages course, instead of a course in the Arts.

4.2.2 Other IB Programmes

The Primary Years Programme

The IB PYP is delivered to students between the ages of 3-12 and expands beyond the academic curriculum to focus on the child as a whole. This curriculum includes three sections: what students should learn (written curriculum); how students should learn (taught curriculum); and how to determine what students have learned (assessed curriculum). The final year of the IB PYP includes a collaborative project referred to as the IB PYP exhibition.

The Middle Years Programme

The IB MYP is offered to students aged 11-16 and includes eight subject groups from which students choose their courses. An interdisciplinary unit, combining two or more subjects, is also required during each year of the programme. The IB MYP curriculum framework consists of the required concepts, skills and objectives that teachers must adapt into their teaching curriculum. From May 2016 onward, an IB MYP Certificate is awarded to students who complete examinations in five subjects, an ePortfolio in two subjects (or alternatively an examination on a second language), a personal project and community service.

The Career-related Programme

The IB CP is a two-year programme also offered to students between the ages of 16-19 and intends to provide students with transferable and lifelong skills and competences in preparation for further or higher education, apprenticeships or employment. As part of the curriculum, students take a minimum of two IB DP courses, a core (with four components) and engage in career-related study (i.e. a vocational qualification offered by BTEC, or OCR National[20]). All IB DP courses are externally examined, while the CP core is internally assessed.

[20] International Baccalaureate Organization, 2014. *The IB Career-related Programme: A Guide for Employers.*

5. Comparing the Philosophical Underpinnings of the IB DP and the Pakistani School System

Key findings

On the whole, similarities are evident to some extent between the philosophical underpinnings of IB DP and the NEP of Pakistan. Differences, where noted, reflect the differing contexts for which the IB education and NEP are written.

In particular, the NEP outlines the national strategy for education with emphasis on delivering an education system that reflects the needs and values of society in Pakistan. By contrast, the IB educational philosophy centres on the type of learner that IB programmes should develop (in terms of skills and qualities); and, being international in nature, does not adhere to one particular system, but instead provides an adaptable framework that can meet the needs of various institutions.

Nonetheless, the IB DP and NEP share some key principles and aims, in particular that both:

- Aim to develop a self-reliant individual, a global citizen, an original thinker and a responsible member of society
- Emphasise the importance of creating an inclusive environment for teaching and learning as well as widening educational access for all learners
- See that education can cater for the social, political and spiritual needs of individuals and society
- Recognise the value of teachers using student-centred pedagogy when delivering classes
- Strive to develop in students, a commitment to justice and equity.

The following sections will aim to elaborate the philosophy comparison underpinning the IB DP and the NEP with particular consideration given to the educational vision, aims and objectives of education, priorities and goals in relation to learning and development.

5.1 Introduction

In order to understand the educational vision, it is useful to provide a brief background on the establishment of the educational policy. According to the NEP 2009, education policies were first established in 1947. In 2005, an early review of the 1998-2010 NEP was completed because the Ministry of Education did not feel the desired educational outcomes were being achieved and that there needed to be a renewed commitment to the provision of quality education for all. This review led to the development of the White Paper in 2007 which forms the basis for the development of the current NEP 2009 document[21].

The purpose of the NEP is to act as a national strategy to guide the development of education in Pakistan and to enhance the overall well-being of its students. Thus, the NEP

[21] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*.

acknowledges the aspirational nature of the strategy and that the intended outcomes of the preceding policy had not been achieved in practice.

The NEP outlines existing overarching challenges, the educational vision for Pakistan, plans for overseeing reform and development of the education system, as well as specific analysis of challenges, priorities and action points for different levels and sectors of education ranging from early childhood to higher education, and including teacher education. It also discusses the role of Islam in education, reflecting that the Islamic ethos is part of the Constitution of the Islamic Republic of Pakistan and therefore, the NEP values the fostering of citizens and teachers who have a strong faith in religion and demonstrate the traditional principles of Pakistan.

5.2 Educational vision

The Ministry of Education, as stated in the NEP, has adopted the following vision:

> "Our education system must provide quality education to our children and youth to enable them to realize their individual potential and contribute to development of society and nation, creating a sense of Pakistani nationhood, the concepts of tolerance, social justice, democracy, their regional and local culture and history based on the basic ideology enunciated in the Constitution of the Islamic Republic of Pakistan"[22].

The educational vision of the NEP is based on the constitution of Pakistan's government which values the importance of creating an inclusive and egalitarian environment for teaching and learning, advancing the economic prosperity of the region by providing education for all citizens, eradicating illiteracy by providing free and compulsory secondary education as well as initiating steps to ensure the full participation of women in all spheres of national life.

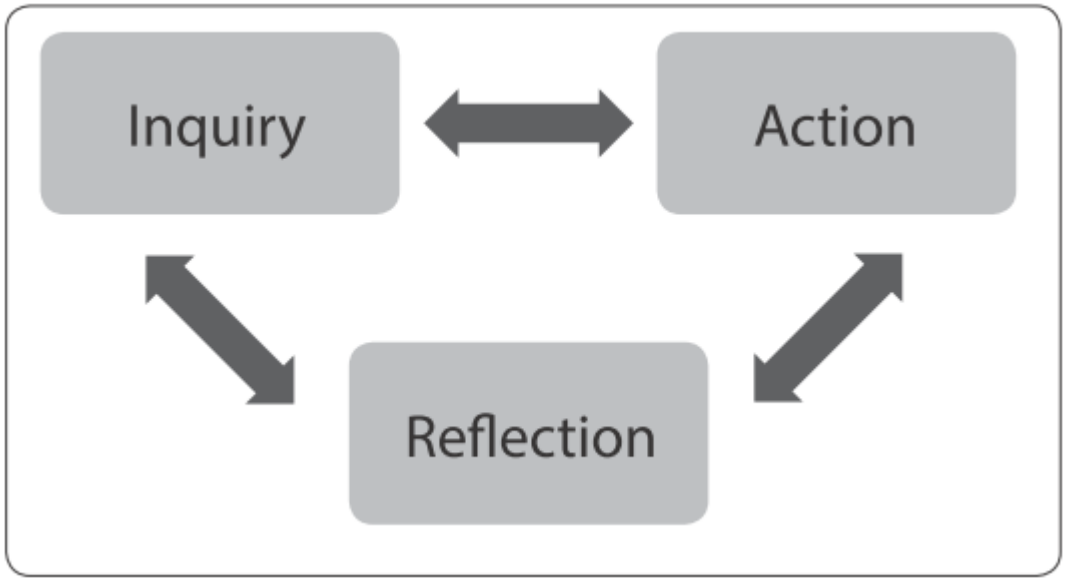
Although Pakistan's education vision aims to be inclusive, the NEP discusses their performance in creating a cohesive national system from a critical perspective, acknowledging: variations in terms of curriculum between public, private and madrassa schools and that enrolment in the different institutes is usually determined by financial or religious factors; that the participation gap amongst gender and rural-urban disparities have increased; and that there is an as-yet unresolved debate on what religious and moral values should be taught throughout the Pakistani educational system and how to accommodate the non-Muslim minorities.

The IB DP's education vision is to develop internationally minded people, who have a global vision and aim to create a better and a more peaceful world by enhancing their interpersonal attributes. These attributes make up the IB Learner Profile and include: being *Open-minded*, *Knowledgeable*, *Risk Takers*, *Balanced*, *Caring*, *Reflective*, *Thinkers*, *Principled* and *Communicators*. In addition, the IB DP (2015) states that it provides an international education that enables learners to understand complex issues of the world and equips them with lifelong skills that may help to contribute to their prosperity and to the betterment of the

[22] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*. p.17.

world. Hence, the fundamental principle underlying the teaching and learning in the IB stems from an understanding of working collaboratively together with diverse approaches represented as the collaboration between asking (inquiry), doing (action) and thinking (reflection). This approach leads towards open classrooms where different views and perspectives are valued. The diagram below demonstrates the interplay in the teaching and learning approach in the IB. "An IB education empowers young people for a lifetime of learning, both independently and in collaboration with others. It prepares a community of learners to engage with complex global challenges through a dynamic educational experience framed by inquiry, action and reflection"[23].

Figure 4: Teaching and learning in the IB



When reviewing the educational vision of the NEP, some clear parallels can be drawn from the IB, in terms of the IB Learner Profile. For example, the IB education seeks to develop a '*Caring*' learner that is characterised as showing "empathy, compassion and respect…commitment to service, and…act to make a positive difference in the lives of others and in the world around us"[24] and an '*Open-Minded*' learner that is defined as a learner who appreciates his/her own culture, personal histories, as well as the values and traditions of others. In addition, an open-minded learner tries to evaluate different viewpoints in order to grow from the experience. The IB DP aims to create learners who are "compassionate lifelong learners. An IB education is holistic in nature – it is concerned with the whole person. Along with cognitive development, IB programmes and qualifications address students' social, emotional and physical well-being. They value and offer opportunities for students to become active and caring members of local, national and global communities; they focus attention on the processes and the outcomes of internationally minded learning described in the IB learner profile"[25].

[23] International Baccalaureate Organization, 2015. *Diploma Programme: From principles into practice*. Internal document. p.9.
[24] International Baccalaureate Organization, 2015. *What is an IB Education? IB Learner Profile.*
[25] International Baccalaureate Organization, 2015. *Diploma Programme: From principles into practice*. Internal document. p.8.

In relation to the NEP's discussion of the role of religion in education, it is relevant to highlight that the IB, while secular and not subscribed to any one religious doctrine, does promote acceptance of diversity and acceptance of varying religious beliefs in line with its global orientation.

5.3 Aims and objectives

Leading on from the Educational Vision, the following section will relate some of the twenty aims and objectives of the NEP and review its similarity with the aims and objectives of the IB DP.

The NEP sets out a number of aims and objectives, many of which underpin or are compatible with the IB education.

✔ Development of a global citizen, able to think analytically, originally and independently and contribute to society

The NEP seeks to develop a self-reliant individual, open to new ideas; an, original thinker; a responsible member of society, aware of human rights; and a global citizen; as well as nurturing the personality of the individual to be dynamic and creative. Similarly, the IB Learner Profile aims to develop a well-rounded 'competent and active citizen'. Particularly, it aims to develop *Thinkers*; nurturing students to understand what it means to be human, to "make sense of their place in an increasingly interdependent, globalized and digitized world. International-mindedness, therefore, starts with self-awareness and encompasses the individual and the local/national and cultural setting of the school as well as exploring wider global perspectives"[26].

✔ Ensure an education that caters for the social, political and spiritual needs of individuals and society

The NEP aims to "revitalise the existing education system with a view to cater to social, political and spiritual needs of individuals and society"[27]. Similarly, the IB DP aims to create a '*Balanced*' student, an IB Learner Profile attribute that is defined as balancing different aspects of intelligence, physicality and emotion in order to achieve well-being for the individual and others. In addition, it echoes similar sentiments with the principles of IB DP in practice, where it aims to develop the unique potential of the learner to be able to understand and enjoy the social and moral aspects of his or her environment.

Moreover, the NEP plays a crucial part "in the preservation of the ideals, which lead to the creation of Pakistan and strengthen[s] the concept of the basic ideology within the Islamic ethos enshrined in the 1973 Constitution of Islamic Republic of Pakistan"[28]. In comparison, the IB DP is an international qualification that does not prescribe to one national system and therefore does not reference the Pakistan or any one nation's constitution. However, IB

[26] International Baccalaureate Organisation, 2015. *Diploma Programme: From principles into practice*. Internal document. p.7.
[27] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*. p.7.
[28] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*. p.7.

World Schools are able to adapt the IB DP at a curriculum level where appropriate standards meet national curriculum requirements. “Each school is unique and needs to consider its own context and the community it serves before deciding on the best way forward”[29].

In addition to the above NEP aim, some of the aims and objectives of the NEP are closely linked with developing a whole sector view of the education system, promoting nationhood and a welfare State. Also, some of the aims are associated with Pakistan’s commitment to achieve the Dakar Framework of Action EFA Goals and Millennium Development Goals relating to education. Meanwhile, the IB DP focusses primarily on the learner and does not intervene with national or governmental policies.

The NEP also aims to “promote national cohesion by respecting each other’s faith, religion, cultural and ethnic diversity”[30] as well as promoting “social and cultural harmony through the conscious use of the educational process”. Although the IB DP does not prescribe aims specifically related to ‘national cohesion’, it does, as highlighted above under *Educational Vision*, try to develop a learner who is equally respectful to both themselves and others[31]. This is reflected within the IB Learner Profile which aims to develop an *Open-Minded* learner who is able to “critically appreciate [their] own cultures and personal histories, as well as the values and traditions of others”[32] and a *Caring* learner that shows empathy, compassion, respect and a commitment to serving the local community in a positive manner.

Overall, the IB DP seeks to provide students with an international education that encourages them to have a better understanding and appreciation of other cultures, languages and points of view.

✔ Ensure the commitment to justice and equity

The NEP aims to raise awareness of human rights and encourages their learners to commit to democratic and moral values by engaging in activities that are conducive to the betterment of society. Likewise, the IB DP similarly aims to develop a *Principled* learner that is defined as behaving with a sense of integrity, justice towards all and have a conscious responsibility towards individual actions. This adheres to developing students with a strong sense of fairness, justice and respecting the dignity as well as the rights of people everywhere.

Overall, the common comparison appears to be with NEP’s aim to widen access to education for all as well as to improve the quality of education to address the needs of the economy. The NEP also aims to create an inclusive environment for learning and to establish better provisions for encouraging the participation of girls as well as special needs learners. Hence, the policy as a whole is striving to be more inclusive. This NEP policy may relate more closely with IB DP’s ethos that aims to widen its accessibility of the programme in addition to expand student participation. Furthermore, the IB DP claims that “learning

[29] International Baccalaureate Organization, 2015. *Diploma Programme: From principles into practice*. Internal document. p.18.
[30] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*.p.7.
[31] International Baccalaureate Organization, 2015. *What is an IB Education?* p 3.
[32] International Baccalaureate Organization, 2015. *What is an IB Education? IB Learner Profile.* p7.

communities become more inclusive as they identify and remove barriers to learning and participation. Therefore, commitment to access and inclusion represents the IB learner in action"[33]. Lastly, the NEP aims to enable the learner to earn honestly their own livelihood through skills that contribute to the national economy and allows them to make informed decisions in life. Similarly, the IB DP aims to foster responsible individuals, for example "In 1968, the IB Diploma Programme (DP) was established to provide a challenging and comprehensive education that would enable students to understand and manage the complexities of our world and provide them with skills and attitudes for taking responsible action for the future"[34].

5.4 Overarching priorities

The overarching priority of the NEP is to widen access to and raise the quality of education. To this end, the NEP defines a large number of goals and policy actions targeting all levels of education, from primary to higher education. This includes ensuring equal educational opportunities for all citizens, encouraging their participation and at the same time committing to achieve the Dakar Framework of Action, EFA Goals and Millennium Development Goals.

This overarching priority is underpinned by several recurring themes. Firstly, that the objective of education is to develop an independent individual, who is capable of utilising both analytical and original thinking skills; and a responsible member of the community: "It is imperative to identify and, possibly define, the touchstone for development of the child as a member of society. Each culture has its own ethos that bears relevance for its individual constituents…"[35].

This closely aligns with IB DP's learner's profile of *Inquirers*, *Thinkers and Principled* for nurturing the curiosity of the learner in developing critical thinking skills in order to analyse, take responsible action, demonstrate empathy as well as respect the local and international community. It similarly reflects the IB DP's approach to teaching and learning in action that commits to creating an inclusive environment for learning and teaching as well as increasing access and participation in learning for all students[36].

Through the NEP, it appears imperative that education is seen as a vital economical investment for both the individual – "The other relevance of education is its ability to provide the graduates with an opportunity to earn a living. Education should be able to increase the earning potential of the individual who is literate; irrespective of the eventual vocation opted;"[37] – and the nation as a whole, given its crucial role for economic growth and social advancement. Though not explicitly part of the IB DP, the IB does clearly state that economic factors should not be a barrier in accessing education and that "Schools are

[33] International Baccalaureate Organization, 2015. *What is an IB Education?* p.3.
[34] International Baccalaureate Organization, 2015. *What is an IB Education?* p.1.
[35] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*. p.19.
[36] International Baccalaureate Organization, 2015. *Diploma Programme: From principles into practice*. Internal document. p.9.
[37] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*. p.19.

encouraged to explore the full range of financial resources that may be available to their students"[38].

5.5 Goals and policy actions

The NEP report highlights two shortcomings in the Pakistan school education system. One being low access to education due to the lack of commitment to education; the second is the poor quality of education. Reasons for these issues could be due to the lack of belief in the value of education for socio-economic, human centred development and potentially a lack of belief in the goals themselves. Moreover, a way forward as suggested by the NEP would be to "require a fundamental change in the thinking that informs policy at all levels"[39].

The NEP outlines a number of goals and policy actions to support the enhancement and development of the education system. Many are highly specific, but there are also a number which indicate the compatibility of the IB DP to the Pakistan context.

In the context of learning and development, both overall and at higher secondary level, this includes the goal to emphasise the importance of moving ahead with uniformity in the structure of education and at the same time allow for reflection of local cultural context; decrease disparities across the provinces and support coordination and sharing of experiences that could enhance the teaching and learning process. These goals are closely linked with the IB, for example in terms of the DP's organisation structure and collaborative planning that enables teachers to gain an overview of their students' learning experiences. According to the IB DP curriculum it is suggested that "Collaborative planning and reflection must take place regularly and systematically in support of programme implementation. It can help schools develop a curriculum that reflects and supports the school's identity, including elements such as education for citizenship, outdoor adventure, experiential education and service within the community. Collaborative planning and reflection can address many aspects such as approaches to learning (ATL) planning, IB learner profile attribute development, theory of knowledge (TOK) integration, and vertical and horizontal articulation"[40]. The IB DP programme also aims to provide 'conceptual learning'[41] that builds the individual capacity of the student to engage with complex ideas and be able to transfer learning to new contexts.

One difference noted is that whilst the NEP clearly states the importance of collaboration with the stakeholder at all levels of education, policy development and programme delivery, the IB DP focusses more on the type of learner it aims to develop.

Teacher training and professional development is also highlighted in the NEP. Firstly, in that the NEP aims to contribute towards teacher's professional development, with the government aiming to implement this by incorporating a reward scheme to increase

[38] International Baccalaureate Organization, 2015. Diploma Programme: From principles into practice. Internal document. p.30.
[39] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*. p.15.
[40] International Baccalaureate Organization, 2015. *Diploma Programme: From principles into practice*. Internal document. p.55.
[41] International Baccalaureate Organization, 2015. *What is an IB education*? Internal document. p.8.

teachers' salaries. To achieve this, the government will draw resources from the private sector through public-sector partnership. It is stated that "development of detailed implementation plans, priorities and strategies is the key to success of the National Education Policy. This is exclusively the task of the provincial and district governments"[42].

Secondly, the NEP suggests that the revised curriculum will be supported by teacher training to promote more student-centred learning. Similarly, the IB DP's educational ethos evolves around student-centred education. Linked to this, is the NEP's intention that in-service teacher training promotes teaching strategies which connect the curriculum taught in the classroom to real life situations and develop conceptual understanding through a curriculum that focusses on concepts, content and skills. Teachers apply the conceptual understanding by integrating learning and organising coherent and relevant ideas across subject areas. In addition, students are encouraged to transfer knowledge and skills across subjects.

Likewise, the IB DP prioritises professional development of their teachers and provides access to online resources as well as training workshops; the curriculum, teaching strategies and assessment are all designed to help students see the links between what they learn in the classroom with the real world. The IB DP supports conceptual learning by using different contexts in the teaching and learning strategies. Johnson (2002, cited in IB 2015, p.83) quoted that "the heart of contextual teaching and learning is the connection that leads to meaning. When young people can connect the content of an academic subject with their own experience, they discover meaning, and meaning gives them a reason for learning. Connecting learning to one's life makes studies come alive"[43].

Lastly, the NEP is aiming to design culturally sensitive training materials for students and teachers to promote Life Skills-Based Education (LSBE) whilst the programme model of IB DP not only equips students with academic and interpersonal skills, but values the development of "life skills needed to live a fulfilled and purposeful life"[44].

[42] Ministry of Education Government of Pakistan, 2009. *National Education Policy 2009*. p.61.

[43] International Baccalaureate Organization, 2015. *Diploma Programme: From principles into practice*. Internal document. p.83.

[44] International Baccalaureate Organization, 2015. *Diploma Programme: From principles into practice*. Internal document. p.5.

6. Comparing the Content and Assessment of the IB DP and the HSSC in Selected Subjects

6.1 Mathematics

Key findings

Both the HSSC and IB DP aim for students to become knowledgeable in mathematics, develop logical thinking, reasoning and graphing skills, and an appreciation of technology. The four National Curriculum standards for mathematics are similarly represented in the IB DP, with the exception of *Measurements and Geometry* in which only some of the benchmarks are included in the IB DP.

Many key mathematics topics are covered in both programmes including: trigonometry, functions, vectors, and probability. Most of the sub-topics set in the Pakistan National Curriculum are similarly included within the IB DP content outline and overall the curriculums are of a similar depth and breadth. For these shared topics, the IB DP sets similar expectations on the content that students are expected to learn.

Minor differences were identified in the mathematical topics that are taught in each programme. For example, the Pakistan National Curriculum includes topics on conics, linear programming, and matrices; whereas the IB DP teaches statistics and discrete mathematics.

In terms of assessment, the IB DP and HSSC include a similar duration and volume of externally assessed written examinations. Additionally, both programmes place the majority of the examination weighting on the assessment of student's application skills. However, the following differences were identified between the assessments:

- The IB DP assessment comprises compulsory multi-part structured questions that are worth a higher number of marks in comparison to the HSSC
- The IB DP places greater weight than the HSSC on assessing a student's ability to communicate mathematically
- The HSSC uses multiple choice questions which are not included in the IB DP
- Unlike the HSSC, the IB DP does not include questions that solely test a student's ability to recall their mathematical knowledge.

Although IB DP mark schemes were reviewed, no FBISE mark schemes were available in the public domain and therefore it was difficult to determine if, like in the IB DP, HSSC students are required to show their method when coming to an answer and whether or not accuracy marks are dependent or independent of this.

6.1.1 Aims and objectives

The *National Curriculum for Mathematics Grades I-XII*[45] includes an outline of the curriculum, assessment, benchmarks and standards for Grades I-XII. Many of the Pakistan national curriculum documents include aims and objectives for each of the subjects; however the Mathematics national curriculum does not include aims or objectives but rather provides the following themes that apply to all grades within the Mathematics national curriculum. These themes were searched for in the *IB DP Mathematics HL Guide*[46]*.*

Table 8: Aims and objectives of the Pakistan and IB DP Mathematics

Pakistan National Curriculum Mathematics [47]	Included in the IB DP
The curriculum is designed to help students build the solid conceptual foundation in Mathematics that will enable them to apply their knowledge skilfully and further their learning successfully	✓
The curriculum emphasizes on the geometrical concepts that enable the students to think logically, reason systematically and conjecture astutely	✓
The curriculum stresses graphics that enable the students to visualize and interpret mathematical expressions correctly rather to manipulate them 'blindly'	✓*
The curriculum recognizes the benefits that current technologies can bring to the learning and doing mathematics. It, therefore, integrates the use of appropriate technologies to enhance learning in an ever increasingly information-rich world.	✓

The aims of the Pakistan National Curriculum for Mathematics are similar to the aims found in the IB DP with both emphasising that students should develop key mathematical concepts and logical, critical and analytical thinking skills. Using technology and understanding its benefits to mathematics is similar to the IB DP aim to "appreciate how developments in technology and mathematics have influenced each other"[48]. Similarly, the Pakistan National Curriculum highlights that students should be able to visualise mathematical expressions using graphics. Although this is not a direct aim of the IB DP, it is implied within the use of technology, and additionally, the IB DP Mathematics Guide where the use of graphic calculators and technology to "enhance visualisation" is highlighted.

To observe the HSSC in practice, the objectives from the FBISE are also useful to compare with the IB DP. In addition, the FBISE includes the aim to enable students to apply their mathematical understanding in other disciplines, an aim echoed by the IB DP to "apply and transfer skills to alternative situations, to other areas of knowledge and to future

[45] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Mathematics Grades I-XII 2006*. [pdf].
[46] International Baccalaureate Organization, 2016. *Diploma Programme Mathematics HL Guide - First examinations 2014*. Internal document.
[47] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Mathematics Grades I-XII 2006*. [pdf].
[48] International Baccalaureate Organization, 2016. *Diploma Programme Mathematics HL Guide - First examinations 2014*. Internal document.

developments"[49]. The objective for students to be able to communicate mathematics clearly is also shared between the programmes.

In addition to these aims, the IB DP further wishes for students to enjoy and appreciate mathematics, the work of mathematicians and the international dimension in mathematics including its multicultural and historical perspectives.

6.1.2 Learning outcomes

The *National Curriculum for Mathematics Grades I-XII*[50] includes a series of benchmarks for a set of five standards that indicate the competencies that students are expected to develop at each of the five developmental stages; the fifth being Grade XI-XII. These are also supplemented by a large set of content specific and detailed learning outcomes for each of the curriculum units. The below table compares these Grade XI-XII benchmarks with the IB DP aims and syllabus content, as the IB DP does not prescribe learning outcomes.

In some cases, the Pakistani benchmarks are similar to the topics included in the IB DP list of expected prior learning (before completing the IB DP). For example, "use appropriate laws of trigonometry to solve the triangles" is part of the expected trigonometry knowledge to know "simple applications for solving triangles". These have been highlighted in the table below as 'Expected Prior Learning'.

Table 9: Learning outcomes of the Pakistan Grade XI-XII and IB DP Mathematics

Pakistan National Curriculum Mathematics Grade XI-XII		Included in the IB DP
Standards	**Benchmarks** *The students will be able to:*	
Numbers and Operations	Identify complex numbers and their properties and carry out basic operations on complex numbers	✓
	Evaluate determinant, find inverse and rank of a matrix	✓*
	Explain and construct various sequences, and series of real numbers	✓
	Apply principle of Mathematical Induction to prove statements, identities and formulae	✓
	Find approximate values of the binomial expansions having indices as rational numbers	✓
	Integrate technology to aid the process of mathematical exploration	✓
Algebra	Solve equations with complex coefficients	✓
	Solve system of homogeneous and non-homogeneous linear equations by appropriate method (matrix inversion, Gauss elimination, Gauss Jordan and Cramer's rule)	✓
	Analyze attributes of functions and give their graphical representation	✓

[49] International Baccalaureate Organization, 2016. *Diploma Programme Mathematics HL Guide - First examinations 2014*. Internal document.
[50] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Mathematics Grades I-XII 2006*. [pdf].

Pakistan National Curriculum Mathematics Grade XI-XII		Included in the IB DP
Standards	**Benchmarks** *The students will be able to:*	
	Evaluate limits of functions	✓
	Differentiate and integrate algebraic and transcendental functions	✓*
	Find extreme values of a function	
	Solve ordinary differential equations of first order and first degree	✓
	Find orthogonal trajectories of a given family of curves	✓*
	Find partial derivatives of a function of two variables and verify Euler theorem	✓
	Solve non-linear equations in one variable by numerical techniques	
	Evaluate definite integrals by numerical methods	✓
	Integrate technology to aid the process of mathematical exploration	✓
Measurements and Geometry	Identify vectors in space and apply vector addition, dot/ cross product, scalar triple product	✓
	Differentiate and integrate vector functions	
	Use appropriate laws of trigonometry to solve the triangles	Expected Prior Learning
	Apply trigonometric formulas to find area of a triangle	✓
	Find radii of circles connected with triangles and prove their relationships	Expected Prior Learning
	Interpret graphically the algebraic and transcendental functions	✓
	Interpret and recognize equations of a straight line in standard form	Expected Prior Learning
	Show the concurrency of right bisectors/ medians/altitudes of a triangle	Expected Prior Learning
	Identify and analyse conic sections (circle, parabola, ellipse and hyperbola)	
	Integrate technology to aid the process of mathematical exploration	✓
Information Handling	Solve real life problems involving arithmetic/geometric sequence and series	✓
	Use partial fractions to find sum to *n* terms and to infinity the series	✓*
	Find sum to n terms of arithmetico-geometric series	✓*
	Solve problems involving permutation and combination	✓
	Use various methods to solve probability problems	✓
	Integrate technology to aid the process of mathematical exploration	✓
Reasoning and Logical Thinking	Identify valid and invalid arguments	✓*
	Apply mathematical ideas and arguments logically	✓
	Use graphics to optimize a situation	✓*
	Acquire ability to apply mathematics in physical situations and use	✓

Pakistan National Curriculum Mathematics Grade XI-XII		Included in the IB DP
Standards	**Benchmarks** *The students will be able to:*	
	numerical techniques to find approximate solution	
	Develop and communicate logical proofs and counter examples for geometrical and mathematical statements.	✓*

As the above table demonstrates, the majority of the Pakistan benchmark statements are similarly reflected within the IB DP aims or syllabus content outline. One Pakistan benchmark statement, "integrate technology to aid the process of mathematical exploration" is repeated in each of the Pakistan standards, and is similar to the IB DP aim to appreciate the importance of technology in mathematics.

Many of the other Pakistan benchmarks statements are reflected in the IB DP syllabus content. For example, the benchmarks for the *Numbers and Operations* standard are broadly similar to content included under the IB DP *Algebra* topic. Overall, many of the benchmarks under the five standards were similarly found under the IB DP topics, with the exception of *Statistics and Probability* (core and optional) and the optional *Sets, relations and groups* topics.

Further Pakistan benchmarks were only partially identified within sections of the IB DP. For many of these benchmarks, only broadly similar mathematical topics could be found within the IB, but often the topic was covered in a different context than in Pakistan. For example, the benchmark to "find orthogonal trajectories of a given family of curves" could be seen as partially similar to the IB DP content on indefinite integrals in which these are "interpreted as a family of curves".

6.1.3 Content and structure

The *National Curriculum for Mathematics Grades I-XII*[51] includes a content outline for each grade with units, sub-units and corresponding learning outcomes. The following table lists these units and the curriculum of the IB DP Mathematics HL programme.

[51] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Mathematics Grades I-XII 2006*. [pdf].

Table 10: Content in the Pakistan and IB DP Mathematics

	Pakistan National Curriculum Mathematics [52]	IB DP Mathematics HL
Topics	**Grade XI** • Complex Numbers • Matrices and determinants • Vectors • Sequences and series • Miscellaneous series • Permutation, combination and probability • Mathematical induction and binomial theorem • Functions and graphs • Linear programming • Trigonometric identities of sum and difference of angles • Application of trigonometry • Graphs of trigonometric and inverse trigonometric function and solution of trigonometric equations. **Grade XII** • Introduction of symbolic package: Maple • Functions and Limits • Differentiation • Higher order derivatives and applications • Differentiation of vector functions • Integration • Plane analytic geometry – straight line • Conics I • Conics II • Differential equations • Partial differentiation • Introduction to numerical methods.	**Compulsory topics:** • Algebra • Functions and equations • Circular functions and trigonometry • Vectors • Statistics and probability • Calculus • Mathematical exploration **Optional topics (students must study one of the following):** • Statistics and probability • Sets, relations and groups • Calculus • Discrete mathematics.
Number of topics	12 topics in each grade	8 topics overall
Recommended Teaching hours	Grade XI: 280 periods (40 minutes each period; 11,200 minutes (or 186 hours and 30 minutes)	240 hours overall

[52] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Mathematics Grades I-XII 2006*. [pdf].

	Pakistan National Curriculum Mathematics [52]	IB DP Mathematics HL
	Grade XII: 280 periods (40 minutes each period; 11,200 minutes (or 186 hours and 30 minutes)	

In addition to the number of teaching hours for each unit/topic, the Pakistan National Curriculum sets out the weightings for each unit/topic. In Grade XI, Algebra makes up 60% of the curriculum, Trigonometry 30% and Vectors 10%. In Grade XII Calculus makes up 60% of the curriculum, Analytic Geometry 30% and Numerical methods 10%.

Table 11: Content comparison of the Pakistan and IB DP Mathematics

Pakistan National Curriculum Mathematics Grade XI-XII		Included in the IB DP
Grade XI	Complex Numbers	✓
	Matrices and determinants	
	Vectors	✓
	Sequences and series	✓
	Miscellaneous series	✓
	Permutation, combination and probability	✓
	Mathematical induction and binomial theorem	✓
	Functions and graphs	✓
	Linear programming	
	Trigonometric identities of sum and difference of angles	✓*
	Application of trigonometry	✓
	Graphs of trigonometric and inverse trigonometric function and solution of trigonometric equations.	✓*
Grade XII	Introduction of symbolic package: Maple	
	Functions and Limits	✓*
	Differentiation	✓
	Higher order derivatives and applications	✓
	Differentiation of vector functions	
	Integration	✓
	Plane analytic geometry – straight line	
	Conics –I	
	Conics II	
	Differential equations	✓*
	Partial differentiation	✓*
	Introduction to numerical methods.	

As seen in the table above, the majority of the Grade XI topics, and broadly half of the Grade XII, are similarly found in the IB DP Mathematics syllabus content, in particular the core IB DP topics. Both the Pakistan and IB DP syllabi provide a detailed outline of the content and sub-topics to be taught, however the Pakistan National Curriculum includes detailed lists of each term, function and equation that should be taught, whereas the IB DP focusses on listing concepts, rules and theorems supplemented by the key equations and functions. For example, the concepts of permutation, combination and probability are all similarly included in both curriculums, with many similar sub-topics/sub-units referenced in both. However, matrices, included in the Pakistan National Curriculum, are not directly referenced within the IB DP topic outline.

Vectors is similarly taught in both programmes, with common topics discussed related to scalars and the concepts and components of a vector. Some of the sub-units or sub-topics differ slightly, however, in that the Pakistan National Curriculum includes dot product, cross product and scalar triple product. Although these are not directly referenced within the IB DP curriculum document, there is clear scope for these sub-topics to be included.

Despite both programmes including the overarching topics of trigonometry, some of the sub-topics and sub-units do not cover similar content. However, a similar breadth and depth of trigonometry topics are included in both programmes.

A symbolic package (presumed to be a computer programme) called ‘Maple’ is also referenced in the Pakistan National Curriculum and, as expected, is not found within the IB DP. This programme is introduced in the first unit for Grade XII and is integrated into many of the following units.

Some of the topics taught in the Pakistan National Curriculum are stated prior learning topics for the IB DP. These include commutative properties, right-angle trigonometry, geometry (i.e. the circle, sector, arc, sector, tangent and segment) and content related to coordinate geometry (i.e. The Cartesian plane, and the mid-point of a line segment and distance between two points in the Cartesian plane).

To examine the Pakistan National Curriculum in practice, the syllabus outline from the FBISE was compared with the IB DP to determine if any of the above topics not found in the IB DP could be further contextualised in the FBISE. In general, the FBISE syllabus outline includes some structural differences from the Pakistan National Curriculum. In Grade XI, it was noted that the syllabus does not include any topics related to linear programming, however it does include matrices; overall, similar topics are covered in the FBISE and IB DP. The Grade XII also includes the majority of the topics from the national curriculum; however it does not reference the ‘Maple’ programme.

Overall, the Pakistan curriculum (as demonstrated in the National Curriculum and the FBISE) prescribes a slightly smaller breadth but similar depth of mathematics topics compared to the IB DP (when considering the Core topics and one optional topic). However, there are further differences in the topics taught. In addition to the Core IB DP topics (which were broadly

similar to the Pakistan topics), the IB DP syllabus features four optional topics with sub-topics that are not similarly taught in the Pakistan programme.

6.1.4 Assessment methods

The table below shows the use and weighting of external and internal assessment of the HSSC and IB DP Mathematics HL respectively:

Table 12: HSSC and IB DP Mathematics assessment methods and weighting

	FBISE HSSC Mathematics	IB DP Mathematics HL
External assessment		
Weighting	100%	80%
Methods	Written examination, under test conditions	Written exam, under test conditions
Internal assessment		
Weighting	0%	20%
Methods		Project

As this shows, the HSSC is assessed entirely through written examination, whilst the IB DP Mathematics HL combines written examination with a student project. The project is a mathematical exploration where students are expected to write a short report of 6-12 pages on a relevant mathematical topic. More details on the skills assessed within the project are detailed further down.

The table below shows a more detailed breakdown of the summative assessment methods used by each board:

Table 13: HSSC and IB DP Mathematics assessment format

	FBISE HSSC Mathematics	IB DP Mathematics HL
Number and type of assessments each examination series	Two written papers: one on completion of Grade XI, one on completion of Grade XII	Three written exam papers One project
Duration	For each grade, the paper consists of two sections: • Section A: 25 mins • Section B and C: 2 hrs 35 mins	Paper 1 – 2 hrs Paper 2 – 2 hrs Paper 3 – 1 hr
Type(s) of question	Multiple choice questions Short answer questions	Short-answer questions Multi-part structured questions Extended problem questions
Total marks available	Grade XI – 100 marks • Section A – 20 marks	Paper 1 – 120 marks Paper 2 – 120 marks

	FBISE HSSC Mathematics	IB DP Mathematics HL
	• Section B – 40 marks • Section C – 40 marks Grade XII – 100 marks, distributed between sections A-C as outlined above.	Paper 3 – 60 marks

As shown in the table above, both programmes employ written examinations as the primary method of assessment in mathematics. The overall duration and volume of assessment is broadly similar, albeit longer in the IB DP: the HSSC papers for each year are three hours (making a total of six hours' assessment); the written examinations for the IB DP total five hours, but there is additionally the student project which adds to the overall assessment duration. In terms of volume, students have just over two and a half hours to answer 15 short-answer questions in the HSSC, whilst students of the IB DP have two hours to answer 12-14 questions (applicable to Paper 1 and 2). Many of these 12-14 questions are nonetheless further divided into sub-questions meaning the volume of assessment in conjunction with the shorter time available to answer the questions seems to be higher in the IB DP.

Question types and demand

As the above table shows, both awarding bodies employ short-answer questions in the assessment of mathematics. In the HSSC, this includes 10 questions worth four marks each, and five questions worth eight marks each, accounting for 80% of each year's exam. Though questions appear to be broken down into parts (e.g. Question 2, part a, b, c, d etc.), the parts are standalone questions which do not build on preceding parts or questions.

In contrast, the IB DP Mathematics HL makes use of multi-part structured questions. These multi-part questions present a complex problem in sub-questions where candidates are expected to calculate a particular value in the first sub-question, which can then be used to answer subsequent sub-questions. In some instances, the parts may be equally weighted, whilst in others the first part, involving a one-step calculation for example, would be worth two marks, with the subsequent part worth a notably higher number of marks.

By weighting questions equally in each section, the impact of a student being unfamiliar in a given topic is slightly less in the HSSC than in the IB DP papers, where the use of multi-part questions can mean that individual questions in a given paper may be worth anywhere from six to 19 marks of a 120-mark paper (5-15%) versus the HSSC (5-10%, based on Sections B and C).

In comparing the question types in the HSSC and IB DP Mathematics papers, two further key differences can be observed. The first is in the use of multiple-choice questions, which in the HSSC, account for 20% of each paper (and 20% of the overall mark for the subject). These multiple choice questions in the HSSC are used to test students' knowledge recall and understanding of mathematics as well as their ability to apply it, by completing

calculations and selecting the correct answer from a choice of four possible answers (distractors). By contrast, the IB DP Mathematics does not use multiple choice questions in any of its exam papers and questions typically focus on application. Whilst knowledge recall and understanding would inevitably be required, there are no questions solely testing this, whereas the HSSC includes a small number of questions specifically on recalling mathematical expressions and terms.

The second difference is the aspect of choice. In the IB DP, students may sit one of four elective papers for Paper 3, depending on the elective topic studied. The options are:

- Discrete mathematics
- Calculus
- Sets, relations and groups
- Statistics and probability.

Within the IB papers themselves however, all questions are compulsory; a direct contrast to the HSSC Mathematics papers where students can choose which questions to answer in Sections B and C of each paper. In Section B, students must answer 10 questions from a choice of 15, and in Section C, must answer five questions from a choice of seven.

The IB DP assessment of mathematics also places greater weight on students' ability to communicate mathematically. This is observed in the written exam papers which firstly require students to show workings for each question (discussed more fully below) and secondly include questions where students are expected to provide a short written explanation as to why a statement may be correct / incorrect, or whether a particular model is appropriate. This is also supported by the internally assessed project where students should write a written report, encompassing relevant formulae, diagrams, graphs as appropriate and providing accompanying commentary and reflection. Students' projects are assessed in part on their ability to communicate coherently (Criterion A: Communication), use mathematical language and representations appropriately (Criterion B: Mathematical Presentation) as well as their ability to analyse and evaluate (Criterion D: Reflection).

Overall both the IB DP and HSSC's assessment of mathematics places emphasis on testing students' ability to apply their mathematical knowledge to solve unseen equations and calculations. Nevertheless, students' ability to analyse and evaluate is evident in the IB DP assessment, with marks clearly allocated to these cognitive skills. The HSSC by contrast, allocates a small number of questions and accompanying marks to the testing of recall and understanding of mathematical terms.

In terms of content, the breadth of assessment is broadly similar in relation to the content breadth of each programme, although the option for HSSC to choose questions from a selection, would give some variation in the breadth of assessment depending on the individual's selection: for example, they could choose to primarily answer questions focussing on functions and circular functions. The IB DP assessments, with all questions being compulsory, test across all core areas of the IB DP Mathematics HL curriculum evident within the exam papers reviewed[53].

[53] Algebra; Calculus; Circular Functions and Trigonometry; Statistics and Probability; and Vectors.

The depth at which topics are covered appears to be greater in the IB DP assessments however. For example, in one of the HSSC papers reviewed, there were a number of standalone questions on circular functions, whilst in the IB DP, these would be assessed through multi-part structured questions which first require students to calculate an answer and use it to subsequently complete a further sub-question.

Marking approaches and guidelines

Marking guidelines are not published in the public domain by the FBISE and the following observations are therefore based on consideration of the exam paper instructions and mark allocations for the different questions. Part A contains multiple-choice questions worth one mark each indicating that the 20 marks available for this section would be awarded for accuracy only. Parts B and C instruct candidates to answer the questions in a separately provided answer book. Given the number of marks available per question (4 in Section B, and 8 in Section C), it would imply that marks are awarded both for accuracy and method: that is to say, that students should show their workings out. There are however no instructions to candidates about showing their workings meaning it is not wholly clear, both to the project team and potentially candidates themselves, what students are marked on.

By contrast, IB DP Mathematics examination papers clearly indicate that candidates should show their workings. These method marks are in many instances independent of accuracy marks meaning that if the candidate is able to demonstrate understanding and the ability to apply this in answering mathematical questions, but through error reach an incorrect answer, candidates may still obtain some marks. This also means that should a candidate reach the correct answer without showing their workings, full marks will not be awarded for that question.

6.2 Biology

Key findings

Both the IB DP and HSSC share similar aims for students to develop scientific and biological knowledge, understanding, and skills. Further, many similar expectations or benchmarks are set on what students should be able to demonstrate in terms of their scientific knowledge, how to construct new knowledge or reflect on what they have learned.

Where Pakistan benchmarks were not identified in the IB DP, this was often related to the slightly different scope of topics or sub-topics covered in programmes. For example, the Pakistan benchmarks to discuss or describe the historical development of biology or the political and social factors affecting this development are not similarly included within the IB DP curriculum. Nonetheless, both programmes cover a similar breadth and depth of biology topics with the exception of *Biology and Human Welfare* and *Biodiversity* which is covered in more depth in the Pakistan National Curriculum. Further, the IB DP covers *Cell biology*, *Ecology*, and *Genetics* in more depth.

The overall summative assessment methods for the HSSC Grade XI and Grade XII and IB DP are similar, as both assess the cognitive demands of knowledge, understanding and application of the learner through written and practical assessments.

Differences were identified after reviewing the duration, number of questions and weighting of questions in different sections of the summative assessments.

6.2.1 Aims and objectives

The *National Curriculum for Biology Grades XI-XII*[54] includes a set of aims that students should develop during the course. Further objectives are also prescribed that relate to each of the aims and provide further information on the expectations for students. The following table compares the Pakistan National Curriculum Biology aims (with the objectives considered to provide further context) with the aims for the *IB DP Biology Guide*[55].

Table 14: Aims and objectives of the Pakistan and IB DP Biology

Pakistan National Curriculum Biology[56]	**Included in the IB DP**
The course aims for students to develop:	
A scientific understanding of the living world	✓
Mental and motor abilities appropriate to the acquisition and use of biological understanding	✓

[54] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Biology Grades XI-XII 2006.* [pdf].
[55] International Baccalaureate Organization, 2015. *Diploma Programme Biology Guide - First assessment 2016.* Internal document.
[56] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Biology Grades XI-XII 2006.* [pdf].

Pakistan National Curriculum Biology[56]	Included in the IB DP
The course aims for students to develop:	
An appreciation of the products and influences of science and technology, balanced by a concern for their wise application	✓
An understanding of the nature and limitation of scientific activity	✓
An ability to apply biological understanding to appropriate problems (including those of everyday life) and to approach those problems in rational ways	✓
Respect for evidence, rationality and intellectual honesty	✓
Capacities to express themselves coherently and logically, both orally and in writing, and to use appropriately modes of communication characteristic of scientific work	✓
An ability to work effectively with others.	✓

As demonstrated in the table above, many of the Pakistan National Curriculum aims are also present in the IB DP. For example, the Pakistan National Curriculum states that students should have an understanding of the living world and of the nature and limitation of scientific activity. Similarly, the IB DP aims for students to "acquire a body of knowledge, methods and techniques that characterize science and technology" and to "develop an appreciation of the possibilities and limitations of science and technology". The ethical implications or awareness of certain applications of science are also similarly developed in both programmes.

The Pakistan National Curriculum aim to respect "evidence, rationality and intellectual honesty" is not a direct aim of the IB DP, but is nonetheless present in the IB DP's description on the *Nature of Science*[57] for biology, chemistry and physics courses; the IB DP emphasises that evidence and rationality are integral to science. Academic honesty is also key goal of the IB and supported by the IB attribute for learners to be *Principled*.

The Pakistan National Curriculum further aims for students to develop specific mental and motor abilities that will allow them to understand biology. Further examination of the objectives related to this aim demonstrates that students are expected to conduct research, investigations, and collect and analyse data. This is similar to the IB DP, which aims to "develop an ability to analyse, evaluate and synthesize scientific information" and "experimental and investigative scientific skills".

Although the final aim regarding working with others is more strongly emphasised in the Pakistan National Curriculum, the IB DP programme does include group work and collaboration, and the IB Learner Profile aims for all learners to "collaborate effectively"[58].

An examination of the FBISE Biology aims and objectives demonstrate that both programmes aim to develop knowledge and understanding; appreciation for science; and

[57] International Baccalaureate Organization, 2015. *Diploma Programme Biology Guide - First assessment 2016.* Internal document.
[58] International Baccalaureate Organization, 2015. *Diploma Programme Biology Guide - First assessment 2016.* Internal document.

practical skills including the use of techniques, methods and investigative skills. Some of the content specific or religious aims (i.e. “enable the student to appreciate that Allah (SWT) is Creator and Sustainer of the universe”) are not similarly reflected, but the overall goals are compatible.

One additional aim prescribed by the IB DP is for students to “develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge.”

6.2.2 Learning outcomes

The *National Curriculum for Biology Grades XI-XII*[59] prescribes standards and benchmarks that identify what Grade XI-XII students should know and be able to do at the end of the programme. The key concepts and themes from these benchmarks have been searched for within the IB DP, as seen in the following table:

Table 15: Learning outcomes of the Pakistan Grade XI-XII and IB DP Biology

Pakistan National Curriculum Biology		Included in the IB DP
Standards	**Benchmarks** *The students will be able to:*	
Using Scientific Knowledge	Explain viruses and viral diseases and the importance, evolutionary position, structure, modes of nutrition, reproduction and major groups of prokaryotes, protists and fungi	✓
	Describe the general characteristics and model life cycles of major plant groups	✓
	Analyse the diversity in animals in terms of invertebrate phyla and vertebrate classes	✓
	Analyse the structural and functional details of organelles and rationalize the use of latest techniques in cytology	✓
	Explain the classification of enzymes, mechanism of enzyme action, enzyme sensitivity and enzyme inhibition	✓
	Justify the roles and structures of organic molecules present in protoplasm	
	Interpret photosystems and distinguish the raw materials and products of each step of dark and light reactions and the glycolysis, Krebs cycle and election transport chain	✓
	Describe the functional details and abnormalities in the regions of human alimentary canal and identify the hormonal control of gut secretions	✓
	Evaluate and describe the transportation in plants and in man, Explain the control of heartbeat and the principles of electrocardiogram. Explain cardiovascular diseases and the latest treatments	✓
	Describe the functioning of the components of the first line of defense, the nonspecific defences and the inborn and acquired immunity	✓*

[59] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Biology Grades XI-XII 2006.* [pdf].

Pakistan National Curriculum Biology		Included in the IB DP
Standards	**Benchmarks** *The students will be able to:*	
	Identify the properties of leaves that make gaseous exchange possible and identify the properties of the air passage way in man relating with the mechanism of breathing and respiratory volumes, transportation of gases and respiratory disorders	✓
	Analyze the adaptations in plants and animals, including man for osmotic adjustments and thermoregulation. Evaluate the structure of human kidney, relate it with its functioning and with infections, stones and kidney failure and evaluate the principles of dialysis and kidney transplant	✓
	Explain the generation and transmission of nerve impulse and analyze the properties of receptors responsible for smell, tastes and touch, pain etc. Categorize nervous disorders and relate them with EEG, CT scan and MRI	✓*
	Compare the important human endocrine glands, their hormones, their functions, chemical nature, modes of action, feedback control and imbalance	✓*
	Introduce the nature of behavior and relate different examples with the innate behavior, learning and social behavior.	✓
	Identify the bones of human skeleton, ball-n- socket and hinge joints. Explain the action of antagonistic muscles at knee joint and describe the disorders of skeletal system	✓*
	Differentiate the types of muscles and describe the sliding filament model of muscle contraction	✓*
	Identify the structures in plants responsible for support and analyze the effects of plant growth regulators	
	Describe the human male and female reproductive systems, their hormonal regulation and relate these with infertility and STDs	
	Describe human embryonic development and birth and evaluate the concepts of postnatal development and aging	✓*
	Describe the chromosomal theory of inheritance and justify DNA as the hereditary material, the replication of DNA and explain gene expression and regulation	✓
	Evaluate the results of genetic crosses using the formula of probabilities and quote examples to explain the patterns of inheritance other than Mandelism	✓
	Analyze gene linkage, sex linkage and crossing over and compare different mechanisms of sex determination	✓
	Describe and evaluate the concepts and evidences of evolution	✓
	Analyze trophic levels and productivity and relate these with the water and nitrogen cycles. Describe ecological succession and population dynamics. Analyze human impacts on environment and identify environmental resources and evaluate their depletion	✓
	Describe the principles and application of recombinant DNA technology, polymerase chain reaction, DNA sequencing, DNA analysis, tissue culturing and constructing genome maps	✓

Pakistan National Curriculum Biology		Included in the IB DP
Standards	**Benchmarks** *The students will be able to:*	
	Evaluate the importance of vaccination and the role of microbes in human welfare	✓*
	Evaluate the techniques used in animal husbandry; to enhance crop and fruit yields and in home gardening	
	Identify cellular and tissue level structure from prepared slides, cultures, preserved materials, living materials and diagrams	
	Investigate and/or demonstrate the phenomena of life and the effects of variables e.g. effect of boiled and un-boiled enzymes, measurements in micrometry, extraction of pigments, growth responses in plants, blood groups and blood agglutinations	✓
	Compare the ECGs and MRIs and measure blood pressure	✓
	Prepare slides of cells using differential staining	✓
	Recording of instincts by providing it various stimuli to a spider's web	
	Describe the specificities of flowers and draw evolutionary trees	✓*
	Evaluate the inheritance of genes through mathematical probabilities	✓*
	Constructing pie chart and histogram to present the collected data	✓
Constructing New Scientific Knowledge	Ask questions that can be investigated empirically	✓
	Justify plans or explanations on a theoretical or empirical basis	
	Describe some general limitations of scientific knowledge	✓
	Discuss the historical developments of biological concepts and principles	
	Develop an awareness of and sensitivity to the living world	✓*
Reflecting on Scientific Knowledge	Explain the social and economic advantages and disadvantages / risks of new technologies	✓
	Show how common themes of science, mathematics and technology apply in surrounding world	✓
	Creatively address the problems in personal, social and professional life by using the principles of biological methodology	
	Describe the historical, political and social factors affecting developments in biological research.	

As demonstrated in the above table, the benchmarks for Grade XI-XII in the Pakistan National Curriculum are covered in many of the aims and topics or sub-topics of the IB DP (including the prescribed 'understandings', 'applications and skills' or 'links to the aims' sections of the syllabus). As the Pakistan benchmarks are often topic specific, or relate to specific tasks and content, rather than skills or overarching outcomes, some of these could not be similarly found within the IB DP. Nonetheless, the majority were identified, or partially identified within the IB DP. For example, the Pakistan benchmark to "describe and evaluate the concepts and evidences of evolution" is covered in the IB DP topic on *Evolution and biodiversity* and in particular, the subtopic on *Evidence for evolution*. This benchmark can

also be seen as similar to the IB DP aims to acquire, apply and evaluate scientific information.

Some of the benchmark statements are not explicitly included within the IB DP, such as those related to the 'role of microbes in human welfare', 'concepts of postnatal development and aging', and 'protists and fungi'. However for some of these, the overarching concept/topics of the benchmark statement could be found or partially found within the IB DP.

In addition to the above, the IB DP includes aims regarding critical awareness, an appreciation of the limitations of science, developing investigative skills, and understanding the relationship between different scientific disciplines and their influence on other areas of knowledge.

6.2.3 Content and structure

The *National Curriculum for Biology Grades XI-XII*[60] includes a content outline based on six overarching key themes. For each theme there are a number of chapters with corresponding major concepts and sub-topics. The following table lists these key themes and chapters, and the curriculum of the IB DP Biology HL programme.

Table 16: Content in the Pakistan and IB DP Biology

	National Curriculum Biology [61]	IB DP Biology HL
Topics	**Cell Biology** • Cell Structure and Functions • Biological Molecules • Enzymes • Bioenergetics **Biodiversity** • Acellular Life • Prokaryotes • Protists and Fungi • Diversity among plants • Diversity among animals **Life Processes** • Form and Function in Plants • Digestion • Circulation • Immunity • Respiration • Homeostasis • Support and Movement	**Core and HL topics** • Cell biology • Molecular biology • Genetics • Ecology • Evolution and biodiversity • Human physiology • Nucleic acids • Metabolism, cell respiration and photosynthesis • Plant biology • Genetics and evolution • Animal physiology **Optional topics (teacher pick one)** • Neurobiology and behaviour • Biotechnology and bioinformatics • Ecology and conservation • Human physiology **Practical scheme of work activities**

[60] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Biology Grades XI-XII 2006.* [pdf].
[61] Government of Pakistan Ministry of Education - Islamabad, 2006. *National Curriculum for Biology Grades IX – XII.* [pdf].

	National Curriculum Biology [61]	IB DP Biology HL
	• Nervous Coordination • Chemical Coordination • Behavior **Continuity in Life** • Reproduction • Development and Aging • Inheritance • Chromosome and DNA • Evolution **Ecology** • Man and His Environment **Application of Biology** • Biotechnology • Biology and Human Welfare	• Practical activities • Individual investigation • Group 4 project
Number of topics	27 overarching topics ('Chapters')	12 topics
Recommended Teaching hours	400 periods overall[62]	240 hours

The table below provides a more detailed breakdown of the content for biology in each award:

Table 17: Content comparison of the Pakistan and IB DP Biology

Pakistan National Curriculum Biology		Included in the IB DP
Cell Biology	Cell Structure and Functions	✓
	Biological Molecules	✓
	Enzymes	✓
	Bioenergetics	✓
Biodiversity	Acellular Life	
	Prokaryotes	✓*
	Protists and Fungi	
	Diversity among plants	
	Diversity among animals	
Life Processes	Form and Function in Plants	✓
	Digestion	✓

[62] The National Curriculum for Biology does not indicate how many hours each period should last; however if each period is equal to 40 minutes of teaching, as found in the National Curriculum for Mathematics, then there should be about 267 hours of teaching in total.

Pakistan National Curriculum Biology		Included in the IB DP
	Circulation	✓*
	Immunity	✓*
	Respiration	✓
	Homeostasis	✓
	Support and Movement	✓*
	Nervous Coordination	✓
	Chemical Coordination	✓
	Behaviour	✓
Continuity in Life	Reproduction	✓*
	Development and Aging	✓*
	Inheritance	✓*
	Chromosome and DNA	✓
	Evolution	✓*
Ecology	Man and His Environment	✓*
Application of Biology	Biotechnology	✓
	Biology and Human Welfare	

Both the IB DP and Pakistan National Curriculum include the concepts that should be understood for each topic, and the skills that should be learnt in relation to these. The structure of the topics differs however, in that the IB DP presents processes/concepts/principles (i.e. “Enzyme inhibitors can be competitive or non-competitive”); whereas the Pakistan National Curriculum presents learning outcomes (i.e. “Name the molecules which act as inhibitors”). In some cases, it was difficult to determine whether the sub-topics and sub-content were similar, as a result of this difference in presentation. Often, the overarching topics were relied upon for the comparisons.

Another difference between the programmes is the structuring and organisation of the topics. Where the above topics and sub-topics have been found within the IB DP syllabus, they have often been included under multiple IB DP topics. For example, the Pakistan topic on *Prokaryotes* was related to some of the understanding or application and skills sub-sections for sections on the following:

- Microbiology: organisms in industry
- Species, communities and ecosystems
- Defence against infectious disease
- Classification of biodiversity.

For this topic on *Prokaryotes*, the Pakistan National Curriculum is prescribed in further depth and therefore can only be partially identified within the IB DP. Similarly, the Pakistan

curriculum goes more in depth on protists and fungi, classification and types of vascular and non-vascular plants, classification and types of animals. Alternatively, the IB DP presents concepts referred to as an 'Essential Idea' or 'Nature of Science'. Classification of plants and animals are sat under one sub topic on Classification of biodiversity: the 'Essential Idea' that "Species are named and classified using an internationally agreed system" and the 'Nature of Science'[63] that "Cooperation and collaboration between groups of scientists—scientists use the binomial system to identify a species rather than the many different local names." Overall, the principles of biodiversity are explored in the IB DP but more sub-topics regarding *Biodiversity* are included in the Pakistan curriculum.

The Pakistan National Curriculum is also different in that it includes a focus on viruses, diseases, and other medical or health related terms and concepts. For example, the topic on respiration includes sub-topics on *Respiratory Tract Infections* and disorders of the lungs, and the topic on support and movement discusses disorders of the skeleton. Further Pakistan sub-topics that are not similarly reflected within the IB DP include:

- Photorespiration
- Viruses- discovery and structure
- Birth and nursing
- Disorder during embryonic development
- Postnatal development
- Aging
- Lamarckism is specifically stated as a term that is not required in the IB DP.
- Animal husbandry
- Home Gardening.

Equally, the IB DP content syllabus includes additional core sub-topics to those in the table above. For example, Meiosis, Carbon cycling, and Cadistics are not noticeably discussed within the Pakistan content outline. Further optional topics are also included within the IB DP, including Neural development, Microbiology: organisms in industry, Environmental protection, and ecology and conservation. However it is acknowledged that IB World Schools only teach one of the four optional topics.

Comparing the type of content provided within both of the programmes, it can be observed that the IB DP includes more 'skills' and suggestions for application, alongside the section on understanding than in the Pakistan curriculum. Further, the IB DP skills include more analysis, and evaluation of the concepts in comparison to Pakistan where recall and understanding of the concepts is more commonly listed.

Nonetheless, the two programmes prescribe similar topics to be taught, with some of the concepts or skills be replicated. For example, both programmes expect students to be able to draw and label the structure of a sarcomere. Both also similarly cover innate and learned behaviour with sub-topics discussing Pavlov's experiments with dogs, imprinting and reflexes.

[63] The Nature of Science theme is shared across the IB DP science courses.

Overall, the IB DP covers a slightly larger breadth of content to the Pakistan programme, when considering all of the core and one optional IB DP topic. Given that the IB DP curriculum is made up of eleven required core topics and only one of the four optional topics, the Pakistan topics reflect or partially reflect most of the IB DP core topics (in particular *Molecular biology*, *Human physiology*, and *Animal physiology*) and the optional topic on *Human physiology*. Some topics are covered in a similar depth between the programmes, however certain key topics are covered more in-depth in the IB DP including *Cell biology*, *Ecology*, and *Genetics*.

A detailed look at the HSSC curriculum in practice through the FBISE syllabus demonstrates that some further topics may be shared between the HSSC and IB DP, including: sexual reproduction in flowering plants, meiosis, and ecology.

6.2.4 Assessment methods

The following table includes the assessment methods and their relative weighting in the HSSC in Biology as well as the IB DP Biology HL:

Table 18: IB DP and HSSC Biology assessment methods and weighting

	FBISE HSSC Biology[64]	IB DP Biology HL
External assessment		
Weighting	100%	80%
Methods	Written and practical examinations, under test conditions	Written examinations, under test conditions
Internal assessment		
Weighting	0%	20%
Methods		Internal assessment component

The next table provides a more detailed breakdown of the summative assessment used in the HSSC and the IB DP Biology HL. As illustrated, the HSSC Grade XI Theory paper has the same duration, marks, and exam instructions to the HSSC Grade XII Theory paper.

Table 19: HSSC Biology and IB DP Biology assessment format

	FBISE HSSC Biology	IB DP Biology HL
Number and type of assessments each examination series	Two written theory papers: one on completion of Grade XI, one on completion of Grade XII One practical examination	Three written external examinations One internal assessment
Duration	**Grade XI:** One theory question paper: 3 hours (three sections):	Paper One: 1 hour Paper Two: 2 hours 15 minutes Paper Three: 1 hour 15 minutes

[64] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Biology* XI-XII.[pdf].

	FBISE HSSC Biology	IB DP Biology HL
	• Section A: 25 minutes • Sections B and C: 2 hours 35 minutes **Grade XII:** One theory question paper: 3 hours (three sections): • Section A: 25 minutes • Sections B and C: 2 hours 35 minutes **Grade XI and XII Composite** Practical question paper: 3 hours	Internal assessment: 10 hours
Type(s) of question	Grade XI and Grade XII theory question papers: • Section A – compulsory : multiple choice questions • Section B: short answers and providing definitions (students can answer any fourteen questions) • Section C: detailed responses (students can answer two questions) Practical question paper: five questions	Paper One: multiple choice questions Paper Two: data-based questions, short answers and extended response questions (students can answer two out of three extended response questions) Paper Three: • Section A: short answer questions based on experimental skills and techniques, analysis and evaluation, using unseen data • Section B: short answer and extended response questions from one optional topic content Internal assessment: one scientific investigation and 6 to12 page write-up
Total marks available	Grade XI: 85 marks • Section A: 17 marks • Section B: 42 marks • Section C: 26 marks Grade XII: 85 marks, distributed between sections A-C as outlined above. Practical question paper: 30 marks	Paper One: 40 marks Paper Two: 72 marks Paper Three: 45 marks Internal assessment: 24 marks

As shown in the table above, both programmes have written examinations, which make up the majority of the assessment, and a separate practical component. Further, both

programmes utilise multiple choice questions, short answer and extended response questions within the written examinations.

A similar volume and duration of multiple choice questions is included in both programmes. Section A of the HSSC Theory question papers consists of 17 multiple choice questions that must be answered in 25 minutes, for a total of 34 questions in 50 minutes. Similarly, Paper One in the IB DP consists of 40 multiple choice questions that must be answered in one hour. Both programmes award one mark for each question.

Further, both programmes include an element of choice in the questions that can be answered. The IB DP allows students to select from two out of three extended response questions in Part B of Paper Two, while the HSSC theory question papers for both grades include optional questions for the majority of the examinations: Section B requires students to answer 14 out of 19 total questions, Section C requires students to answer two out of three possible questions.

It should be noted that the IB DP Paper Three has a section dedicated to the optional topic selected by teachers for the curriculum. Assessment questions for all four optional topics are included in the examinations, but students are only required to answer questions on the optional topic they studied. For this section of the IB DP examination, students answer five to six short answer and extended response questions.

In regard to the duration of the examinations, the HSSC has two theory examinations that are completed over a total six hours, while the IB DP three examinations are completed over a total of four and half hours. Although the IB DP includes less assessment time, most of the assessment questions include multiple sub-questions, therefore requiring IB DP students to complete more questions in a shorter period of time. These are examined in more detail in the following section.

The duration spent on the HSSC practical question paper (three hours) is less than the IB DP internal assessment (10 hours), but it is expected that further practical investigations are completed as part of the HSSC that are not included under this assessment time. Similarly, IB DP students are allowed to engage in a wide variety of practical activities throughout the course of the programme.

To evaluate the progress of the learner, both programmes also conduct continued formative assessment. In the HSSC teachers are encouraged to develop regular formative class tests and two formative internal examinations to evaluate the learner's performance. Formative assessment is similarly encouraged in the IB DP as a tool for monitoring a learner's progress and to improve teaching quality.

To highlight what students are expected to demonstrate in each assessment, the IB DP prescribes assessment objectives. These are assessed in both the written examinations and internal assessment component. For example, in IB DP Paper One, the multiple choice questions align with objective 1, that refers to providing precise meaning; objective 2, identifying the correct answer from a list of possible answers; and objective 3 which focusses

on analytical information. Although the HSSC sets aims and objectives for the curriculum, it does not prescribe assessment objectives.

Question types and demand

Concerning the distribution of weighting for each assessed learning domain, the Pakistan National Curriculum for Biology designates 85% toward knowledge, comprehension, analysis, evaluation, synthesis, and application, 5% covers student's communication skills that build on planning, designing experiments and interpreting data, and 10% encompasses performing lab work and sensorimotor skills[65]. When examining the assessment materials published by the FBISE, the theory question papers make up 85% of the assessment but include questions that assess recall, understanding and application rather than synthesis, analysis and evaluation. The practical assessment broadly makes up the remaining 15%, with most of the marks allocated to application skills in a practical setting.

In terms of different types of question reviewed in the HSSC and IB DP Biology exam papers, the following question types have been identified:

- Multiple choice
- Short answer
- Multi-part
- Extended response.

Multiple choice questions

As highlighted above, both programmes include a similar volume and duration of multiple choice questions; the HSSC has an overall total of 34 questions in 50 minutes, while the IB DP has 40 questions in one hour. Each programme awards one mark per question.

When examining the structure and wording of the questions, both programmes provide students with four possible answers (distractors) to select from. However, the HSSC questions primarily assess recall of a student's knowledge, providing students with a definition or concept, and then students have to pick the key term associated with it (one word answers). In comparison the IB DP includes questions that assess a student's understanding or application; further, many of the possible answers are longer and more complex. The IB DP also uses diagrams to provide context to many of the understanding and application questions.

Short-answer and multi-part questions

Short answer questions and multi-part questions are evident in both programmes. As outlined above, Section B of the HSSC theory question papers require students to complete 14 (out of 19) short answer questions that ask students to illustrate their responses by using equations, calculations, listing different functions, describing diagrams, comparing, and providing cause and effect. Students are instructed to give a concise answer that does not

[65] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Biology Grades XI-XII 2006.* [pdf]. p.107.

exceed 3 to 4 lines. Further, Section C requires students to answer two multi-part / extended response questions (with a total of four to five sub-questions) from a choice of three. In the IB DP, Paper Two includes four compulsory multi-part questions (with a total of 19 sub-questions), and two further multi-part / extended response questions (with a total of six sub-questions) chosen from a selection of three.

When comparing these assessment sections, Section B and C of one HSSC paper include 18-19 total sub-questions that must be answered in two hours and 35 minutes. In comparison, IB DP students have two hours and 15 minutes to answer a total of 25 sub-questions in Paper Two. Therefore, there is more demand on the IB DP students, especially when considering that the majority of these questions are compulsory. Further, the IB DP assesses a student's understanding, application, and analysis with questions that require students to analyse diagrams, infer meaning, predict conditions or describe charts, whereas the HSSC questions mostly assess understanding or, in few cases, application.

Further multi-part questions are included in the IB DP Paper Three, with three compulsory questions (seven sub-questions), and four to five [66] multi-part questions (with various amounts of sub-questions), and one extended response.

Extended response

Extended response questions are evident in Section C of the HSSC Theory question papers in both grades, as well as the IB DP Paper Two and Paper Three (within Section B in both). As outlined above, the HSSC requires students to answer two questions from a choice of three. Similarly, in the IB DP Paper Two, Section B, student's select two out of three questions, and in Paper Three, Section B, one further extended response question is compulsory. All of the IB DP extended response questions require students to provide a detailed analysis involving explanations of biological mechanisms or processes. Alternatively, the HSSC questions require students to demonstrate their understanding.

Practical assessments

Practical assessment is used in both the IB DP and HSSC. For the IB DP, the internal assessment includes a scientific investigation chosen by the student and agreed on by the teacher. Students have 10 hours to complete the investigation before completing a 6-12 page write up that addresses a research question. For this task, students can complete a hands-on laboratory investigation or a selection of other investigations suggested by the IB.

In the HSSC, the practical question paper is worth 30 marks and must be completed in three hours. Students must apply their knowledge to identify materials or elements from slides or diagrams, and to demonstrate their understanding of animal classifications. A second section requires students to describe eight different elements of a flower. The final two sections require students to demonstrate and record the procedure for an experiment before recording data and providing results; the final question being a short problem related to blood type or inheritance.

[66] Depending on the optional topic studied during the curriculum.

HSSC students are also expected to answer questions on the experiments conducted, termed a viva voce (worth three marks), and submit their notebooks for review (worth four marks). The notebook should contain information related to the internal practical investigations completed during the two year programme.

In comparison to the HSSC, the IB DP includes a more flexible approach to the practical assessment, allowing students to pick and complete an investigation of their choice, thus promoting scientific enquiry and independent thinking. However, both seek to test students' ability to apply their knowledge of biology in practical settings.

Marking approaches and guidelines

The marking approaches, guidelines and mark schemes for IB DP external assessments are clearly provided for external examiners. However, there are no mark schemes or marking guidelines for the FBISE HSSC available in the public domain at the time of writing, other than the marks allocated to each question of the exam paper. Therefore, although observations can be made about the IB DP marking approaches, the observations for the HSSC are limited and can only be based on consideration of the exam paper instructions and mark allocations for the different questions.

In both the IB DP Paper One and Section A of the HSSC theory papers students score one mark for every correct multiple choice answer; in the IB DP a mark scheme is provided to examiners with the correct answer.

Examining the short answer questions, it is unclear how the marks are allocated in the HSSC. As each question is worth three marks, it is expected that each mark may be allocated to different elements of the answer; for questions with three sub-questions (i.e. to define three different biology terms), it is clear that one mark is awarded to each answer. In the IB DP, the mark scheme provides detailed information on the content expected in the students answer. Similarly, for the IB DP extended response questions, the mark scheme indicates a list of points that must be included in their answers. For example, in Section B of Paper Two students can be awarded a total of 16 marks for each question (15 marks are awarded for content and one mark for quality of response). Quality of response is awarded when a student provides a coherent answer with relevant evidence.

In regards to the information provided to students, both programmes show the distribution of marks to students, enabling a student to judge the relative level of detail needed in responding to a question, such as ones asking students to outline, describe or explain a given law or process.

For the practical assessment, the allocation of marks for the HSSC has been previously described above. It is not possible to draw detailed conclusions on the specific marking approaches from the level of detail available on this assessment, but as mentioned above, it would seem that the emphasis is on practical skills demonstration, with some consideration given to the students' ability to communicate orally and in writing.

For the IB DP, students' scientific investigation is assessed against five different assessment criteria:

- Personal engagement (8%)
- Exploration (25%)
- Analysis (25%)
- Evaluation (25%)
- Communication (17%).

In doing so, the internal assessment evaluates the extent to which students are able to:

- Demonstrate independent thinking and initiative
- Use appropriate concepts and techniques
- Awareness of ethical, environmental and safety considerations
- Select, record, process and interpret data sufficient to support a conclusion
- Identify and evaluate strengths, weakness and limitations of the investigation
- Draw conclusions and make suggestions for improvement or extension of their investigation[67].

[67] International Baccalaureate Organization, 2015. *Diploma Programme Biology Guide - First assessment 2016. Internal document* p.155-158.

6.3 Chemistry

Key findings

Similar aims and objectives are set in the IB DP and HSSC for students to become knowledgeable and skilled in chemistry; with the ability to apply technology, communicate their understanding, and apply their learning to the real-world. Further, the majority of the National Curriculum benchmarks are similarly included in the IB DP, with both expecting students to be able to demonstrate their understanding and be able to apply their knowledge of chemistry concepts while also developing and reflecting on new knowledge.

Regarding content, both programmes include similar key chemistry topics within their curriculums. Although many of topics areas are shared, the Pakistan National Curriculum covers the topics in more detail, while the IB DP has a larger breadth of topics covered.

The overall summative assessment methods and questions types for the HSSC Grade XI and Grade XII are similar to the IB DP HL Chemistry, as both attempt to assess the cognitive demands of knowledge, understanding and application through written examinations and practical assessment.

Differences were identified after reviewing the duration, number of questions and weighting of questions in different parts/sections of the assessments.

Although internal assessments are valued by both programmes as a means of monitoring and addressing the needs of the students, the FBISE HSSC Grade XI and Grade XII evaluate students' progress differently to the IB DP. The FBISE HSSC Grade XI and Grade XII use continued formative assessment, but does not include it as a core component. Meanwhile, the IB DP allocates 20% weighting towards the internal assessment that is added to the final mark.

6.3.1 Aims and objectives

The *National Curriculum for Chemistry Grades XI-XII 2006*[68] includes a set of aims regarding the skills and knowledge that students are expected to develop during the course with corresponding objectives that further specify that is expected of the student. The following table compares the aims and objectives of the *IB DP Chemistry Guide*[69].

[68] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Chemistry Grades XI-XII 2006.* [pdf].
[69] International Baccalaureate Organization, 2015. *Diploma Programme Chemistry Guide - First assessment 2016*. Internal document.

Table 20: Aims and objectives of the Pakistan and IB DP Chemistry

Pakistan National Curriculum Chemistry[70]	Included in the IB DP
The course aims for students to develop:	
A scientific understanding of the physical world	✓
Cognitive, affective, and psychomotor abilities appropriate to the acquisition and use of chemical knowledge, understanding, attitude, and skills	✓
An appreciation for the products and influences of science and technology, balanced by a concern for their appropriate application	✓
An understanding of the nature and limitation of scientific activity	✓
An ability to apply the understanding of Chemistry to relevant problems (including those from everyday real-life) and to approach those problems in rational ways	✓
Respect for evidence, rationality and intellectual honesty	✓
The capacities to express themselves coherently and logically, both orally and in writing, and to use appropriate modes of communication characteristic of scientific work	✓
The ability to work effectively with others.	✓

As seen in the table above, the IB DP and Pakistan National Curriculum for Chemistry share similar aims for their respective programmes. Many of these aims are repeated between the science programmes in both the IB DP and Pakistan programmes. For example, both programmes aim for students to develop scientific knowledge and understanding including the ability to demonstrate these knowledge and skills. Further, students are expected to appropriately use scientific technology and understand scientific limitations.

The Pakistan National Curriculum also aims for students to have coherent and logical communication skills. This is reflected in the IB DP aim for students to "develop and apply 21st-century communication skills in the study of science".

In addition to the above aims, the IB DP further highlights that the programme should enable students to do the following:

- Appreciate scientific study and creativity within a global context through stimulating and challenging opportunities
- Develop an ability to analyse, evaluate and synthesize scientific information
- Develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge.

[70] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Chemistry Grades XI-XII 2006.* [pdf].

6.3.2 Learning outcomes

The *National Curriculum for Chemistry Grades XI-XII 2006*[71] prescribes standards and benchmarks that identify the expected knowledge and skills of Grade XI-XII students. Learning outcomes are also prescribed alongside the curriculum outline for each of the Chapters that outline the understanding and skills associated with each topic; however these are topic-specific and will be used to inform the content comparison. The key concepts and themes from these Pakistan benchmarks have been searched for within the IB DP, as seen in the following table:

Table 21: Learning outcomes of the Pakistan Grade XI-XII and IB DP Chemistry

Pakistan National Curriculum Chemistry		Included in the IB DP
Standards	**Benchmarks** *The students will be able to:*	
Using Scientific Knowledge	Describe various properties of materials that make them suitable and useful for differing jobs	✓
	Analyse properties of common household and agricultural materials in terms of risk and benefit balance	
	Classify elements based on their properties into common families	✓
	Explain how elements differ in terms of the structural parts and electrical charges of atoms	✓
	Analyse the motion of molecules in the various states of matter including plasma	
	Explain chemical changes in terms of the breaking of bonds and the rearrangement of atoms to form new substances	✓
	Explain how and why mass is conserved in chemical changes	✓*
	Contrast different types of chemical reactions in inorganic and organic chemistry	✓*
	Describe energy transformation involved in physical and chemical changes, and contrast their relative magnitudes	✓
	Explain changes in matter and energy involving heat transfer	✓
Constructing New Scientific Knowledge	Ask questions that can be answered empirically	✓
	Develop solutions to problems through reasoning, observation, and investigations	✓
	Design and conduct scientific investigations	✓
	Recognize and explain the limitation of measuring devices	✓
	Gather and synthesize information from books and other sources of information	✓
	Discuss topics in groups by making clear presentations, restating or summarizing what others have said, asking for clarification or elaboration, and defending a position	✓*

[71] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Chemistry Grades XI-XII 2006.* [pdf].

Reflecting on Scientific Knowledge	Justify plans or explanations on a theoretical or empirical basis	
	Describe some general limitations of scientific knowledge	✓
	Show how common themes of science, mathematics, and technology apply in real-world contexts	✓
	Discuss the historical development of key scientific concepts and principles	
	Explain the social and economic advantages and risks of new technology	✓
	Develop and awareness of and sensitivity to the natural world	✓*
	Describe the historical, political, and social factors affecting developments in science.	✓

As seen in the table above, many of the Pakistan benchmarks are similarly reflected in the IB DP Chemistry programme. The above benchmarks include a combination of subject specific benchmarks ('Using Scientific Knowledge') and broader benchmarks ('Constructing new scientific knowledge' and 'Reflecting on Scientific knowledge').

For the subject specific benchmarks these were mostly included within the IB DP. Where they are not included, it is likely that these could be incorporated in the IB DP curriculum as they are minor sub-topics.

For the broader benchmarks, these were broadly similar to many of the IB DP aims, or other sections of the subject guide. For example, both programmes aim for students to develop investigative skills including the ability to evaluate and synthesize, while also appreciating the limitations of science and the ethical implications of new technology.

6.3.3 Content and structure

The Pakistan National Curriculum outlines the content of the programme using chapters for the associated textbook in each grade. Each chapter includes sub-topics referred to as 'Major Concepts' and associated learning outcomes. The prior learning concepts from Grade IX-X are also included. The Pakistan National Curriculum chapters for each grade are included in the table below alongside the IB DP curriculum including the core and optional key topics.

Table 22: Content in the Pakistan and IB DP Chemistry

	Pakistan National Curriculum Chemistry [72]	IB DP Chemistry HL
Topics	**Class XI** • Stoichiometry • Atomic Structure • Theories of Covalent Bonding	**Core and HL Topics** • Stoichiometric relationships • Atomic structure • Periodicity

[72] Government of Pakistan Ministry of Education - Islamabad, 2006. *National Curriculum for Chemistry Grades IX –XII*.[pdf].

	Pakistan National Curriculum Chemistry [72]	IB DP Chemistry HL
	and Shapes of Molecules • State of Matter (including Liquids and Solids) • Chemical Equilibrium • Acids, Bases and Salts • Chemical Kinetics • Solutions and Colloids • Thermochemistry • Oxidation, Reduction and Electrochemistry **Class XII** • s and p Block Elements • d- Block Elements • Organic Compounds • Hydrocarbons • Alkyl Halides and Amines • Alcohols and Phenols • Aldehydes and Ketones • Carboxylic Acids • Biochemistry • Industrial Chemistry • Environmental Chemistry • Analytical Chemistry.	• Chemical bonding and structure • Energetics/thermochemistry • Chemical kinetics • Equilibrium • Acids and bases • Redox processes • Organic chemistry • Measurement and data processing • Atomic structure • The periodic table—the transition metals • Chemical bonding and structure • Energetics/thermochemistry • Chemical kinetics • Equilibrium • Acids and bases • Redox processes • Organic chemistry • Measurement and analysis **Optional topics (teachers pick one)** • Materials • Biochemistry • Energy • Medicinal chemistry **Practical scheme of work activities** • Practical activities • Individual investigation • Group 4 project.
Number of topics	12 topics each year; 24 topics total.	22 total
Recommended Teaching hours	122 hours[73] each year; 244 total hours.	240 hours overall

As seen in the table above, the Pakistan National Curriculum recommends a similar number of teaching hours to the IB DP for a similar number of over-arching chemistry topics. To better understand how these topics compare, the content of the IB DP has been compared to the Pakistan National Curriculum chapters (with the major concepts, and learning outcomes used to provide further context) in the table below:

[73] The Pakistan National Curriculum refers to these numbers as 'teaching' so it has been assumed these mean 'teaching hours'.

Table 23: Content comparison of the Pakistan and IB DP Chemistry

Pakistan National Curriculum Chemistry[74]	Included in the IB DP
Grade XI	
Stoichiometry	✓
Atomic Structure	✓
Theories of Covalent Bonding and Shapes of Molecules	✓
States of Matter I: Gases	✓*
States of Matter II: Liquids	✓*
States of Matter III: Solids	✓*
Chemical Equilibrium	✓
Acids, Bases and Salts	✓
Chemical Kinetics	✓
Solutions and Colloids	✓*
Thermochemistry	✓
Electrochemistry	✓
Grade XII	
s and p Block Elements	✓
d- Block Elements	✓
Organic Compounds	✓
Hydrocarbons	✓
Alkyl Halides and Amines	✓*
Alcohols, Phenols and Ethers	✓*
Aldehydes and Ketones	✓*
Carboxylic Acids and Functional Derivatives	✓*
Biochemistry	✓
Industrial Chemistry	✓*
Environmental Chemistry	✓
Analytical Chemistry	✓

As seen in the table above, the IB DP and Pakistan National Curriculum include many similar over-arching topics at both Grade XI and Grade XII. Further, in each Grade a small portion of the topics were considered to be partially reflected within the IB DP. This was often a result of a significant portion of the Pakistan sub-topics not being similarly included in

[74] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Chemistry Grades XI-XII 2006.* [pdf].

the IB DP. For example, the following Pakistan sub-topics (referred to as major concepts) or topic-specific learning outcomes are not similarly included in the IB DP:

- Quantum Theory
- Dalton's law of partial pressure
- Molar heat of fusion and molar heat of vaporization
- Phenols.

Further, the Pakistan National Curriculum teaches the states of matter (i.e. gases, liquids) in a different format to the IB DP. The IB DP does discuss these topics but in relation to different overarching concepts. Therefore the IB DP curriculum goes more in depth on the overarching concept rather than the state of matter (i.e. liquids) as seen in the Pakistan National Curriculum. Therefore these topics are only partially included in the IB DP. For example, the Pakistan *States of Matter II: Liquids* topic aims for students to develop the skill to be able to "compare and explain the volatility of different liquids at same temperature based on intermolecular forces". This is a very specific concept that is expected of students. Alternatively, the IB DP section on *Intermolecular forces* aims for students to be able to explain the "physical properties of covalent compounds (volatility, electrical conductivity and solubility) in terms of their structure and intermolecular forces." This is a broader concept than that used in the Pakistan National Curriculum.

Industrial chemistry, although discussed in both programmes, is covered more in-depth in the Pakistan National Curriculum. In the IB DP, some of the elements of industrial chemistry, including dyes and pesticides, are discussed as part of the utilization or related aims for the sub-topics, rather than key concepts or elements that need to be understood within the curriculum.

The elements of the periodic table (s and p, d and f) are also discussed differently in the two programmes. The Pakistan National Curriculum separates each block, and in some cases groups or elements, for each sub-topic. Alternatively, the IB DP topic on *Periodicity* introduces the periodic table and periodic trends over a recommended six teaching hours, and touches on some of the Pakistan sub-topics across different topics including *The periodic table – the transition metals*. The expected teaching hours for these topics also indicate that the Pakistan National Curriculum recommends almost double the amount of time on these topics. Therefore, it appears that the Pakistan programme goes more in-depth on these topics.

Similarly, the Pakistan National Curriculum covers Organic Compounds, Hydrocarbons, Alkyl Halides, Amines, Alcohols, Phenols, Ethers, Aldehydes and Ketones in more-depth than the IB DP where the overarching topic on 'Organic Chemistry' covers a similar breadth of sub-topics but in less depth. The Pakistan National Curriculum also indicates that nearly 18.5% of the two year programme will be spent on these topics, whereas the IB recommends about 9.5% of the curriculum should focus on it.

Nonetheless, some topics are covered in a similar amount of detail between the IB DP and Pakistan National Curriculum. For example, *Chemical Kinetics* is similarly covered in both programmes. The IB DP discusses *Chemical Kinetics* as a key topic, and many of the sub-

topics reflect those in the Pakistan programme. *Electrochemistry* from the Pakistan National Curriculum is also similarly covered in the IB DP under the key topics on *Redox Processes* with similar sub-topics on *oxidation and reduction* and *electrochemical cells*.

Overall, when examining the IB DP core curriculum and one optional topic, the IB DP includes a larger breadth of topics, with many additional topics and sub-topics covered in the programme including, metallic bonding, covalent structures (including Lewis (electron dot) structures), the pH scale, entropy and spontaneity, and pH curves. The IB DP also has further optional topics, that although are not required, allow IB World Schools the opportunity to teach other topics including: Materials (i.e. Catalysts, Polymers, and Nanotechnology) and Medical Chemistry.

Although the IB DP is of a larger breadth than the Pakistan National Curriculum, both programmes cover their respective key topics in a similar depth. However, when focussing on the shared topics between the programmes, some of the topics in the Pakistan National Curriculum (i.e. elements of the periodic table, industrial chemistry, states of matter, organic chemistry) are covered in more detail in the Pakistan curriculum. Alternatively, the IB DP covers chemical bonding and structures, biochemistry, and thermodynamics in more detail.

A review of the FBISE documents found that the Grade XI curriculum is identical to the prescribed topics in the Pakistan National Curriculum for Grade XI. The FBISE Grade XII syllabus does not provide a breakdown of the content to be taught and therefore cannot be used to assist in the comparison.

6.3.4 Assessment methods

The following table demonstrates the use and weighting of the external and internal assessment in the HSSC and IB DP Chemistry HL respectively:

Table 24: IB DP and HSSC Chemistry assessment methods and weighting

	FBISE HSSC Chemistry	IB DP Chemistry HL
External assessment		
Weighting	100%	80%
Methods	Written and practical examinations, under test conditions	Written examinations, under test conditions
Internal assessment		
Weighting	0%	20%
Methods		Internal assessment component

As seen in the table above, both programmes include a substantial portion of external assessment, and include an added practical component. Further information on the assessment format, question types and mark allocation are provided below:

Table 25: HSSC Chemistry and IB DP Chemistry assessment format

	FBISE HSSC Chemistry	IB DP Chemistry HL
Number and type of assessments each examination series	Two theory examinations: one on completion of Grade XI, one on completion of Grade XII One practical examination	Three written external examinations One internal assessment
Duration	**Grade XI:** One theory question paper: 3 hours (three sections): Section A: 25 minutes Sections B and C: 2 hours 35 minutes **Grade XII:** One theory question paper: 3 hours (three sections): Section A: 25 minutes Sections B and C: 2 hours 35 minutes **Grade XI and XII Composite** Practical question paper: 3 hours	External assessment Paper One: 1 hour Paper Two: 2 hours 15 minutes Paper Three: 1 hour 15 minutes Internal assessment: 10 hours
Type(s) of question	Grade XI and Grade XII theory question papers: • Section A – compulsory : multiple choice questions • Section B: short answers and providing definitions (students can answer any fourteen questions) • Section C: detailed responses (students can answer two questions)	Paper One: multiple choice questions Paper Two: data-based questions, short answers and extended response questions (students can answer two out of three extended response questions) Paper Three: Section A: short answer questions based on experimental skills and techniques, analysis and evaluation, using unseen data Section B: short answer and extended response questions from one optional topic content Internal assessment: one scientific investigation about 6 to 12 pages
Total marks available	Grade XI: 85 marks • Section A: 17 marks • Section B: 42 marks • Section C: 26 marks Grade XII: 85 marks, distributed	Paper One: 40 marks Paper Two: 72 marks Paper Three: 45 marks Internal assessment: 24 marks

	FBISE HSSC Chemistry	IB DP Chemistry HL
	between sections A-C as outlined above. Practical question paper: 30 marks	

As shown in the table above both programmes include a set of written examinations, and one practical component, with the structure, mark allocation, and duration reflecting that seen in the biology programmes. Similar question types are also used including: multiple choice, short answer, and multi-part. However, differences can be noted in the duration of some components and the volume of questions, which are examined in the following section. As discussed in the biology comparison, the IB DP internal assessment component is the same for all three science courses. Students complete one scientific investigation, selected by themselves in agreement with their teachers. They have 10 hours to complete the investigation and conclude the assignment with a 6-12 page write-up.

Question types and demand

Similar question types were identified in the HSSC and the IB DP Chemistry exam papers, as follows:

- Multiple choice
- Short answer
- Multi-part.

Multiple choice questions

In the HSSC, multiple choice questions make up the entirety of Section A in both grades theory question papers, with 17 questions worth one mark each to be completed in 25 minutes (a total of 34 questions overall in a 50 minute timeframe). Similarly, IB DP candidates complete 40 multiple choice questions in one hour.

Both programmes provide students with four possible answers (distractors) and include questions that assess recall, understanding, and application, or require the student to complete calculations. However, in the IB DP it is specified that students must not use a calculator to answer questions.

Short-answer and multi-part questions

In Section B of the HSSC students must select 14 out of 19 multi-part questions (27-29 sub-questions) and in Section C, two out of three multi-part questions (six total sub-questions). These questions assess the students' knowledge and understanding through recall, understanding and application questions and are completed in two hours and 35 minutes. Students are asked to define and identify terms, provide chemical reactions and equations, or compare elements.

Paper Two in the IB DP is also conducted over a similar duration of two hours and 15 minutes. Within this examination, students answer seven multi-part questions (69 sub-

questions), substantially more than in the HSSC. Similar to the HSSC, students must recall equations and chemical reactions. However, many questions require students to complete calculations and in some cases the questions are inter-related in that an answer is used in subsequent questions. Therefore many questions assess the student's ability to apply their knowledge of equations, elements, or other chemistry concepts in new calculations, diagrams, and other previously unseen problems.

The IB DP Paper Three, Section A also has two multi-part questions (10 sub-questions) and three to five questions (and multiple sub-questions) in Section B (depending on which option students must answer). Similar to Paper Two, these also assess a student's application of their chemistry knowledge.

Practical assessments

As evident in the earlier tables, both programmes include a practical assessment. For the IB DP, students choose a practical investigation (i.e. hands on laboratory experiment, data extraction, or other various investigations) to be completed over 10 teaching hours. A 6-12 page write up is then completed on conclusion of the assessment.

In the case of the HSSC, students complete a major experiment and a minor experiment. In the two part major experiment, students follow instructions to complete a series of tests and experimental procedures. Each step is worth one to three marks, with each part of the experiment worth eight marks. In the minor experiment, the students select one of two experiments to conduct; three marks are awarded for the student's performance and procedure for a total of six marks. As seen with the other HSSC practical assessments, further marks are awarded for an oral element (four marks) and on the student's notebook (four marks) which presumably include reports on the investigations completed internally during the programme. No publically available guidance was identified to determine the type, scope and demand of questions posed during the viva.

Although different approaches are used, it is clear from the practical assessments that both the IB DP and HSSC seek to test students' ability to apply their knowledge of chemistry in a practical setting.

Marking approaches and guidelines

For all external assessments the IB DP provides mark schemes that specify the mark allocations and guidelines on what should be considered a correct response. The marking guidelines are illustrated in a table that corresponds to each assessment question, with information on the correct answer, notes and the total possible marks. In the FBISE, HSSC marking guidelines are not available in the public domain, and therefore, limited observations can be made on the marking approaches used. Information obtained from the examination instructions and mark allocations are examined where possible.

For the multiple choice question papers, both the IB DP and HSSC award one mark based on the correct answer being selected. Further, students are aware of the marks awarded for

each question (in the multiple choice, and all other sections of the examinations), as each question and sub-question includes the mark allocation alongside it. This allows students to determine the level of detail needed in an answer.

For the short-answer / multi-part questions in the HSSC, it is not possible to deduce how the marks are awarded for a complete answer; however where three marks are awarded to a question with three sub-questions in Section B, it can be assumed that one mark goes to the correct response in each sub-question. In comparison, the IB DP specifies exactly what is needed in a response for each mark to be awarded, and where calculations take place, how to award marks for method or accuracy in determining the correct answer.

The IB DP internal assessment and HSSC practical assessment are similar across the three science subjects. Therefore, as evaluated in the Biology comparative analysis, it is not possible to draw detailed conclusions for the HSSC on the specific marking approaches from the level of detail available on this assessment, but as mentioned above, it would seem that the emphasis is on practical skills demonstration, with some consideration given to the students' ability to communicate orally and in writing.

For the IB DP, students' scientific investigation is assessed against five different assessment criteria:

- Personal engagement (8%)
- Exploration (25%)
- Analysis (25%)
- Evaluation (25%)
- Communication (17%).

In doing so, the internal assessment evaluates the extent to which students are able to:

- Demonstrate independent thinking and initiative
- Use appropriate concepts and techniques
- Awareness of ethical, environmental and safety considerations
- Select, record, process and interpret data sufficient to support a conclusion
- Identify and evaluate strengths, weakness and limitations of the investigation
- Draw conclusions and make suggestions for improvement or extension of their investigation[75].

[75] International Baccalaureate Organization, 2015. *Diploma Programme Biology Guide - First assessment 2016. Internal document* p.155-158.

6.4 Physics

Key findings

Both programmes aim for students to become scientific and rational life-long learners who are knowledgeable in physics. Nearly all of the physics objectives to construct, reflect on, and use scientific knowledge are also similarly expected of IB DP students with both focussing on students developing investigative skills.

The majority of the Pakistan National Curriculum topics are similarly included within the IB DP content outline, with the exception of two Grade XII topics: *Physics of solids* and *Electronics*. Overall, the programmes cover a similar breadth of topics and are mostly of a similar depth. In some cases, the IB DP includes further focus on application and skills within these topics.

To assess students, both programmes use a combination of written and practical assessment and include a similar volume and duration of multiple choice questions. However, a number of differences were identified:

- The IB DP includes a larger proportion of short answer and multi-part questions that must be completed in a shorter amount of time than in the HSSC examinations
- More weight is placed on questions in real-life applications in the IB DP
- Although both programmes include a practical assessment, the IB DP allows students to select an investigation to complete, promoting scientific inquiry and independent thinking.

6.4.1 Aims and objectives

The *National Curriculum for Physics Grades XI-XII 2006*[76] includes aims regarding the knowledge and skills that the course should enable students to develop. Unlike the previously examined Pakistan National Curriculum's in the science subjects, the Physics National Curriculum does not include any objectives in relation to these aims. Therefore the aims and objectives of the *IB DP Physics Guide*[77] have been compared to the Pakistan National Curriculum aims in the table below:

Table 26: Aims and objectives of the Pakistan and IB DP Physics

Pakistan National Curriculum Physics[78]	Included in the IB DP
The course aims to enable the student to:	
Develop the habit of scientific and rational thinking and an attitude to search for order and symmetry in diverse phenomena of nature and thereby to appreciate the supreme wisdom and creative powers of the creator	✓*

[76] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Physics Grades XI-XII 2006*. [pdf].
[77] International Baccalaureate Organization, 2014. *Diploma Programme Physics Guide - First assessment 2016*. Internal document.
[78] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Physics Grades XI-XII 2006*. [pdf].

Pakistan National Curriculum Physics[78]	Included in the IB DP
The course aims to enable the student to:	
Become life-long learner, effective problem solver, responsible and productive citizens in a technological world	✓
Strengthen the concepts developed at the secondary level to lay firm foundation for further learning of physics at the tertiary level, in engineering or in other physics dependent and vocational courses	✓
Develop process skills and experimental, observational, manipulative, decision making and investigatory skills in the students	✓
Understand and interpret scientific information presented in verbal, mathematical or graphical form and to translate such information from one form to another	✓
Understand and appreciate the inter relationship and balance that exists in nature, the problems associated with the over exploitation of the environmental resources and disturbance because of the human activities in the ecological balance, thus taking care of the environment.	✓

Both the IB DP and Pakistan National Curriculum aim for students to become inquisitive, life-long learners, responsible global citizens and to develop scientific thinking and investigative skills. The programmes also aim to prepare students for further study at higher education. The last aim in the Pakistan programme regarding an appreciation of the affect humans have had on the environment and their responsibility to take care of the environment is similar to the IB DP aim to appreciate and be aware of the possibilities and ethical implication of science. Additionally, the IB Learner Profile reflects the aim that learners should become responsible and caring citizens.

Although the first part of the Pakistan National Curriculum aim regarding scientific and rational thinking is similarly reflected within the IB DP as discussed above, the second part of the aim also states that students should learn to "appreciate the supreme wisdom and creative powers of the creator". As the IB DP does not promote any one nation's religion or customs, this part of the aim is not similarly reflected within the IB DP.

In addition the aims discussed above, the IB DP further aims for students to:

- Appreciate scientific study and creativity within a global context through stimulating and challenging opportunities
- Develop a critical awareness of the need for, and the value of, effective collaboration and communication during scientific activities
- Develop and apply 21st-century communication skills in the study of science
- Develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge.

6.4.2 Learning outcomes

In addition to the above aims, the *National Curriculum for Physics Grades XI-XII 2006*[79] prescribes the knowledge and skills that are expected of students at the end of the programme within a set of standards and benchmarks. Learning outcomes are also presented, but are topic-specific and correspond to the units of the curriculum. Therefore, these learning outcomes will be used to contextualise the content comparison in the next section.

Table 27: Learning outcomes of the Pakistan Grade XI-XII and IB DP Physics

Pakistan National Curriculum Physics		Included in the IB DP
Standards	**Benchmarks** The students will be able to:	
Constructing New Scientific Knowledge	Ask questions that can be investigated empirically	✓
	Develop solutions to problems through reasoning, observation, and investigations	✓
	Design and conduct scientific investigations	✓
	Recognize and explain the limitations of measuring devices	✓
	Gather and synthesize information from books and other sources of information	✓
	Discuss topics in groups by making clear presentations, restating or summarizing what others have said, asking for clarification or elaboration, taking alternative perspectives, and defending a position	✓*
Reflecting on Scientific Knowledge	Justify plans or explanations on a theoretical or empirical basis	
	Describe some general limitations of scientific knowledge	✓
	Show how common themes of science, mathematics, and technology apply in real world contexts	✓
	Discuss the historical development of the key scientific concepts and principles	✓
	Explain the social and economical advantages and risks of new technology	✓
	Develop an awareness and sensitivity to the natural world	✓*
	Describe the historical, political and social factors affecting developments in science	✓
Using Scientific Knowledge	Appreciate the ways in which models, theories and laws in physics have been tested and validated	✓
	Assess the impacts of applications of physics on society and the environment	✓
	Justify the appropriateness of a particular investigation plan	✓
	Identify ways in which accuracy and reliability could be improved in investigations	✓

[79] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Physics Grades XI-XII 2006*. [pdf].

Pakistan National Curriculum Physics		Included in the IB DP
Standards	**Benchmarks** The students will be able to:	
	Use terminology and report styles appropriately and successfully to communicate information	✓
	Assess the validity of conclusions from gathered data and information	✓
	Explain events in terms of Newton's laws and law of conservation of momentum	✓
	Explain the effects of energy transfers and energy transformations	✓
	Explain mechanical, electrical and magnetic properties of solids and their significance	✓
	Demonstrate an understanding of the principles related to fluid dynamics and their applications	✓
	Explain that heat flow and work are two forms of energy transfers between systems and their significance	✓
	Understand wave properties, analyze wave interactions and explain the effects of those interactions	✓
	Demonstrate an understanding of wave model of light as e.m waves and describe how it explains diffraction patterns, interference and polarization	✓
	Explain the effects of electric, magnetic and gravitational fields	✓
	Demonstrate and understand the properties, physical quantities, principles and laws related to electricity and magnetism and make use of them	✓
	Investigate and explain basic properties of semi-conductors devices (diodes and transistors) and make electronic circuits and make use of them	✓*
	Search, for information and explain nuclear reactions, fission, fusion, interaction between matter and energy benefits and risks of nuclear energy. Describe quantum theory, special theory of relativity and other modern concepts in Physics.	✓

The above Pakistan National Curriculum Physics learning outcomes for *Constructing New Scientific Knowledge* and *Reflecting on Scientific Knowledge* are the same as those prescribed in the Pakistan National Curriculum for Chemistry. As the IB DP aims and IB Learner Profile are also the same throughout the science programmes, the same comparisons can be drawn here with the exception of one Pakistan aim regarding the "historical development of the key scientific concepts" which is nonetheless reflected within the IB DP Physics content outline.

The third Pakistan standard regarding the use of scientific knowledge includes benchmarks unique to the Physics National Curriculum. Overall, these are reflected within the IB DP programme, either as part of the content outline for the subject-specific benchmarks, or within the IB DP aims and assessment objectives. For example, both the Pakistan National Curriculum and IB DP aim for students to be able to explain electric, magnetic and

gravitational field. Additionally, the Pakistan benchmark for students to “assess the validity of conclusions from gathered data and information” is similarly reflected within the IB DP aim to “develop an ability to analyse, evaluate and synthesize scientific information,” but also in the IB DP internal assessment criterion on analysis that measures if the student has provided enough raw data to support a valid conclusion.

One of the Pakistan benchmarks under this third standard is partially included within the IB DP. Although both programmes aim for students to conduct investigations and understand electronic circuits, the rest of the aim regarding semi-conductor devices (diodes and transistors) could not be identified within the IB DP Guide.

6.4.3 Content and structure

The Pakistan National Curriculum includes a content syllabus with a set of twenty units (also referred to as Chapters). For each unit an overview of the concept and a list of major concepts, and the learning outcomes are provided. A note on the previous topic taught at Grade IX-X is also included. In the below table, the Pakistan National Curriculum units have been listed alongside the IB DP Physics HL curriculum.

Table 28: Content in the Pakistan and IB DP Physics

	Pakistan National Curriculum Physics[80]	IB DP Physics HL
Topics	**Grade XI** • Measurement • Vectors and Equilibrium • Forces and Motion • Work and Energy • Rotational and Circular Motion • Fluid Dynamics • Oscillations • Waves • Physical Optics • Thermodynamics **Grade XII** • Electrostatics • Current Electricity • Electromagnetism • Electromagnetic Induction • Alternating Current • Physics of Solids • Electronics • Dawn of the Modern Physics • Atomic Spectra • Nuclear Physics.	**Core and HL topics** • Measurements and uncertainties • Mechanics • Thermal physics • Waves • Electricity and magnetism • Circular motion and gravitation • Atomic, nuclear and particle physics • Energy production • Wave phenomena • Fields • Electromagnetic induction • Quantum and nuclear physics **Optional topics (teachers select one)** • Relativity • Engineering physics • Imaging • Astrophysics **Practical scheme of work activities** • Practical activities • Individual investigation (internal assessment – IA) • Group 4 project.
Number of topics	20 (10 in each grade)	13
Recommended Teaching hours	Grade XI: 222 periods; 148 hours Grade XII: 219 periods; 146 hours[81]	240 hours

The Pakistan National Curriculum includes a similar portion of key topics, and teaching hours, with the IB DP covering the programme over roughly 60 hours less than in the Pakistan programme. To better understand how these physics topics compare, the table below demonstrates the content comparison of the IB DP to the Pakistan National Curriculum.

[80] Government of Pakistan Ministry of Education - Islamabad, 2006. *National Curriculum for Physics Grades IX – XII*. [pdf].
[81] Calculated on the assumption that each period lasts about 40 minutes, as stated in the National Curriculum for Mathematics.

Table 29: Content comparison of the Pakistan and IB DP Physics

Pakistan National Curriculum Physics[82]	Included in the IB DP
Grade XI	
Measurement	✓
Vectors and Equilibrium	✓*
Forces and Motion	✓
Work and Energy	✓*
Rotational and Circular Motion	✓
Fluid Dynamics	✓
Oscillations	✓
Waves	✓
Physical Optics	✓
Thermodynamics	✓
Grade XII	
Electrostatics	✓*
Current Electricity	✓
Electromagnetism	✓*
Electromagnetic Induction	✓*
Alternating Current	✓*
Physics of Solids	
Electronics	
Dawn of the Modern Physics	✓
Atomic Spectra	✓*
Nuclear Physics.	✓

As seen in the table above, all of the Pakistan Grade XI topics and most of the Grade XII topics were found in the IB DP. Partial coverage is indicated where the overall topics are covered, but where differences are evident in some of the sub-topics. For example, the Pakistan National Curriculum topic on *Electrostatics* was only partially found in the IB DP as the Pakistan sub-topics on Gauss's law, electric flux, and electric field due to a dipole were not highlighted or discussed in the IB DP curriculum. Similarly, in the Pakistan topic on *Electromagnetism*, some sub-topics were similarly reflected in the IB DP (including magnetic field of current-carrying conductor, Magnetic force on a current-carrying conductor) but others are not similarly taught in the IB DP including Ampere's law, and e/m of an electron.

[82] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Chemistry Grades XI-XII 2006.* [pdf].

Overall, both programmes cover many of the same laws that are applied in physics, including Faraday's Law, Lenz's Law, Kirchhoff's Law, and the first and second law of thermodynamics. Many similar equations are also included within the content outlines, however the IB DP typically includes more equations overall in each sub-topic.

The Pakistan National Curriculum also goes more in-depth on the Grade XII topic of *Alternating Current*. Although this topic is briefly touched on in the IB DP topic on *Electromagnetic induction* (and in particular, the sub-topic on *Power generation and transmission)*, some of the Pakistan sub-topics or associated learning outcomes are not similarly reflected within the IB DP. Similarly, the Pakistan topic on *Electronics* only shared a couple sub-topics with the IB DP; both discuss the half-wave and full-wave rectification, therefore this topic is not similarly reflected within the IB DP.

Another topic not similarly taught in the IB DP is that on *Physics of solids*. None of the sub-topics or learning outcomes in this topic are reflected within the IB DP.

Both the IB DP and Pakistan programme include key topics on work and energy. The sub-topics in both are also broadly similar, and it is expected that for the most part, the Pakistan topics are reflected within the IB DP programme. The comparison is only seen as partially included, however, as nearly all of the Pakistan key terms for this section are absent from the IB DP curriculum, including: 'constant force', 'work energy principle', 'force-displacement graph', and 'conventional or non-conventional sources'.

In addition to the shared topics discussed above, the IB DP includes the following sub-topics or content:

- Modelling a gas
- Resolution
- Energy sources
- In relation to Nuclear Physics: the Rutherford scattering, the neutrino, and nuclear energy levels.

Amongst the optional topics, the IB DP also allows IB World Schools to teach *Relativity, Imaging,* and *Astrophysics.* However, when comparing the IB DP optional topics to the Pakistan National Curriculum, *Engineering Physics* includes some similar content to the Pakistan content.

The IB DP also goes into more detail on the structure of matter, with exchange particles, baryons, mesons, and Feynman diagrams included.

Overall, the IB DP and Pakistan National Curriculum cover a similar breadth of topics, and where these topics are similarly taught within the programmes the level of understanding expected is mostly of a similar depth. However, for many of these topics, the IB DP prescribes additional application and skills that are expected of students.

A review of the FBISE HSSC syllabi demonstrates the HSSC curriculum in practice. The Grade XI and Grade XII topics reflect those of the Pakistan National Curriculum, and

therefore the same comparisons apply. It was noted, however, that the weightings/number of periods for each topic are different in the FBISE than observed in the Pakistan National Curriculum.

6.4.4 Assessment methods

The table below shows the use and weighting of external and internal assessment of the HSSC and IB DP Physics HL respectively:

Table 30: HSSC and IB DP Physics assessment methods and weighting

	FBISE HSSC Physics	IB DP Physics HL
External assessment		
Weighting	100%	80%
Methods	Written and practical examinations, under test conditions	Written exam, under test conditions
Internal assessment		
Weighting	0%	20%
Methods		Scientific investigation

As this shows, the HSSC is assessed through a combination of written and practical examinations, with the latter being incorporated only recently into the HSSC assessment. The IB DP Physics HL similarly assesses students through a combination of written and practical examinations. More information on the assessment format, question types and mark allocation are provided below:

Table 31: HSSC and IB DP Physics assessment format

	FBISE HSSC Physics	IB DP Physics HL
Number and type of assessments each examination series	Two written papers: one on completion of Grade XI, one on completion of Grade XII One practical paper	Three written papers and one internal assessment
Duration	For each grade, the paper consists of two sections: • Section A: 25 mins • Section B and C: 2 hrs 35 mins	Paper 1 – 1 hr Paper 2 – 2 hr 15 mins Paper 3 – 1 hr 15 mins
Type(s) of question	Multiple choice questions Short answer questions Multi-part questions	Multiple choice questions Short answer questions Multi-part and extended questions
Total marks available	Grade XI – 85 marks • Section A – 17 marks • Section B – 42 marks	Paper 1 – 40 marks Paper 2 – 95 marks Paper 3 – 45 marks

	FBISE HSSC Physics	IB DP Physics HL
	• Section C – 26 marks Grade XII – 85 marks, distributed between sections A-C as outlined above. Practical examination – 30 marks	Individual investigation – 24 marks

Question types and demand

In terms of the written examinations, both the IB DP and HSSC employ similar types of questions.

Multiple choice questions

Both programmes use multiple choice questions, worth one mark each. In each grade, the HSSC (Section A), students have 25 minutes to answer 17 such questions while the IB DP (Paper 1), students have one hour to answer 40 such questions indicating a relatively similar level of demand in terms of the volume of assessment between the two papers. Nevertheless when considering the focus and wording of the questions, some differences can be seen. For example the HSSC Section A, at both Grade XI and Grade XII, include a considerable number of questions testing knowledge recall where students are asked to select the appropriate definition of a term, to identify what certain laws of physics refer to and what different units are. The ability to recall such information would inevitably be required for students of the IB DP Physics HL, and is similarly tested through selected multiple choice questions however the proportion of marks available for knowledge recall questions is typically lower than in the HSSC.

Both papers also use multiple-choice to test students' ability to apply their knowledge of physics and mathematics, for example by calculating resonance frequency (HSSC), calculating pressure, average current and resistance (IB DP).

Short-answer and multi-part questions

Both programmes also use short-answer and multi-part questions testing students' understanding of physics. Students of the HSSC have, for both grades, just over two and a half hours to complete 14 short-answer questions (from a choice of 19) and two multi-part questions (from a choice of three). IB DP students should answer all questions set in Paper 2. In the papers reviewed, this gave students two and a quarter hours in Paper 2 to answer nine multi-part questions (with a total of 41 sub-questions), which indicates a greater demand given the number of questions to be answered in a shorter timeframe.

In Paper 3 of the IB DP, Section A is compulsory for all students, but for Section B, students answer questions on the optional topic studied during the curriculum, either relativity; engineering physics; imaging; or astrophysics.

In terms of the multi-part questions, these attract the greatest proportion of marks in each paper. In the case of the HSSC, multi-part questions are worth a total of 13 marks, typically distributed as follows:

- Six marks to describe or explain a principle or law
- Four marks on an application question, where students are typically asked to calculate a particular value (e.g. temperature co-efficient of resistance or flux through a coil)
- Three marks to describe a further rule, theory or process.

Whilst the sub-questions are related, they are not necessarily inter-related, and it would be possible to answer certain sub-questions without answering the preceding ones, or to obtain a good proportion of marks from questions testing students' knowledge recall and understanding through description and or explanation of key rules, laws or terms.

In the IB DP papers, multi-part questions may vary in structure, weighting and mark allocation among sub-questions though it is important to remember that students must by contrast, answer all questions. The questions test a range of knowledge and at a range of levels. For example there are questions testing students' ability to recall certain laws of physics, and demonstrate understanding of effects or key terms. Most of the questions however focus on application, asking students to calculate values and in some cases explain the effect of a given scenario on their calculation. Sub-questions typically do build upon preceding questions though it is acknowledged that questions asking for terms to be outlined or explained can, as with the HSSC, be answered in isolation.

Of particular note in the IB DP Physics (particularly in Paper 2) is the grounding of most questions in real life applications. This is observed in a small number of HSSC questions, but to a lesser extent, particularly so given that these questions are optional.

Practical assessments

As evident in the earlier tables, both programmes comprise a practical assessment. For the IB DP scientific investigation, students are asked to conduct a practical investigation on a topic of their choice, although this must be appropriate to the level of the course. There are 10 teaching hours assigned to this, and students are required to produce a write-up of 6-12 pages to address a purposeful research question. Students may complete a hands-on laboratory investigation as part of this investigation but examples of other possible tasks listed by the IB include:

- Using a spreadsheet for analysis and modelling
- Extracting data from a database and analysing it graphically
- Producing a hybrid of spreadsheet/database work with a traditional hands-on investigation
- Using a simulation, provided it is interactive and open-ended[83].

[83] IB (2014). *IB Diploma Programme - Physics Guide. First assessment 2016.*

In the case of the HSSC, students are required to perform two experiments, each one from a choice of three. This may involve determining a particular value (e.g. gravitational force, frequency, resistance, focal length) or identifying characteristics (e.g. of a semi-conductor diode, or NPN transistor). They are awarded 10 marks for the conduct of each of these. They will also be expected to answer questions on the experiments conducted, termed a viva voce, (worth five marks) and submit their notebooks for review (also worth five marks). No publically available guidance was identified to determine the type, scope and demand of questions posed during the viva.

It is clear from the practical assessments that both the IB DP and HSSC seeks to test students' ability to apply their knowledge of physics in a practical setting but with some differences in approach. The HSSC has a defined list of practicals (10 for section A, 13 for section B) from which three from each section will be selected for inclusion in the exam paper of a given year. Two thirds of the marks are assigned to the student's practical conduct of these two experiments. By contrast, the IB student is able to select their own topic of investigation and as such the emphasis of assessment is less on exhibiting specific competency in a prescribed experiment but rather on promoting scientific enquiry and independent thinking. The ability to conduct the relevant task or experiment is an integral part of the assessment but the ability to articulate an appropriate research question, explore and research the topic and to draw and communicate conclusions are also assessed, and to a greater extent than in the HSSC, as evidenced by the output they must produce (a 6-12 report) and the distribution of marks (a third combined for the viva and notebook in contrast to those assigned for the IB DP Individual Investigation, described in further detail in the subsequent sub-section, *Marking Approaches and Guidelines*).

Marking approaches and guidelines

Marking guidelines are not available in the public domain for any of the FBISE HSSC Physics assessments and observations on the approaches to marking are therefore limited, and based on consideration of the exam paper instructions and mark allocations for the different questions. For the purpose of this study, the IB provided mark schemes for the written exam papers and assessment criteria for the internal assessment.

The multiple choice question papers of both the IB DP and HSSC Physics will be marked for accuracy against the answers given in the mark scheme, with each question worth a single mark.

For the short-answer questions in the HSSC, it is not possible to deduce the proportion of marks allocated to accuracy and method in the absence of a mark scheme. Candidates are not explicitly instructed to show their workings when calculating particular values. Given that three marks are attached to these questions, it is assumed that some marks would be allocated for method but unclear whether accuracy marks are dependent on method marks. Interestingly the IB DP Physics paper does not explicitly reference the need to show workings out for calculation questions either; though it is perhaps implied by the answer space given for each question, but the mark schemes clearly show distribution of marks based on both the method and reaching the correct answer.

Both programmes do however show the distribution of marks to students, enabling a student to judge the relative level of detail needed in responding to a question, such as ones asking students to outline, describe or explain a given law or process.

The IB DP internal assessment and HSSC practical assessment are similar across the three science subjects. Therefore, as evaluated in the Biology and Chemistry comparative analyses it is not possible to draw detailed conclusions on the specific marking approaches from the level of detail available on this assessment, but as mentioned above, it would seem that the emphasis is on practical skills demonstration, with some consideration given to the students' ability to communicate orally and in writing.

For the IB DP, students' scientific investigation is assessed against five different assessment criteria:

- Personal engagement (8%)
- Exploration (25%)
- Analysis (25%)
- Evaluation (25%)
- Communication (17%).

In doing so, the internal assessment evaluates the extent to which students are able to:

- Demonstrate independent thinking and initiative
- Use appropriate concepts and techniques
- Awareness of ethical, environmental and safety considerations
- Select, record, process and interpret data sufficient to support a conclusion
- Identify and evaluate strengths, weakness and limitations of the investigation
- Draw conclusions and make suggestions for improvement or extension of their investigation.

7. Comparing the Pedagogical and Learning Approaches in the IB DP and HSSC

Key findings

The National Curriculum for Mathematics, Biology, Chemistry, and Physics all include information on the teaching strategies and approaches or *Teaching-Learning Programme* that is expected for the HSSC. When comparing the IB DP policies, practices, and standards to these approaches for the HSSC, the following common themes were found:

- Teachers should be knowledgeable of the subject they are teaching and sufficiently trained
- Teachers should focus on student-centred teaching, not on teaching to the test
- Inquiry-based teaching and learning should be encouraged
- Students should be given the opportunity to apply their learning to real-world experiences; include practical and hands on experiences in the classroom
- Teachers should provide students with sufficient opportunity for collaborative work and discussion in the classroom
- Students should develop written and oral communication skills
- Students should develop analytical, critical and evaluative thinking skills
- Teachers should use a combination of formative and summative assessment.

Further, the intended learning outcomes (aims, objectives, and benchmarks) for the HSSC are also similar to standards and practices in the IB DP. In particular, both aim for students to develop the relevant subject knowledge and skills, understand the importance of technology and the limitations of science.

7.1 Intended learning outcomes

To examine how the IB DP principles, practices and standards compare with the intended learning outcomes for the HSSC, a variety of aims and objectives provided at both national level (in the National Curriculum) and board level (as demonstrated in the FBISE) have been collated in this section. These aims and objectives were examined within the content comparison in Section 6 but for this section were used to identify the overarching level of skills expected of students upon completion of the HSSC, and thus provide a good indication of the intended learning outcomes of the programme.

On a national level, benchmarks and standards are also provided that outline what students are expected to know and be able to do on completion of the course, similar to learning outcomes. Thus these were examined in the learning outcome comparison in Section 6. Alongside these, the National Curriculum provides actual learning outcomes within the curriculum outline at topic level. These are listed under each sub-topic and are very subject specific. Overall, these aims, objectives, benchmarks, standards, and learning outcomes jointly provide information on the knowledge and skills expected of students upon completion

of the HSSC and allow for the overarching intended learning outcomes to be identified. Therefore, the following section compares the IB DP principles, practices, standards, and associated aims or curriculum content to these HSSC outcomes.

7.1.1 Aims and objectives

From the aims and objectives of the Mathematics, Physics, Biology, and Chemistry National Curriculum and FBISE syllabus, the following were shared amongst many or all of the subjects:

- Solid knowledge of the subject
- Scientific/rational thinking
- Experimental and investigative skills
- Importance of technology
- Understand the limitations of science
- Application of science to the real-world problems
- Communication skills (oral and writing)
- Collaborative / group work skills
- Cognitive, affective and psychomotor abilities.

It should be noted that a final important aim regarding developing a life-long learner was also included in the National Curriculum for Physics.

Similarly the IB DP aims to develop inquisitive life-long learners capable of critical thinking. This is evident from both the IB Learner Profile and the IB Group 4 (sciences) and Group 5 (mathematics) aims. Further the aims in both groups emphasise that IB DP students will develop the key knowledge and understanding of the subject and the importance or limitations of science and technology. Communications skills are also developed in both groups. The development of experimental and investigative skills is a key aim for Group 4 (sciences). Similar to the Pakistan aims regarding scientific or rational thinking, the IB DP Mathematics HL course aims to develop logical thinkers, while the IB DP science courses aim for students acquire scientific knowledge, techniques, methods and analytical skills. Although it is not included within the IB DP aims, the application of the students' knowledge and understanding to real-world applications is included in the curriculum or content outline for both the mathematics and science courses.

The Pakistan aim regarding cognitive, affective and psychomotor abilities is also shared with the IB DP as part of cognitive, metacognitive and affective skills to be developed in the IB *Approaches to learning*. In particular, the IB defines five skills that IB DP students will develop includes: thinking, communication, social, self-management and research skills[84].

[84] International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015.* Internal document.

7.1.2 Standards and benchmarks

7.1.2.1 National Curriculum outcomes

From the standards and benchmark statements in the Mathematics, Physics, Biology, and Chemistry National Curriculums, further subject and HSSC specific benchmarks indicate the level of skills expected of students in relation to each overall standard. In Mathematics, these benchmarks or outcomes are mostly application or analysis based with expectations to evaluate, explain, apply, or use mathematical concepts, or solve mathematical problems and find mathematical solutions. One of these outcomes regarding application to real-world problems echoes the shared aim from above.

Biology and Chemistry are similar to Mathematics in that the expectation for students to develop understanding, application, and analysis skills is reflected from the majority of the standards and outcomes. These include outcomes to explain, analyse, evaluate, compare, interpret, and differentiate. A student's ability to understand and recall information is also expected with some outcomes referencing the student identifying or describing concepts and facts. Similar to Mathematics, application to the real-world was an outcome for both Biology and Chemistry. Additionally, the students are expected to become inquisitive and understand the limitations of science.

The Physics National Curriculum also includes outcomes regarding application and analysis (i.e. for students to investigate, explain, and assess), however most of the outcomes are related to the student's level of understanding. These outcomes state that the student should be able to recognise, describe, identify, understand, or demonstrate their understanding of different physics concepts and knowledge.

7.1.2.2 FBISE outcomes

To understand how the National Curriculum benchmarks and standards are applied in practice, further outcomes and objectives identified in the FBISE syllabi can be examined.

In all of the FBISE Science and Mathematics syllabi there is a section on *Learning-Teaching Guidelines for Students and Teachers*. These are defined in all as 'instructional objectives' related to the expected achievement level for students completing the course. They are also intended to assist teachers in their preparations for teaching the course. Although they are not specified as being so, they are structured like learning outcomes but are unit and topic specific, appearing to outline each bit of knowledge expected of the students.

According to the FBISE, there are two groups of objectives. The first being those related to recalling facts with terms such as 'define', 'describe', and 'state' included. The second group is intended to be related to scientific experiments (as specified in both the Science courses and the Mathematics course), and the key words include: 'design', 'preform', and 'demonstrate'. In addition to these specified to be used in the groups, the Mathematics course includes objectives that refer to 'being able' to complete specific problems, 'prove'

other problems or theorems, and 'solve' or 'calculate' problems. 'Understand', 'know', and 'use' are also included to highlight further information that students should recall.

Despite the Chemistry syllabus stating that the two groups of terms will be used in the objectives, the objectives all begin with the phrase: the student will. For example, one objective states "the student will learn the properties of solutions of liquids"[85]. As a result, most of these objectives relate to the recall of information rather than application or analysis. This is also reflected in the Physics syllabus.

Alternatively, the Biology syllabus does use the most of the terms identified for the two groups of objectives, and as such, includes many objectives to recall information, and a few to compare, measure, and investigate.

When considering these FBISE objectives in comparison to benchmarks and statements of the National Curriculum, there is a clear difference in the expectations. Despite the National Curriculum stating that practical, investigative and analytical skills should be developed, with less focus on 'teaching to the test' and more focus on inquisitive learning and applying learning to real-life every day experiences, these FBISE *Learning-Teaching Guidelines for Students and Teachers* do not fully reflect this. Alternatively, these FBISE guidelines demonstrate a focus on recall and memorisation of factual information. Therefore, there is conflicting information provided to teachers and students regarding the level of skills expected for students to learn and teachers to teach.

7.1.2.3 IB DP outcomes

Unlike the Pakistan outcomes reviewed above, in the IB DP, there are multiple policies and standards that outline the expected knowledge and skills of students in broader terms rather than on a topic level. This is because the IB DP is focussed on students constructing their own personal understanding and meaning collaboratively. Therefore, the IB DP aims are broad and focus on the skills and overarching understanding that is needed in order to succeed at constructing these meanings and acquiring the relevant topic knowledge. Furthermore, the IB DP is a concept-driven curriculum which allows for teaching and learning centred on ideas rather than specific topics or facts. Within the IB DP Guides, the content outlines are based on these essential ideas in relation to the IB's understanding of the nature of science. Further information on the expected understanding, application, and skills for these concepts are also provided. Therefore, IB DP students are expected to understand and apply the majority of these concepts. However, analysis and synthesis is also expected as seen from the IB DP command terms in examinations.

Although the IB DP outcomes may seem similar to the National Curriculum expected outcomes, the guidelines provided in the FBISE demonstrate a lower level of expected knowledge and skills.

[85] Federal Board of Intermediate and Secondary Education Islamabad, 2015. *Chemistry Syllabus- Grade XI.*

7.2 Pedagogical and learning approaches

Within both the Pakistan National Curriculum documents, and the FBISE syllabi, pedagogical and learning approaches for the HSSC are outlined, however the approaches suggested in both do not align. Therefore, the overarching approaches from the National Curriculum are examined below.

✔ Teachers should be knowledgeable and sufficiently trained

In the Chemistry National Curriculum a section on *Instructions in the Classroom* includes a list of notes for teachers in order to ensure quality in their teaching. For example, teachers should know the subject, have a 'scholarly attitude', have communication skills, be inquisitive and analytical, be aware of students' prior learning, and use justified teaching theories and models. Teachers should engage with their students and the curriculum, frequently looking for ways to improve their teaching, the curriculum, or identify students that need further help.

Similarly, the IB DP *Programme Standards and Practice*[86] specifies that an IB World school must provide qualified staff to implement the programme and provide them with professional development.

✔ Move away from teaching to the test (teacher-centred teaching) and use student-centred teaching

Although the Mathematics National Curriculum applies to earlier years of a Pakistani education in addition to the HSSC, a section on *Teaching Strategies* is applicable to the HSSC. This section discusses how teachers need to move away from teaching to the test, and for students to only be able to recall what they learn. The National Curriculum specifies that teachers need to encourage learning through a stimulating and interactive classroom environment.

Further, in the Biology and Chemistry National Curriculums there is a similar section on a *Teaching-Learning Programme* which highlights the recommended teaching approaches and materials for the course. One of many approaches is for the teaching to be student-centred and be "assisting students to derive their own concepts from evidence and providing practical opportunities to develop individual reasoning abilities and motor skills"[87]. Additionally, in the Chemistry National Curriculum, teachers are instructed to give students the time and space to express their understanding of the topics taught.

These themes are further echoed in the Physics National Curriculum section on *Teaching Methodologies and Strategies* which states that teaching should follow a student-centred approach; an interactive and participative model in which students are encouraged to be

[86] International Baccalaureate Organization, 2016. *Programme Standards and Practices - For use from 1 January 2014.* [pdf] Published by: International Baccalaureate Organization.
[87] Government of Pakistan Ministry of Education, 2006. *National Curriculum for Chemistry Grades XI-XII 2006*. [pdf].

active learners[88]. In the *Teaching /Instructional Strategies* section, instructions and guidance is given on a number of teaching methods including lectures, interactive demonstrations, discussions, and inquiry/investigations.

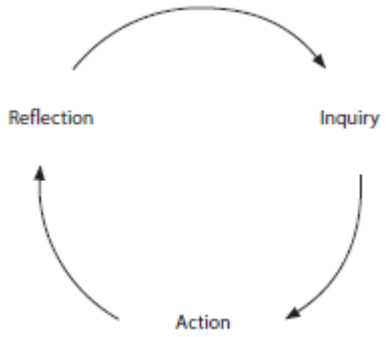
This student-centred approach to teaching is similarly integral to the IB DP, with the *Programme Standards and Practices*[89] reinforcing that the written curriculum takes into account students' previous learning and their individual needs. Standards are also set for the teaching and learning of the programme requiring a strongly student centred approach. Further by encouraging students to build their conceptual understanding, the IB moves away from teaching students to memorise factual knowledge, and focusses on allowing students to collaboratively construct their own meaning and develop a personal understanding that can be used to make sense of the world[90].

✔ Use inquiry-based teaching

In the Biology National Curriculum and the Chemistry National Curriculum, a *Teaching-Learning Programme* is included which highlights the recommended teaching approaches and materials for the course. In particular, it is suggested that inquiry-based teaching strategies be used where possible. This strategy is also emphasised in the IB DP standards and teaching practices. In particular, the IB DP standards require that teaching and learning "engage students as inquirers and thinkers" and support students to "become actively responsible for their own learning" and further to reflect on "how, what and why they are learning"[91]. Further, the IB aims to develop students as *Inquirers* with a natural curiosity that enables them to become lifelong learners. In order to achieve this, the IB suggests that in content heavy courses (such as mathematics and the sciences) an 'inquiry learning cycle' be used in the classroom, as seen in the figure below.

[88] It should be noted however, that teacher-centred approaches to teaching are also mentioned as being appropriate at times.
[89] International Baccalaureate Organization, 2016. *Programme Standards and Practices - For use from 1 January 2014.* [pdf] Published by: International Baccalaureate Organization.
[90] International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015*. Internal document.
[91] International Baccalaureate Organization, 2016. *Programme Standards and Practices - For use from 1 January 2014.* [pdf] Published by: International Baccalaureate Organization.

Figure 5: IB DP Inquiry learning cycle



Source: International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015*. p.68.

The IB also refers to this as a constructivist approach that leads to open democratic classrooms. This is also an aim from the Mathematics National Curriculum, for students to be able to openly share their thoughts and questions on the curriculum in the classroom.

✔ Apply learning to real-world experiences; include practical and hands on experiences

Throughout all of the science and mathematics national curriculums in Pakistan, practical and real-world experiences are highlighted as important teaching methods. In particular, the Mathematics National Curriculum specifies that the course should include practical tasks, problem-solving, and investigations.

In the Biology and Chemistry National Curriculums a *Teaching-Learning Programme* suggests that the programme provides real-life and hands on experiences (i.e. in the classroom, laboratory, or through field work) and applies scientific understanding and problem-solving in everyday settings.

In the Physics National Curriculum, a section on *Teaching Methodologies and Strategies* presents important information for teachers regarding how understanding should be emphasised using investigations. Further, the course should include the application to the real-world, and social, economic, and environmental issues.

These skills are also developed in the IB DP as seen through various policies and practices. For example, one of the approaches to learning skills that the IB aims to develop is research skills, which are developed through hands on practical experiences either in the laboratory or classroom. Secondly, the IB DP Core (TOK and CAS) encourages students to apply their knowledge and understanding in real-life contexts, including through physical activities. Thirdly, through *Action*[92], from the *Inquiry*, *Reflection*, and *Action* cycle during the teaching and learning process, students are learning by 'doing' and engaging in practical and real-world experiences.

[92] International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015*. Internal document. p 9-10.

✔ Include collaborative work and discussions

In all four Pakistan National Curriculums examined, discussions were emphasised as an important approach used in the classroom. The Biology and Chemistry National Curriculums further emphasised that students should have opportunities to engage in collaborative work.

Overall, collaboration is another technique to ensure classrooms are student-centred, and is therefore similarly recommended within the A*pproaches to Teaching and Learning*[93] in the IB DP. Further, the IB uses collaborative learning, in addition to many other IB values, to teach students to learn how to learn. Effective teamwork and collaboration is also one of the six key pedagogical principles that underpin teaching in the IB[94]. Open and productive discussions naturally occur as a result of this teaching method.

✔ Develop written and oral communication skills

In addition to the teaching approaches that are recommended to be used when teaching a programme, the Pakistan and IB programmes specify the skills that should be taught by teachers. In the Biology and Chemistry National Curriculum *Teaching-Learning Programme* section it is recommended that teachers provide opportunities for students to develop written and oral communication skills.

Similarly, the IB DP identifies the teaching and learning strategies, skills, and attitudes through a focus on approaches to learning (ATL). In particular, the approaches to learning skills include communication, but also thinking, social, self-management, and research skills.

✔ Develop analytical, critical and evaluative thinking skills in students

In the Physics National Curriculum, a section on *Teaching Methodologies and Strategies* suggests that teachers should ensure the course develops analytical, critical, and creative thinking in students, and the ability to evaluate. These skills are also developed in IB DP students as established in the IB Learner Profile attribute, *Thinkers*, which states that learners will "use critical and creative thinking skills"[95]. Further the IB states that a quality DP curriculum should reflect the *Approaches to Teaching and Learning* in that analysis, synthesis and evaluation will promote critical reflection and thinking.

✔ Use formative and summative assessment

Formative and summative assessments are recommended evaluative tools in both the Biology National Curriculum and the Chemistry National Curriculum, as part of the *Teaching-Learning Programme* and within the IB DP as stated in the *Approaches to Teaching and*

[93] International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015*. Internal document.
[94] International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015*. Internal document. p. 66.
[95] International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015*. Internal document.

Learning and within the IB guidance *Diploma Programme: From Principles into Practice*[96]*.* Both programmes also provide further guidance on the different types of formative assessments that could be used in the classroom. The IB emphasises that formative assessment should be used to provide feedback to students and teachers and for future curriculum planning.

[96] International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015*. Internal document.

8. Comparing the Recognition of the IB DP and HSSC by International Universities

Key findings

There are significant differences in the recognition of the IB DP and the HSSC for the purpose of admission to top ranked universities around the world.

A review of admission requirements for universities within the Times Higher Education (THE) World Rankings Top 100 for 2016, cross-referenced with key destination markets for Pakistani students, found the IB DP to be uniformly and globally recognised as a pre-university qualification giving access to Bachelor degree level study, In the USA, it is further recognised for advanced standing through credit exemptions towards the first year of study.

By contrast the HSSC is not as widely accepted for direct entry to international universities, with many requiring an additional year of study before entering a Bachelor degree.

From a sample of 25 highly ranked universities across the globe, all accepted the IB DP subject to achievement of requisite grades set by the university whilst only eight accepted the HSSC.

The differences are even more apparent when looking at recognition by THE Top 100 institutions in countries such as the UK, where all 12 Top 100 universities with published admission requirements accepted the IB DP for direct entry, whilst only two of the 12 would accept the HSSC, and specifically the pre-engineering or pre-medical streams, rather than all streams.

Recognition of the HSSC was also limited in countries such as Germany and Australia, whilst a number of other countries such as the US, Netherlands, Sweden and Denmark had little information available publically on the HSSC for admissions despite all having published statements on the recognition of the IB DP.

This section provides a summary of university recognition of the IB DP and Pakistan HSSC for the purposes of admission to undergraduate study. Emphasis has been firstly placed on key destination markets for Pakistani students, with reference to the UNESCO Institute for Statistics' *Global Flow of Tertiary-Level Students*.

8.1 Recognition of the IB DP and HSSC by UK universities

This data identified the UK as the top destination country for Pakistani students, a country with 12 universities in the THE Top 100 for 2016. A review of published admission requirements by the 12 universities demonstrated the following:

Table 32: Recognition by top-ranked UK universities

THE Rank 2016	Institution Name	Recognition for the purposes of undergraduate admission	
		IB DP	HSSC
1	University of Oxford	✔ Direct entry (38- 40 points)	✗ Further study required
4	University of Cambridge	✔ Direct entry (40-41)	✗ Further study required
8	Imperial College London	✔ Direct entry (grade requirements vary by degree programme)	**N/A** No information
15	University College London (UCL)	✔ Direct entry (minimum of 34)	✗ Further study required
25	The London School of Economics and Political Science (LSE)	✔ Direct entry (grade requirements vary by degree programme)	✗ Further study required
27	University of Edinburgh	✔ Direct entry (grade requirements vary by degree programme)	✔* Selected HSSC streams only (grade requirements apply)
36	King's College London	✔ Direct entry (grade requirements vary by degree programme)	**N/A** No information
55	University of Manchester	✔ Direct entry (32-37, may vary by programme)	✗ Further study required
71	University of Bristol	✔ Direct entry	✗ Further study required
82	University of Warwick	✔ Direct entry (grade requirements vary by course)	✗ Further study required

THE Rank 2016	Institution Name	Recognition for the purposes of undergraduate admission	
		IB DP	HSSC
88	University of Glasgow	✔ Direct entry (grade requirements vary by degree programme)	✔** For selected programmes
96	Durham University	✔ Direct entry (grade requirements vary by degree programme)	✗ Further study required

Notes:
*The University of Edinburgh will accept the HSSC in the pre-engineering or pre-medical streams only, and with an overall mark of 75% (825/1100). For all other streams, further study – such as international foundation year programme – would be required prior to admission to degree level study.
**Holders of the HSSC with a minimum overall mark of 75% (825/1100) may be considered to meet the requirements for direct entry to selected programmes. Those wishing to undertake Bachelor degree programmes in medicine, dentistry or veterinary medicine would need to undertake further study.

As shown above, the IB DP is well recognised for the purposes of admission to top ranking UK universities, with grade requirements varying by programme. For some universities, and for certain programmes, specific subjects and grades at HL may be additionally requested.

The recognition of the HSSC by UK universities varies, with many suggesting that further study would be required prior to admission to Year 1. Such further study might include study towards a Bachelor degree in Pakistan (BA/BSc/BCom), A Levels, the IB DP, or an international foundation year programme from a recognised provider.

8.2 Recognition of the IB DP and HSSC by Australian universities

The second biggest destination market for outbound students from Pakistan is Australia, where the THE 2016 World Rankings identified six universities in the Top 100. Information drawn from published admission requirements is summarised in the following table:

Table 33: Recognition in top-ranked Australian universities

THE Rank 2016	Institution Name	Recognition for the purposes of undergraduate admission	
		IB DP	HSSC
33	University of Melbourne	✔ Direct entry (grade requirements vary by degree programme)	✗*
47	Australian National University	✔ Direct entry (28-42 depending on the degree programme)	**N/A** No information
60	The University of Sydney	✔ Direct entry (grade requirements vary by degree programme)	✗* Further study required
60	The University of Queensland	✔ Direct entry (grade requirements vary by degree programme)	✔** Direct entry – selected streams only
74	Monash University	✔*** Direct entry (grade requirements vary by degree programme)	**N/A***** Unclear
78	University of New South Wales	✔ Direct entry (grade requirements vary by degree programme, min. 27)	✗ Further study required

Notes:

*The HSSC is not listed under the university's list of acceptable qualifications for admission, although it is acknowledged that the list is not intended to be exhaustive. The HSSC is however listed under acceptable qualifications for entry to the Trinity College Foundation Studies programme linked to the University of Melbourne; and for Taylor College, the main foundation programme provider for the University of Sydney suggesting that the HSSC is not accepted for direct entry to Bachelor degree level study at either of these universities.

**The University of Queensland will accept the HSSC in the pre-engineering or pre-medical streams only for direct entry.

***Information specific to Pakistan and the HSSC is not provided in relation to degree level admission as guidance is general, indicating the satisfactory completion of the final year of secondary school level (any country) may be accepted. However the affiliated foundation programme, the Monash University Foundation Year (MUFY) suggests that holders of the HSSC would be accepted for admission to the foundation programme, with grades of 55-65%. Those achieving 24 in the IB would

also be accepted, whilst those with higher scores in the IB DP (variable by degree programme) would be accepted for direct entry to degree level study.

As with the UK, the IB DP is typically accepted by top-ranking Australian universities for direct entry to Bachelor degree programmes providing the student has met the requisite grades for their intended programme of study. There is limited published information in the admissions requirements about the HSSC and it is therefore assumed that it would be considered on a case-by-case basis, taking into consideration the stream and final grades achieved by the individual applicant. However, it is observed that the qualification is also listed as acceptable for admission to international foundation year programmes at affiliated providers, suggesting this would be the normal route for holders of the HSSC looking to study in Australia.

8.3 Recognition of the IB DP and HSSC by other top-ranked universities

After the UK and Australia, the *Global Flow of Tertiary-Level Students* identified many further destination countries for students from Pakistan. Many of these, such as Saudi Arabia, Malaysia and the United Arab Emirates, currently have no universities in the Top 100; other destination countries such as the USA, Canada and Germany by contrast have a number of universities listed in the Top 100. The admission requirements where found are summarised in the table below. It should be noted that few US universities publish country-specific entrance requirements meaning objective, published data on acceptance of either the IB DP or HSSC is more limited in the US than in other countries. Countries such as Germany also have centralised sources of information on international qualifications accepted by universities in those countries.

Table 34: Recognition in top-ranked universities in other destination countries

Country	THE Rank 2016	Institution Name	Recognition for the purposes of undergraduate admission	
			IB DP	HSSC
USA	Various from 10-51[97]	University of California (all campuses)	✔ Direct entry (grade requirements vary by degree programme)	✔ Direct entry (grade requirements vary by degree programme)
	13	University of Pennsylvania	✔ Direct entry (grade requirements vary by degree programme)	**N/A** No information
	21	University of Michigan	✔ Direct entry or advanced standing depending on scores and HL subjects	**N/A** No information

[97] Berkeley campus (10), Los Angeles (14), San Diego (41), Santa Barbara (48), Davis (51), and Irvine (98).

Country	THE Rank 2016	Institution Name	Recognition for the purposes of undergraduate admission	
			IB DP	HSSC
	33	Georgia Institute of Technology	✔ Direct entry or advanced standing depending on scores and HL subjects	**N/A** No information
	45	University of Wisconsin-Madison	✔ Advanced standing	**N/A** No information
	51	Brown University	✔ Advanced standing	**N/A** No information
	64	Boston University	✔ Direct entry. Advanced standing is available for those with grades of 5, 6 or 7 at HL.	✔ Direct entry (grade requirements vary by degree programme)
Canada	22	University of Toronto	✔ Direct entry (min. score of 27)	✔ Direct entry (grade requirements vary by degree programme)
	36	University of British Columbia	✔ Direct entry (grade requirements vary by degree programme)	✔ Direct entry (74%, 820/1100)
	42	McGill University	✔ Direct entry (grade requirements vary by degree programme)	✔ Direct entry (First Division)
Germany	30	LMU Munich	✔ Direct entry (grade requirements vary by degree programme)	✗* Further study required
	43	Heidelberg University		
	46	Technical University of Munich		
	57	Humboldt University of Berlin		
	75	Free University of Berlin		
	78	RWTH Aachen University		

Country	THE Rank 2016	Institution Name	Recognition for the purposes of undergraduate admission	
			IB DP	HSSC
	82	Technical University of Berlin		
	89	University of Tübingen		
	95	University of Freiberg		
Sweden	28	Karolinska Institute	✔ Direct entry (grade requirements vary by degree programme)	No information though direct entry implied
	93	Uppsala University		
	96	Lund University		
Finland	91	University of Helsinki	✔ Direct entry (grade requirements vary by degree programme)	**N/A** No information
Nether-lands	59	Delft University of Technology	✔ Direct entry (grade requirements vary by degree programme)	**N/A**** No information
	63	University of Amsterdam	✔ Direct entry (grade requirements vary by degree programme)	**N/A**** No information
	69	Erasmus University	✔ Direct entry (grade requirements vary by degree programme)	**N/A**** No information
	77	Leiden University	✔ Direct entry (grade requirements vary by degree programme)	**N/A**** No information
	80	University of Groningen	✔ Direct entry (grade requirements vary by degree programme)	**N/A**** No information
	86	Utrecht	✔ Direct entry (grade requirements vary by degree programme)	**N/A**** No information

Country	THE Rank 2016	Institution Name	Recognition for the purposes of undergraduate admission	
			IB DP	HSSC
	94	Maastricht University	✔ Direct entry (grade requirements vary by degree programme)	**N/A**** No information
Denmark	98	Aarhus University	✔ Direct entry (grade requirements vary by degree programme)	✔*** Selected streams only
Hong Kong	43	University of Hong Kong	✔ Direct entry (40)	✔ Direct entry (with 85% in each of the six subjects)
	49	Hong Kong University of Science and Technology (HKUST)	✔ Direct entry (36-40)	✔ Direct entry (85%)
	76	Chinese University of Hong Kong	✔ Direct entry (grade requirements vary by degree programme)	✔ Direct entry (with 80% in each of the six subjects)

Notes

*Students wishing to study in Germany can look up requirements and acceptance of their secondary school certificate on the Anabin site (German only) or the DAAD site. Based on completion of the HSSC, DAAD recommends holders qualify for "subject-restricted admission to a preparatory course".

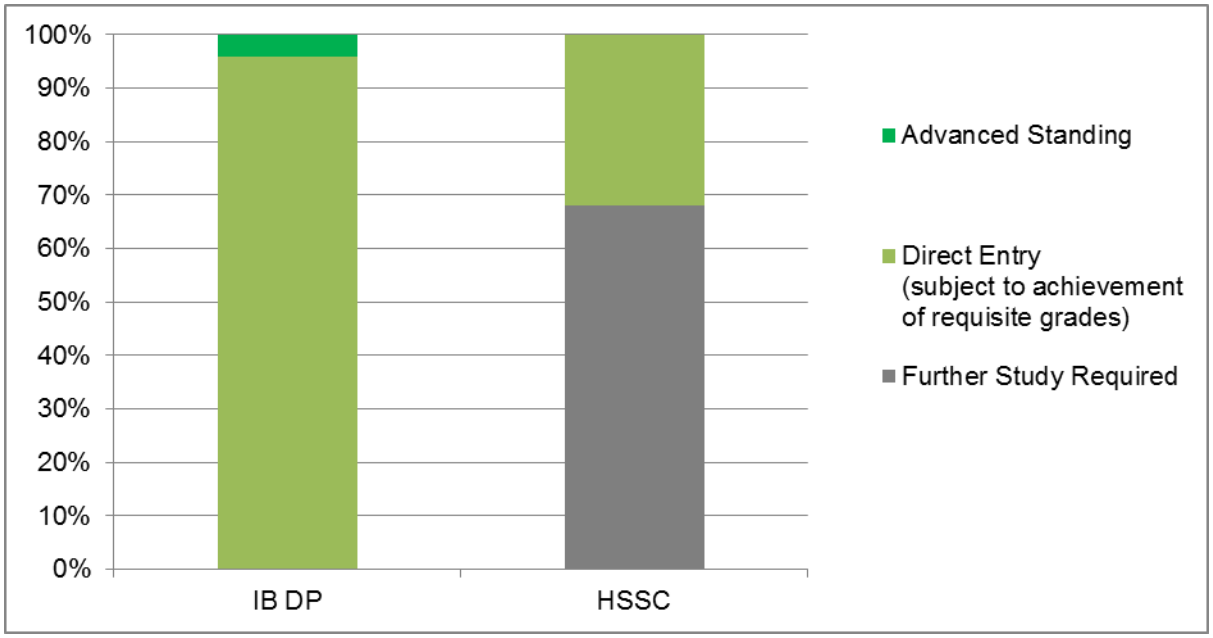
**Dutch universities typically publish a list of high school diplomas considered comparable to the Dutch upper secondary school diploma (VWO). The IB DP is included on these, but Pakistan is not, and accordingly it is assumed that further study would be required for admission to Dutch universities or that admission would be made on a case-by-case basis for applicants with the HSSC.

***According to the Danish Agency of higher education, it would typically be expected that applicants holding qualifications from Pakistan should hold both the HSSC and one year of higher education study for admission to an undergraduate degree programme. Some institutions may admit candidates with the HSSC pre-engineering or pre-medical stream passed with 75% and above.

8.4 Summary of recognition from 25 highly ranked universities globally

As shown above, published admissions requirements for many institutions in the Top 100 do not provide specific information on acceptance of the HSSC, indicating that applications are likely to be considered on a case-by-case basis. To enable further comparison, the chart below provides a summary of the recognition of the IB DP and HSSC from 25 universities[98]. These universities have been selected from the 32 universities providing specific information on the recognition of the two qualifications, based on their position in the THE rankings.

Figure 6: Acceptance of the IB DP and HSSC from 25 highly ranked universities worldwide



[98] University of Oxford (1); University of Cambridge (4); University of California (all campuses) (10, various – counted as a single institution); University College London (15); University of Toronto (22); LSE (25); University of Edinburgh (27); LMU Munich (30); University of Melbourne (33); University of British Columbia (36); McGill University (42); Heidelberg University (43); University of Hong Kong (43); Technical University of Munich (46); HKUST (49); University of Manchester (55); Humboldt University of Berlin (57); University of Sydney (60); University of Queensland (60); Boston University (64); University of Bristol (71); Free University of Berlin (75); Chinese University of Hong Kong (76); RWTH Aachen University (78); University of New South Wales (78).

9. Summary of Key Findings

9.1 Philosophical underpinnings of the IB DP and Pakistani school system

Whilst the NEP acknowledges the aspirational nature of the 2009 strategy, its overarching priority is to widen access to education for all and improve the quality of education to address the needs of the economy. The overall philosophy, priorities and goals (policy actions) associated with this are in many ways echoed by the IB education; notably that both the IB and Pakistan education systems:

- Aim to develop a self-reliant individual, a global citizen and an original thinker who values their individual responsibility towards their society
- Strive to deliver an education that caters for the social, political and spiritual needs of individuals and society
- Aim to adhere to justice and equity, raising students who are aware of human rights and encouraging their students to engage in service oriented activities that uphold the principles of fairness, justice and respect
- Recognise the importance of linking what is taught in the classroom and real life, with both understanding the importance of teacher professional development to ensure teachers are well placed to deliver this in practice.

Differences were observed in the operational context of the educational systems. Although the NEP aims to be inclusive, it does predominantly adhere to Islamic values when designing curriculum materials. Meanwhile, the IB DP allows flexibility in the design principles and does not prescribe to one specific system and instead aims to develop a learner who is open- and internationally-minded.

9.2 The IB DP and the HSSC

9.2.1 Aims, objectives, standards

The National Curriculum aims and objectives for Mathematics, Biology, Chemistry and Physics are all included, or partially included, within the IB DP. Although the aims and objectives are developed and tailored for each of the four subjects reviewed, many common themes were identified among these. Overall, both the HSSC and IB DP aim for students to be life-long learners, problem-solvers, investigative and experimental, with the ability to communication information. Students are further expected to build on their prior knowledge and prepare for further study in that subject.

Some of the HSSC aims were topic- or subject-specific, but were nonetheless identified within the IB DP content outlines or inferred from the IB aims. For example, the National Curriculum for Physics aims for students to understand and appreciate the issues of exploiting environmental resources, the delicate balance in nature, and the influence human activity has on this balance is similarly implied in the IB DP aim for students to understand the ethical implications of science.

Where other aims or objectives were considered partially included in the IB DP, this was often because no clear reference to them could be found within the subject guides. For example, an aim for physics included reference to enabling students to "appreciate the supreme wisdom and creative powers of the creator", which is not similarly referenced in the IB.

Standards, and their associated benchmarks, set in the National Curriculum were also examined as indicators of what students are expected to achieve upon completion of the HSSC. In all four subject reviewed, the majority of the benchmarks were similarly identified within the IB DP. Where benchmarks were not identified within the IB DP, these were often associated with Pakistan topics not similarly covered in the IB programme. For example, the Mathematics National Curriculum benchmark for students to "identify and analyse conic sections (circle, parabola, ellipse and hyperbola)" relates to the key topic on Conics which is not a core topic of the IB DP Mathematics course.

Within the Pakistan National Curriculums for Biology, Physics, and Chemistry, standards regarding *Constructing New Scientific Knowledge* and *Reflecting on Scientific Knowledge* included many similar or identical benchmarks across the three sciences. Many of these benchmarks were identified within the IB DP. For example, all science programmes aim for students to be able to ask questions that can be investigated, explain the risks of new technologies, and identify the relationship of scientific discipline with other areas of knowledge.

9.2.2 Content Comparison

Overall, the content comparison identified many common key topics between the Pakistan National Curriculum for the HSSC and the IB DP, and in most cases, the content was broadly comparable between the programmes. One of the challenges in comparing the subjects however was the varying level of detail to which the programmes are prescribed.

In Mathematics, both programmes cover trigonometry, functions, graphs, probability, vectors, and algebra. Some Pakistan topics could not be identified within the IB DP including matrices, linear programming, conics, and numerical methods.

Both Biology programmes teach cell biology, ecology, evolution, and biodiversity, and most of the Pakistan sub-topics were identified within the IB DP curriculum with the exception of acellular life, protists and fungi, diversity among plants and animals, and biology and human welfare. Overall, a similar breadth of content is covered between the IB DP and National Curriculum for the HSSC, and some shared topics are covered in a similar depth, however certain key topics (cell biology, ecology, and genetics) are covered in more depth in the IB DP.

Similar topics were also identified within the Chemistry programmes with both programmes covering stoichiometry, atomic structure, thermochemistry, chemical kinetics, acids and bases, equilibrium, bonding, and biochemistry. Nearly all of the Pakistan topics are included in the IB DP and only two partially included: solutions and colloids, and alkyl halides and

amines. Overall, the IB DP includes a larger breadth of topics with many additional topics and sub-topics covered including, metallic bonding, covalent structures (including Lewis (electron dot) structures), the pH scale, entropy and spontaneity, and pH curves. Further, some of the topics in the Pakistan National Curriculum (i.e. elements of the periodic table, industrial chemistry, states of matter, organic chemistry) are covered in more detail than in the IB DP, but equally, the IB DP covers chemical bonding and structures, biochemistry, and thermodynamics in more detail.

In Physics both programmes cover similar overarching physics topics such as waves, energy, and measurement. When comparing the content outlines using the sub-topics and Pakistan learning outcomes, it is clear that all of the Pakistan Grade XI topics are similarly or partially included within the IB DP; and most of the Grade XII topics are similarly covered. Physics of solids and electronics were not identified within the IB DP, however four alternative sub-topics are taught within the IB DP, indicating that for some physics topics the programmes focus on slightly different sub-topics. Nonetheless, the IB DP and Pakistan programme cover a similar breadth of topics and similar depth where these topics are shared. However, for many of the physics topics, the IB DP prescribes additional application and skills elements for students.

9.2.3 Assessment Methods and Cognitive Demand

One limitation encountered in the study was the absence of published mark schemes / marking guidelines and assessment objectives and criteria for the HSSC exams and practical assessment, making it difficult to compare the specific expectations of students in the two programmes. Nevertheless through review of specimen exam papers, it is possible to identify similarities and differences in the assessment methods, duration, volume, cognitive demand and the specific skills tested.

Firstly, the summative assessment methods for FBISE HSSC Grade XI and Grade XII in Biology, Chemistry and Physics are similar to those employed for the IB DP HL courses given the combination of written exam papers and practical assessment, whilst for Mathematics, the HSSC is assessed wholly through written examination and the IB DP HL through a combination of written examinations and individual project.

The study has also found the overall duration of assessment in the IB DP and HSSC to be broadly similar though the volume of assessment is slightly higher in the IB DP which tends to use multi-part structured questions with several sub-questions. Multi-part questions are used to a much lesser extent in the HSSC, particularly in Mathematics. Across all subjects, the HSSC employs a similar structure of assessment – a 25-minute multiple-choice test, followed by a 2 hour 35 written test comprising short-answer questions where students are required to answer a given number of questions, typically around two-thirds of the selection of questions available. Multiple-choice questions are similarly used in science subjects for both the IB DP and HSSC, but are not found in the IB DP Mathematics HL.

Assessments in both programmes include questions grounded in real-life scenarios or applications though this was evident to a much greater extent in the IB DP programmes,

reflecting somewhat the structure of the papers with the IB DP comprising multi-part questions which explore a problem in depth, and therefore enable assessment of higher order thinking skills, in comparison to the series of short questions of the HSSC which typically ask students to prove or solve an equation, or calculate a value.

Overall, all four subjects for both programmes address the cognitive demands of knowledge, understanding and application of the taught subjects, although the HSSC exams have slightly more questions testing knowledge recall, than observed in the IB DP papers. Within both, the emphasis is on testing students' ability to apply their knowledge of mathematics and science to calculate key values in unseen equations or problems. Analysis and evaluation skills, though referenced in the National Curriculum, are not explicitly tested within the papers reviewed but can be seen in the IB DP assessments, in particular the internal assessments. Thus, the overall level of demand in student assessment is considered to be higher in the IB DP than the HSSC.

There also appears to be greater emphasis on testing students' written communication skills in the IB DP programmes, firstly in the exam papers with selected questions in all subjects asking for detailed explanations, but notably in the aforementioned internal assessments which for mathematics takes the form of an individual exploration and a 6-12 page essay of an area of mathematics; and for the science subjects, an individual scientific investigation comprising a practical task and 6-12 page write-up assessing research, analytical and evaluation skills. Both the IB DP Biology, Chemistry and Physics courses and the HSSC include further practical activities outside of the assessments[99].

9.3 Pedagogical and learning approaches in the IB DP and HSSC

When comparing the IB DP policies, practices, and standards to the HSSC National Curriculum guidelines for teaching and learning approaches, many common themes were identified. Both programmes require that teachers are fully prepared and trained to teach the subject matter, with continued focus on improving their teaching or receiving professional development.

Another key teaching approach shared by the IB DP and the National Curriculum for the HSSC is for the teaching to be student-centred rather than teacher-centred where the focus is on teaching to the test. Both programmes recognise that it is important for students to be able to do more than just recall what they have learned, and for students to be active learners who develop their own understanding from concepts and ideas. Further, the IB requires that a DP written curriculum takes into account the prior learning of students, and ensures that the curriculum meets their individual needs. Overall, this shared student-centred approach leads to further shared practices and standards that are used to ensure the teaching and learning is student focussed.

The first technique is inquiry-based teaching. Although this teaching approach is recommended by the Pakistan National Curriculum, it is required in the IB DP. As seen from

[99] For example, the IB DP includes the group 4 project.

both the IB Learner Profile and from the *Programme Standards and Practices*[100], IB DP students shall become *Inquirers* through teaching and learning. In particular, an 'inquiry learning cycle' is used in the classroom that focusses on *Inquiry, Action, and Reflection*. Through this inquiry-based approach, the IB allows students to find information and draw their own conclusions and develop their own understandings of a subject. To ensure teachers are able to achieve this, the IB provides detailed information on inquiry-based approaches and techniques.

Another student-centred technique is for teachers to allow students to apply their learning to real-world experiences. Practical and hands on experiences are included in both programmes, especially within the science subjects. The IB DP further requires that students develop research skills and not only apply their learning in practical settings, but learn through action and the process of 'doing'. Further, both programmes aim for the teachers to assist students in developing written and oral communicative skills, and analytical and critical thinking skills. However, the IB also focusses on students learning social and self-management skills.

Finally, the last shared technique for ensuring a student-centred classroom, is for collaborative work and group discussions to take place. Both programmes emphasise that students must have opportunities to engage in group work and discussions. However, "effective teamwork and collaboration" is only one of six pedagogical principles that underpin teaching in the IB[101]; inquiry-based teaching and learning is a second. The other four principles specify that IB teaching is:

- Focussed on conceptual understanding
- Developed in local and global contexts
- Differentiated to meet the needs of all learners
- Informed by assessment (formative and summative).

The use of formative and summative assessment is similarly emphasised in the Pakistan National Curriculum as part of the guidance to teachers on how to evaluate students and both programmes provide recommendations on the type of formative assessments that could be used in the classroom.

9.3.1 Aims, objectives and outcomes

In addition to the teaching and learning approaches, the intended learning outcomes for the HSSC were examined, as set in both the National Curriculum and FBISE. As the aims, objectives, and National Curriculum benchmarks and standards were examined as part of the content comparison, they were reviewed as a whole in this section to determine what overarching aims, objectives, and outcomes were set and if there were any additional information on the expected level of knowledge to be taught or learned.

[100] International Baccalaureate Organization, 2016. *Programme Standards and Practices - For use from 1 January 2014.* [pdf] Published by: International Baccalaureate Organization.
[101] International Baccalaureate Organization, 2015. *Diploma Programme: From Principles into Practice - For use from August 2015*. Internal document. p. 66.

In summary, many aims and objectives are shared between the IB DP and HSSC with some echoing the teaching approaches discussed previously (including experimental skills, application to the real-world, communication and collaborative skills). The additional aims include the following:

- Solid knowledge of the subject
- Scientific/rational thinking
- Importance of technology
- Understand the limitations of science
- Cognitive, affective and psychomotor abilities.

A review of the National Curriculum standards and benchmarks demonstrated the overall level of skills expected of students. Across all four subjects examined, students are expected to have understanding, application, and analysis skills, and these make up the majority of topic specific outcomes. Higher level expectations are seen through some of the outcomes that prescribe students to evaluate, apply, explain, compare, interpret, and differentiate; however, these only make up a select few of the outcomes. Further, when examining how these outcomes are set in the practice through the FBISE *Learning-Teaching Guidelines for Students and Teachers*, similar expectations are seen for students to be able to recall, understand, and in some cases apply their knowledge, however there is much less emphasis on the higher-order thinking skills (i.e. analysis, evaluation, synthesis). In comparison, the IB DP does not set topic level benchmarks or outcomes, but aims to develop student's conceptual understanding with equal focus on the relative understanding application and skills associated with each concept. The higher-order thinking skills set by the Pakistan National Curriculum, although not demonstrated in the FBISE syllabi, are similarly set by the IB DP as demonstrated in the assessments, standards, and practices.

9.4 Recognition of the IB DP and HSSC by international universities

Comparing the recognition of the IB DP and HSSC for the purpose of admission to top ranked universities worldwide highlighted significant differences in the portability of the two qualifications.

Across 25 of the THE World Rankings top 100 institutions, all accept the IB DP for direct admission to Bachelor degree programmes, subject to achievement of the requisite grades for the institution and or degree programme in question. One would additionally offer advanced standing.

By contrast, few accept the HSSC for direct entry with many requiring one further year of study in the form of an International Foundation Year, Year 1 of a degree programme in Pakistan, or even completion of an international secondary qualification such as the DP or A level.

Furthermore, adopting a country-specific approach in the analysis often revealed stark contrasts in universities' view of the IB DP and HSSC as pre-university qualifications. This is especially true in the UK where 100% of the UK's top ranked universities publish their acceptance of the IB DP whilst only 17% stated that the HSSC would be accepted, and only

where the student had followed the pre-engineering or pre-medical stream. This contrast was echoed, to a greater or lesser extent in countries such as Germany and Australia.

In Canada and Hong Kong, the HSSC and IB DP appear to enjoy similar recognition among top ranked Canadian universities whilst in the US, the IB is generally well recognised for direct entry or advanced standing with comparatively little data available on the acceptance of the HSSC indicating that it would be considered by US institutions on a case-by-case basis.

9.5 Comparability of the IB DP to the HSSC

From the key findings above, it is clear that the study has identified many similarities between the IB DP and HSSC in Mathematics, Biology, Chemistry and Physics. The content outlines include similar key topics, and the programmes use similar assessment methods, including written examinations. Similar policies and recommended teaching approaches were also identified indicating that the IB DP and HSSC both aim to develop a well-rounded and knowledgeable individual through student-centred and inquiry based teaching methods.

Examining these ideas in practice, the study identified that the IB DP firmly connects these ideas and demonstrates them from framework to curriculum level, with the cognitive demand of the assessments set high focussing on higher order thinking skills. By contrast, the themes identified in the Pakistan National Curriculum were not fully reflected within the objectives set in practice for the HSSC and the overall assessments (in terms of duration, question types and the skills assessed) were considered to be of a lower demand.

In conclusion, the study has identified that the IB DP is pitched at an overall higher academic level than the HSSC, and as demonstrated from the findings in Section 9.4, is acknowledged to meet the general entrance requirements of many higher education institutions across the globe.

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