Comparison of Senior Secondary School Qualifications

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KICE
Korea Institute for Curriculum and Evaluation

Joint Research Report on the Senior Secondary School Curriculum Comparative Analysis for Mathematics and Science between the Republic of Korea and New Zealand

Registration No. #ORM2015-41

Joint introduction by the Korea Institute for Curriculum and Evaluation and the New Zealand Qualifications Authority

The Korea Institute for Curriculum and Evaluation (KICE) and the New Zealand Qualifications Authority (NZQA) value the opportunity to work in partnership on the comparison of senior secondary school qualifications project. This project has helped promote a shared understanding of the Republic of Korea and New Zealand's education systems and curricula.

The project was initiated in 2013 and sits in the context of the broader education relationship between the Republic of Korea and New Zealand. KICE and NZQA have undertaken a curriculum-to-curriculum analysis to map the Republic of Korea and New Zealand's senior secondary school qualifications for the purpose of gaining agreement on the recognition of these qualifications.

This joint research report sets out the findings of the comparative analysis of senior secondary school curricula for Mathematics and Science undertaken by researchers and subject matter experts in both countries. The report looks at common concepts and differences within the agreed subject parameters to determine the overall comparability.

We trust the results from this project will provide further opportunities for both countries to work together and encourage greater student mobility between the Republic of Korea and New Zealand.

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President, KICE
June 2015

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June 2015

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1. 요약문

전 세계적으로 해외 유학생의 수는 4백 만 이상으로 그 수 또한 계속 증가하고 있습니다. 지식의 폭을 넓히고자 해외 유학을 택하는 학생들이 늘어나면서 국제적 인증 및 자격 취득이 날로 중요해지고 있습니다.

이번 공동연구 프로젝트는 소규모로 진행되었으나 한국과 뉴질랜드의 교육제도 및 고등학교 교육과정을 이해하는 데 한걸음 나아갈 수 있는 역할을 함으로써 양국간 자격 인증 관련 정보 교환 및 공유에 힘을 싣는 계기를 마련할 것입니다.

2014년 뉴질랜드에서 유학하는 한국 학생 수는 약 8천명으로 대부분 뉴질랜드 중·고등학교 또는 사설교육기관 재학생이었습니다. 이번 프로젝트를 통해 수집된 고등학교 교육과정 정보로 한국과 뉴질랜드의 수학 및 과학 교과 내용의 공통점과 차이점을 확인할 수 있었습니다.

이번 연구에서 가장 어려웠던 일 중 하나는 양국 교육과정을 일대일로 비교하는 것이었는데 이는 교육과정 접근 방식에 차이가 있기 때문입니다. 한국의 경우 교육과정에 따른 교과서와 교사용 지도서는 그 내용이 상당히 표준화돼있습니다. 반면 뉴질랜드의 교육과정은 매우 유연하고 구체적인 계획보다는 방향성을 제시하고 있기 때문에 교사는 학생들의 요구를 만족시키기 위해 다양한 아이디어를 제시하고, 여러 학습 자료와 방법을 활용해야 합니다. 그래서 KICE에서 실시한 비교분석 연구에서는 NZQA에서 제공하는 뉴질랜드 교육과정 기반 성취 표준화를 사용했습니다.

한국과 뉴질랜드는 교육제도와 교육과정 상의 분명한 차이는 있지만 양국의 고등학교 수학과 과학 교과에서는 공통점이 더 많았습니다.

수학에서의 가장 큰 차이점인 확률과 통계, 기하학, 벡터의 접근법을 제외하고는 연산과 미적분의 내용은 대체로 비슷했습니다.

과학도 마찬가지로 물리와 화학의 내용은 거의 비슷했습니다. 뉴질랜드의 생물 교과는 그 내용이 주로 진화에 집중되어 있기는 하나 생명과학 또는 생물 주제라는 개념은 한국과 동일했습니다.

반면 한국과 뉴질랜드의 지질학은 달랐습니다. 하지만 한국의 지구과학과 뉴질랜드의 지구와 우주과학 내용은 넓은 의미로의 공통 지질학으로 이어집니다. 가장 큰 차이점은 뉴질랜드의 지질학은 국지적 환경에 초점을 맞추고 있다는 점입니다.

전반적으로 한국과 뉴질랜드의 수학과 과학에는 차이점보다는 유사점이 더 많았습니다. 따라서 최적합이라는 개념을 바탕으로 한국과 뉴질랜드의 고등학교 교육과정은 대체로 비슷하다고 결론 지을 수 있습니다. 약간의 차이가 있는 부분에서도 뉴질랜드 교육과정이 유연하기 때문에 학생들은 조사연구를 통해 한국 교육과정의 주제를 다룰 수 있을 것입니다.

1. Executive Summary

There are over four million globally mobile international students and this number is growing. The value of achieving an internationally recognised and comparable qualification is becoming increasingly important as more students choose to travel abroad to further their education.

This joint research project is a small but significant step to enhancing the understanding of the education systems and senior secondary school curricula between the Republic of Korea and New Zealand. It will pave the way for further exchanges and sharing of information to support the recognition of qualifications between the two countries.

There were approximately 8,000 Korean students studying in New Zealand in 2014. The majority of these students were enrolled in New Zealand secondary schools and private training establishments. The senior secondary school curricula information collected for this project has helped highlight the similarities and differences in the content for Mathematics and Science between the Republic of Korea and New Zealand.

One of the main challenges of this project has been undertaking the curricula-to-curricula mapping due to the different approach to the curriculum by both countries. The Korean National Curriculum provides highly standardised content with textbooks and teachers' manuals provided within the framework of the curriculum. In New Zealand, the curriculum is highly flexible and provides a framework rather than a detailed plan. Teachers are required to draw on a range of ideas, resources and models to fit the needs of their students. As a result, the comparative analysis undertaken by KICE uses the New Zealand Curriculum based Achievement Standards provided by NZQA.

While there are distinct differences in the education system and curricula focus between the Republic of Korea and New Zealand, there is more common content in the senior secondary school curriculum for Mathematics and Science than differences.

In Mathematics, the main differences lies in the approach used in probability and statistics, and geometry and vector. The content for mathematics and calculus however, is broadly comparable.

Similarly for Science, the curriculum content for physics and chemistry are a good fit. While the New Zealand Curriculum concentrates on evolution as the main theme in biology, there are common concepts in the life science/biology topics between the two countries.

The geology in the Republic of Korea and New Zealand is different. However, the content in the earth science curriculum in the Republic of Korea and earth and space science in the New Zealand Curriculum is linked to broader common concepts of geology. The main difference is that in New Zealand, geology focusses on the local environment.

Overall there are more similarities between the Mathematics and Science curriculum content between the Republic of Korea and New Zealand than differences. It is possible to conclude based on the concept of best-fit, that the senior secondary school curricula between the two countries are broadly comparable. Where there are minor differences, the New Zealand Curriculum is flexible enough to enable students to cover topics from the Korean National Curriculum under the research and investigative standards.


TOSHIBA

2. Background

The Ministry of Education, Science and Technology of the Republic of Korea and Ministry of Education of New Zealand signed an Education Cooperation Arrangement during a state visit to New Zealand by the President of the Republic of Korea, Lee Myung-bak in March 2009. The Arrangement provided KICE and NZQA with an opportunity to work together. A joint research project to compare and analyse the senior secondary school curriculum for both countries was agreed in November 2013. This project sits in the context of the broader education relationship between the Republic of Korea and New Zealand.

3. Methodology

The curriculum-to-curriculum comparative analysis focused on Mathematics and Science because of the universal approach to both these disciplines and the limited likelihood of there being country-specific content and questions.

Science subjects selected include life science (Republic of Korea) and biology (New Zealand), chemistry, physics, and earth science (Republic of Korea) and earth and space science (New Zealand).

The concept of 'best-fit' was applied to the comparative analysis process. This concept is founded on a long-standing mathematical and engineering idea for finding harmony between two sets of data or two or more devices. The concept of best-fit requires collective professional judgement from a range of stakeholders so there is confidence in the outcome of the approximation.

KICE and NZQA established a joint working group to undertake the comparative analysis. The joint working group comprised relevant staff and subject matter experts from KICE, NZQA and the New Zealand Ministry of Education.

A Terms of Reference for the project was developed and agreed on, followed by an exchange of information and documents between KICE and NZQA. This included curriculum documents and examination papers. Documents in Korean were translated into English by a professional translation service in New Zealand. A video conference was organised for the joint working group in September 2014 to report on progress, discuss preliminary findings, and to clarify understanding on both sides. A further exchange of information helped to clarify National Certificates of Educational Achievement (NCEA) Levels, New Zealand Curriculum levels, the Republic of Korea College Scholastic Ability Test (CSAT) eligibility, university entrance criteria and Mathematics terminology which may have been lost in the translation process. Analysis tables for Mathematics and Science subjects using the Korean senior secondary school curriculum and the New Zealand Curriculum levels and Achievement Standards were developed. Based on the number of common denominators, a conclusion was agreed.

Both organisations agreed to contribute their findings and analysis to this joint research report. KICE have also published a separate report on their findings for internal distribution.

4. Summary of findings

In order to understand the context of the curriculum-to-curriculum analysis undertaken for Mathematics and Science in this report, it is important to first broadly compare the education systems and curricula between the Republic of Korea and New Zealand.

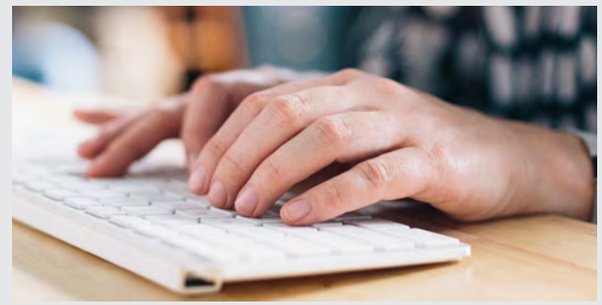
Curricula overview

The Republic of Korea has a highly centralised education system and standardised educational content. Textbooks, teachers' manuals and methods of assessment are developed within the framework of the Korean National Curriculum. The Korean National Curriculum sets strict regulations for the number of school days, subjects taught and the time allocation for each subject. However, local authorities and schools are able to make some modifications. Schools prepare their own curriculum implementation plan in accordance with the national curriculum and the Metropolitan and Provincial Educational Authorities (MPEA) guidelines. There is a differentiated curriculum in high school and students can choose from broad subject groupings.

The Korean National Curriculum aims to foster independent, creative citizens who are able to lead the globalisation and information age of the 21st century.

By comparison, the New Zealand Curriculum provides a framework rather than detailed plan. This highly flexible curriculum requires teachers to draw on a wide range of ideas, resources and models that best address the needs, interest and circumstances of their school's students and community. Teachers and schools are provided with examples of best-practice material and assessment tools linked to the New Zealand Curriculum and benchmarking data. Teachers are expected to make use of these tools for both student development and reporting purposes.

The New Zealand Curriculum is designed to ensure that all young New Zealanders are equipped with the knowledge, competencies and values they will need to be successful citizens in the 21st century.



Education systems

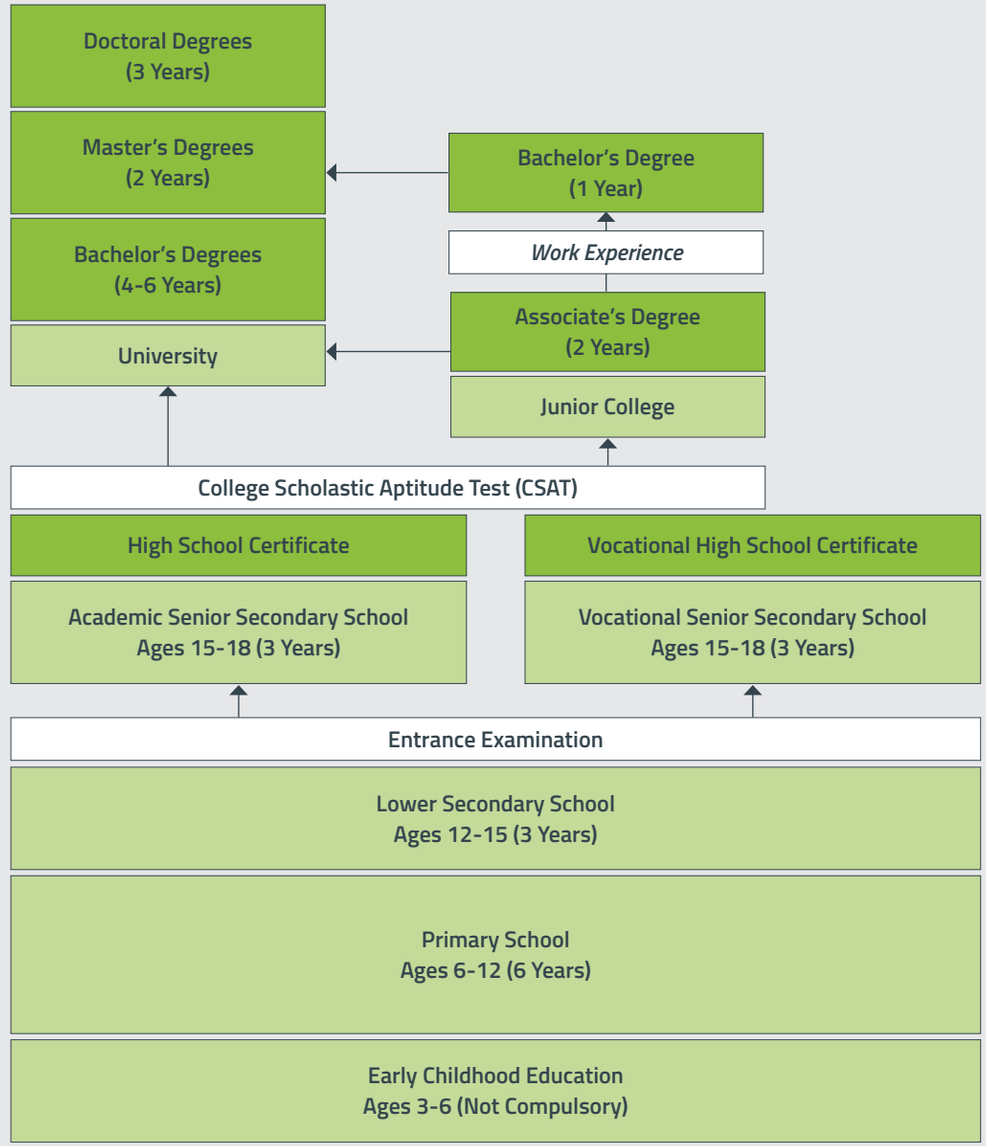
Republic of Korea

The Republic of Korea has a single-track 6-3-3-4 system, which denotes six years of elementary school, three years of middle school, three years of high school, and four years of college and university which also offer graduate courses leading to master's degrees and doctoral degrees. The single track has been characteristic of the Korean education system, which maintains a single ladder system of schooling in order to ensure that every citizen can receive primary, secondary, and tertiary education.

The first nine years of school education in the Republic of Korea are set as a national common basic education period. During this period, students learn from a national curriculum. High schools are separated into two types: general (academic) and vocational. In high school, a flexible and differentiated curriculum is provided for second and third year students. Students choose from seventy nine electives. Electives are set by each metropolitan/provincial education office and school at a minimum of twenty eight units each, for up to fifty percent of students. Schools are granted autonomy in designing the flexible and differentiated curriculum for the second and third year of senior secondary school.

Korean students successfully completing the required number of credit bearing courses are awarded a General High School Certificate on completion of high school. Students applying for admission to university in the Republic of Korea are required to sit CSAT which is administered by KICE and commissioned by the Ministry of Education. The master plan for CSAT is established by the Ministry of Education at the beginning of each year. CSAT results have a major impact on students' higher education prospects. Each Korean university has its own admission standard and selection process.

Diagram 1. Korean education system



New Zealand

The education system for New Zealand schools comprises 13 Year levels. Primary schooling covers Years 1 to 8 (ages 5 to 12); secondary schooling covers Years 9 to 13 (ages 13 to 17). There are also schools known as intermediates, which cover Year 7 and 8 (ages 11 to 12). Some primary schools finish at Year 6, and students go on to an intermediate school; other primary schools go up to Year 8, but students may choose to go to an intermediate school. There is a compulsory National Curriculum for Years 1 to 10. Most schools in New Zealand teach in English, but there are some schools teach that in the Māori language1 . The National Curriculum comprises the New Zealand Curriculum (English-medium schooling curriculum) and Te Marautanga o Aoteroa (Māori-medium schooling curriculum).

Schools have considerable flexibility in designing programmes of learning in senior secondary school (Years 11 to 13). There are no compulsory subjects at these levels although most Year 11 students study programmes in Mathematics and Science. Schools design programmes to meet the needs of the students so that the learning is relevant to a pathway that leads through senior secondary schooling to further study, training and employment. This means that not all students studying Mathematics in Year 12 for example, will be studying the same mathematical content. For example, if a student is intending to go into the building industry, then he or she may likely be studying some mathematical content that is different from a student intending to study Mathematics at university. Both sets of content will be selected from the mathematics and statistics curriculum at level 7.

In secondary schools the timetable is arranged around subjects and although students continue to experience a broad and balanced curriculum, specialisation is possible in Years 11 to 13.

Secondary students may begin courses of a more employment related nature while at school but there is no direct separation of programmes into employment related and tertiary study related streams.

The New Zealand Ministry of Education produces teaching and learning guidelines for each year level. These teaching and learning guidelines give teachers and schools core knowledge content for individual subjects, and allow for common knowledge at specific levels to be covered. Teachers and schools have the flexibility to introduce content but the common knowledge sets would be similar to that of the Korean National Curriculum.

NCEA is the national senior secondary school qualification. Students are able to achieve NCEA at three levels through a wide range of courses and subjects, both within and beyond the traditional school curriculum. For most students, the three levels of NCEA correspond to the final three years of secondary schooling (Years 11 to 13). NCEA allows schools to develop learning programmes to suit students' needs and then assess their achievement against national standards. Students intending to apply for admission to university in New Zealand must achieve NCEA Level 3 and meet the minimum University Entrance requirements.

Diagram 2. New Zealand education: Levels, ages and stages

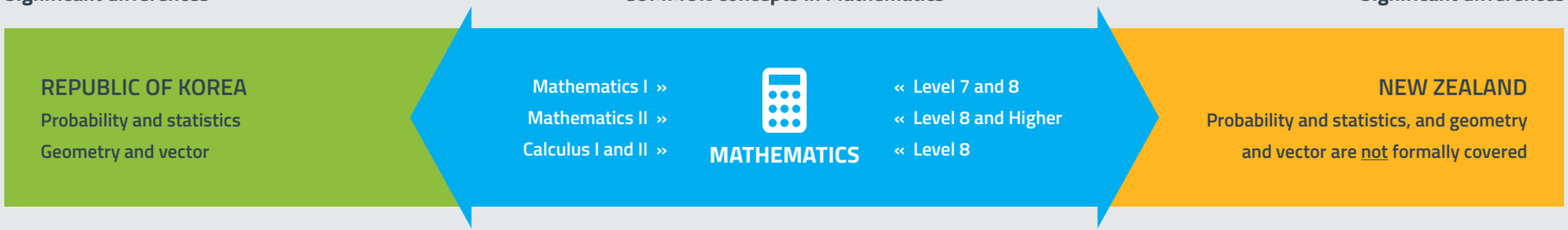
<table>
<tr><th>New Zealand Year (grade)</th><th>Typical student age</th><th>Typical New Zealand Curriculum level</th><th>Typical NCEA level</th><th>National Standards in reading, writing and mathematics</th><th colspan="2">Most common types of school</th></tr>
<tr><td>Year 13</td><td>17-18</td><td>level 8</td><td>Level 3</td><td rowspan="5"></td><td colspan="2" rowspan="5">Secondary schools</td></tr>
<tr><td>Year 12</td><td>16-17</td><td>level 7</td><td>Level 2</td></tr>
<tr><td>Year 11</td><td>15-16</td><td>level 6</td><td>Level 1</td></tr>
<tr><td>Year 10</td><td>14-15</td><td>level 5</td><td></td></tr>
<tr><td>Year 9</td><td>13-14</td><td></td><td></td></tr>
<tr><td>Year 8</td><td>12-13</td><td>level 4</td><td></td><td>8</td><td rowspan="2">Intermediate schools</td><td rowspan="6">Full primary schools (Years 1- 8, mainly in rural areas)</td></tr>
<tr><td>Year 7</td><td>11-12</td><td></td><td></td><td>7</td></tr>
<tr><td>Year 6</td><td>10-11</td><td>level 3</td><td></td><td>6</td><td rowspan="5">Primary schools</td></tr>
<tr><td>Year 5</td><td>9-10</td><td></td><td></td><td>5</td></tr>
<tr><td>Year 4</td><td>8-9</td><td>level 2</td><td></td><td>4</td></tr>
<tr><td>Year 3</td><td>7-8</td><td></td><td></td><td>3</td></tr>
<tr><td>Year 2</td><td>6-7</td><td>level 1</td><td></td><td>2</td></tr>
</table>

**Attendance at school is compulsory from ages 6 to 16*

[1] Māori language is spoken by the Māori people, the indigenous population of New Zealand. Since 1987, it has been one of New Zealand's official languages.

Diagram 3. An overview of school systems in the Republic of Korea and New Zealand

Level	Age	Republic Of Korea	Level	Age	New Zealand
Elementary school There are six years of Elementary School. Schools teach the same core subjects	6 to 11 years	6 years	**Primary** Primary school is compulsory from age 6 but most New Zealand children start school on their fifth birthday	5 to 10 years	6 years
Middle school Students receive a Junior High School Diploma or Lower High School Diploma on successful completion	12 to 14 years	3 years	**Intermediate** Some Primary schools finish at Year 6, and students go on to an Intermediate school	11 to 12 years	2 years
High school A general High School Certificate or Senior Secondary School Certificate is awarded on successful completion of required number of credit bearing courses	15 to 17 years	3 years	**Secondary** NCEA Level 3 is awarded on successful completion of the specified number of credits	13 to 17 years	5 years
University (general Bachelor's Degree) Admission is based on CSAT results	18 years onwards	4 years	**University (general Bachelor's Degree)** Admission is based on achieving NCEA Level 3 and meeting University Entrance requirements	18 years onwards	3 years



Curriculum comparison and analysis for Mathematics

Both the Korean and New Zealand Mathematics curricula place an emphasis on mathematical processes, especially problem solving, along with a focus on the quality of thinking and communicating mathematically. However, the content is structured slightly differently between the two countries.

In the Korean National Curriculum, the content is described separately for each Mathematics course at each level (eg. mathematics I, calculus I, etc.). In the New Zealand Curriculum, content is described for each level (eg. curriculum levels 6, 7 and 8) and schools design their courses by selecting the appropriate content for those courses.

KICE classified levels 6, 7 and 8 of the New Zealand Curriculum for Mathematics into six strands for comparison to the Korean National Curriculum:

- Number Strategies and Knowledge
- Equations and Expressions
- Calculus
- Shapes and Measurement
- Patterns and Relationships
- Probability and Statistics.

These were compared to mathematics I, mathematics II, calculus I, calculus II, probability and statistics, and geometry and vector in the Korean senior secondary school Mathematics curriculum.
The Achievement Standards provided by NZQA were used by KICE to analyse the New Zealand Curriculum for levels 6, 7, and 8.

Level 6 in the New Zealand Curriculum is found to be comparable with the Korean middle school Mathematics curriculum and levels 7 and 8 of the New Zealand Curriculum are similar to the Korean high school Mathematics curriculum.

The content for mathematics I and II, and calculus I and II in the Korean National Curriculum is similar to New Zealand. However, in the New Zealand Curriculum, probability and statistics is covered in more depth and is more advanced compared to the Korean National Curriculum. Content including sets and mathematical induction in mathematics II are not covered in the New Zealand Curriculum. Similarly, vectors and spatial figures in geometry and vector are identified in the Korean National Curriculum.

Synthetic division, method of undetermined coefficients, systems of quadratic inequalities, systems of quadratic equations of two variables under the Number Strategies and Knowledge and Equations and Expressions strands are covered in the Korean National Curriculum but not the New Zealand Curriculum.

De Moivre's Theorem is covered in the New Zealand Curriculum and taught at advanced Mathematics level in the Korean National Curriculum. In the calculus strand, differential equations in the New Zealand curriculum is taught at advanced level Mathematics in the Korean National Curriculum.

Geometry and measurement is covered in more depth in the Korean National Curriculum.

Finding the coordinates of the point of internal or external division, or finding the equation of a sphere is included in the geometry and vector strand in the Korean National Curriculum and the Patterns and Relationships strand of the New Zealand Curriculum.

Sine Law and Cosine Law, and selecting appropriate networks to find optimal solutions are in the New Zealand curriculum but not in the (revised 2009) Korean National Curriculum.

There is a greater difference in the probability and statistics strands. There are substantially more applications of statistics such as identifying characteristics of data, making predictions using models, planning and carrying out experiments and making inferences in the New Zealand Curriculum compared to the Korean National Curriculum.

Overall however, there is a good fit between:

- Korean National Curriculum mathematics I and New Zealand Curriculum level 7
- Korean National Curriculum mathematics II and New Zealand Curriculum level 8
- Korean National Curriculum calculus I and II and New Zealand Curriculum level 8.

The main differences lie in the probability and statistics and geometry and vector strands.

Analysis for Mathematics

Korean National Curriculum (revised 2009)	New Zealand Curriculum	Overall judgement
Mathematics I	levels 7 and 8	Both curricula cover the concepts of polynomials, factorization, linear, circular and quadratic equations and functions, and movement of graphs. There is a good fit between the Korean National Curriculum for mathematics I and New Zealand Curriculum level 7.
Mathematics II	level 8 and higher	Both curricula cover the concepts of functions (rational and irrational), arithmetical and geometrical progression, summation, indices and logarithms. There is a good fit between the Korean National Curriculum for mathematics II and New Zealand Curriculum level 8.
Calculus I	level 8	Most concepts covered in the Korean calculus I programme are also covered in New Zealand Curriculum level 8. There is a good fit between the calculus I programme and the New Zealand Curriculum at level 8.
Calculus II	level 8	Both curricula cover the concepts of exponential and logarithmic functions, trigonometric functions, various differentiations and use of derivatives, various integrations and use of these. There is a good fit between calculus II and New Zealand Curriculum level 8.
Probability and statistics	Probability and statistics	There is little in common between the Korean and New Zealand curricula in probability and statistics. The Korean probability and statistics programme has a more mathematical approach to statistics than the New Zealand Curriculum. The New Zealand Curriculum at levels 7 and 8 covers: **Statistical investigations:** ▪ statistical investigations using the statistical enquiry cycle ▪ making inferences from surveys and experiments. **Statistical literacy:** ▪ evaluating statistically based reports **Probability:** ▪ investigating situations that involve elements of chance. Most of these are not covered in the Korean probability and statistics programme. The Korean probability and statistics programme is quite different in its approach, especially to statistics, when compared to statistics in Levels 7 and 8 in the New Zealand Curriculum.
Geometry and vector	Geometry and vector	The concept of a position vector is common to both. Also the concepts of, and determining equations of, ellipses and hyperbolas. Vector operations, components and dot product of plane vectors and space figures and vectors are not covered in the New Zealand Curriculum. There is little in common between the geometry and vector strands in Korea and New Zealand. Most of the content is not covered in the New Zealand Curriculum.

Curriculum comparison and analysis for Science

The four subject areas for the Science curricula comparison between the Republic of Korea and New Zealand were physics, chemistry, life science/biology and earth science/earth and space science. KICE used NCEA Achievement Standards for levels 6, 7 and 8 of the New Zealand Curriculum to compare against the Korean high school Science content standards.

The New Zealand Curriculum concentrates on the skills and language used in Science by scientists. While the teaching and learning guidelines cover the core content, there is a high degree of flexibility in what is taught in New Zealand schools.

Overall there is a good fit between the Korean and New Zealand Science curricula. The highly flexible New Zealand Curriculum means that content in the Korean National Curriculum is able to be covered by New Zealand schools under the research and investigative standards.

The curriculum content for physics in the Republic of Korea is at a higher level than the other Science subjects. There is similarity between the Korean National Curriculum for physics I and II and New Zealand Curriculum levels 7 and 8. Common concepts include sound waves and their properties, light and its properties, electricity and magnetism, force and motion, and atomic structure. It is possible for New Zealand schools to structure internal components for electronics, duality of matter and quantum physics to meet the Korean physics curriculum content.

Similarly chemistry is a good fit because of the overlap in the content. Topics such as investigations in chemistry, atomic structure and the periodic table, the structure of the molecule and polarity, chemical combination, organic chemistry and hydrocarbon, reaction speed, chemical equilibrium, acid and base, oxidation-reduction are covered in both the Korean and New Zealand chemistry curriculum. There are some minor differences. For example, molecule spectroscopy is included in the New Zealand Curriculum, but not in the Korean chemistry curriculum. It is possible for chemistry topics in the Korean National Curriculum to be covered in the research and investigative standards in the New Zealand Curriculum.

The life science curriculum in Korea and the biology curriculum in New Zealand are a good fit. There are connections found in topics such as exploring biology, the human digestive system, circulatory system, musculature, respiratory system, excretory system and human reproduction, human immune, vegetation, environmental responses of organisms, homeostasis of organisms, the structure and function of the cell, heredity, evolution, the variety of organisms. The differences between the two curricula are minor. Level 8 of the New Zealand Curriculum concentrates on evolution as the main theme. New Zealand's emphasis on evolution follows international programmes in biology.

Earth science/ earth and space science are comparable despite the difference in geology between the two countries. In New Zealand, geology focusses on the local environment the student is in. The subject matter is likely to be different between a school in the North Island and a school in the South Island of New Zealand. However, the content is linked to broader concepts of geology.

Analysis for Science

Korean national curriculum (revised 2009)	New Zealand Curriculum	Overall judgement
Physics I Physics II	level 7 and level 8	There is similarity in the physics content between Korean National Curriculum and New Zealand Curriculum in areas such as waves and light, force and motion, and electromagnetism. Most of the content in physics I is at New Zealand Curriculum levels 7 and 8, while the content for physics II is at New Zealand Curriculum level 8 or higher in specialised fields. There are some differences in topics such as temperature and heat or investigations in physics. If New Zealand secondary schools structured an internal physics knowledge component for electronics, duality of matter and quantum physics, it would meet the requirements covered in physics II in the Korean National Curriculum. This would be covered in the research and investigative standards. While there are minor differences in the content covered, overall, the Korean and New Zealand curricula for physics is comparable.
Chemistry I Chemistry II	level 7 level 8	There is overlap in the chemistry content. Topics such as investigations in chemistry, atomic structure and the periodic table, the structure of the molecule and polarity, chemical combination, organic chemistry and hydrocarbon, reaction speed, chemical equilibrium, acid and base, oxidation-reduction are covered in both the Korean and New Zealand curricula. There are some minor differences in the content covered. Overall, both curricula are close in their agreement. For example, molecule spectroscopy is included in the New Zealand Curriculum, but not in the Korean chemistry curriculum. It is likely that chemistry topics in the Korean National Curriculum can be covered in the research and investigative standards in the New Zealand Curriculum. The overall judgement is that the Korean National Curriculum for chemistry level I is comparable to New Zealand Curriculum level 7 and Korean National Curriculum for chemistry level II is comparable to level 8 of the New Zealand Curriculum.
Life science I Life science II	Biology levels 6, 7 and 8	The life science curriculum in Korea is a close fit to the biology curriculum in New Zealand. There are many connections found in topics such as exploring biology, the human digestive system, circulatory system, musculature, respiratory system, excretory system and human reproduction, human immune, vegetation, environmental responses of organisms, homeostasis of organisms, the structure and function of the cell, heredity, evolution, the variety of organisms. Noticeable differences are in topics such as human evolution, genetic engineering and biotechnology, environment and the ecosystem. Level 8 of the New Zealand Curriculum concentrates on evolution as the main theme. New Zealand's emphasis on evolution follows international programmes in biology. There are minor differences between the two curricula. It is possible for New Zealand and Korean students to follow closely the requirements for life science/ biology in both countries.
Earth science I Earth science II	Earth and space science level 6, 7 and 8	While there are differences with respect to each countries' geology, the content covered in both curricula are comparable. The difference between the Korean and New Zealand geology is minor as the land formation systems are similar. For example, the island of Jiju is now classified as an active volcano (July 2014), so is more relevant to volcanism in New Zealand. Geology, ocean and atmosphere (i.e., materiality), and astronomy strands were used by KICE to compare the curricula. There are many similarities in both curricula such as change in geological structures. In fluid earth including ocean and atmosphere, both curricula focused on the subsystems composing Earth systems and the interaction between them. Both curricula use various scientific subject matter to enhance students' scientific research abilities. The New Zealand Curriculum links the geology of local environments. For example, New Zealand schools in the South Island may look at the Alpine Fault as an example of a Plate Boundary fault line and schools in Auckland may concentrate on hot spot[2] volcanics. These local areas link to the big picture of world geology. Overall, both the curricula are a very good fit. It would be possible to produce a set of guidelines for schools with Korean students that match the Korean National Curriculum. The research and investigative components can be covered in any context local schools in New Zealand think is appropriate.

[2] The places known as hotspots or hot spots in geology are volcanic regions thought to be fed by underlying mantle that is anomalously hot compared with the mantle elsewhere.

5. Conclusion

Overall there are more similarities than differences in the senior secondary school Mathematics and Science curricula between the Republic of Korea and New Zealand.

There are more areas in common than differences in mathematics and calculus. The main distinctions are in the probability and statistics and geometry and vector strands where the approach taken by the Republic of Korea and New Zealand in these two programmes are different.

There is agreement in the Science curricula between the Republic of Korea and New Zealand. The physics, chemistry, life science/ biology, and earth and earth and space science content are generally considered a good fit. The high degree of flexibility in the New Zealand Curriculum would allow students to cover most topics from the Korean National Curriculum and include it in their New Zealand course work. For example, the physics level 3 research standard in the New Zealand Curriculum could include a report on the duality of matter, which is in the Korean National Curriculum.

Based on the comparative analysis of the Mathematics and Science curricula between the Republic of Korea and New Zealand and using the concept of best fit, it is possible to conclude that the senior secondary school curricula for both countries are broadly comparable.

6. Lessons learnt

The curriculum-to-curriculum mapping and analysis of Mathematics and Science subjects was a useful methodology to compare senior secondary qualifications between two countries that operate under different education systems. It provided a snapshot which allowed for common concepts and differences to be discussed, and enabled the concept of 'best-fit' to be applied.

The project findings confirmed the value of utilising subject matter experts from both countries to understand the approach to learning and concepts for each of the subjects.

This methodology could be considered for other country to country recognition projects that do not have comparable frameworks as a way to identify a common understanding of content, curricula, systems and qualifications between countries.

The accuracy of content translated is a critical part of the comparative analysis process. The opportunity for the Joint Working Group to meet through video conferencing helped to clarify content translated for the comparative analysis and enabled subject matter experts to ask relevant questions.

The difference in education systems and curricula is important to understand to enable subject matter experts to compare relevant material. The flexibility of the New Zealand Curriculum, the lack of prescribed textbooks or standardised content for classroom delivery was a challenge. Subject matter experts from the Republic of Korea used New Zealand Curriculum Achievement Standards as a basis for the comparison instead.

7. Acknowledgements

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- Mr Greg Martin, Qualifications Evaluator, Qualifications Recognition Services, NZQA
- Mr Geoff Gibbs, Lead Advisor, Senior Secondary Design, New Zealand Ministry of Education
- Mr Steve Benson, Senior Advisor, International Engagement, New Zealand Ministry of Education

Appendices

I. Overview of the education system in the Republic of Korea

Koreans have traditionally placed great importance on education as a means for self-fulfilment as well as for social advancement. Today, Korea boasts one of the highest literacy rates in the world. Korea's well-educated people have been the primary source of the rapid economic growth that the nation has achieved during the past six decades.

The Ministry of Education is the government body responsible for the formulation and implementation of educational policies. The government provides guidance on basic policy matters as well as financial assistance.

Korea has a single-track 6-3-3-4 system, which denotes six years of elementary school, three years of middle school, three years of high school, and four years of college and university which also offer graduate courses leading to master's degrees and doctoral degrees. The single track has been characteristic of the Korean education system, which maintains a single ladder system of schooling in order to ensure that every citizen can receive primary, secondary, and tertiary education.

In recent years, there have been several changes to secondary school education. The reason for these changes include:

1) a 2009 curriculum revision and educational policy emphasis on creative and character building education
2) the stress of school accountability according to the results of the national level achievement test given to students in the sixth grade of elementary school, third year of middle school, and second year of high school
3) the evaluation of schools and teachers
4) the diversification of secondary schools and expansion of the right to select high schools
5) changes in policies for entrance to universities from a single test to a multiple assessment portfolio.

Many middle and high schools have undergone changes. For example, many schools make their own unique school curriculum by school-based curriculum development (SBCD), and schools emphasize creative activities for students to receive good evaluation.

There are also two- to three-year junior colleges and vocational colleges. The ratio of high school graduates who advanced to institutions of higher learning is about 80 percent for high schools.

The national school curriculum in the Republic of Korea

The Ministry of Education oversees the national school curriculum, as designated by Article 23 of the Primary and Secondary School Education Law, in order to insure equal educational opportunity for all and maintain the quality of education. The national curriculum and regional guidelines accord flexibility to individual schools in accordance with the particular characteristics and objectives of each school.

The national curriculum is revised on a periodic basis to reflect the newly rising demands for education, emerging needs of a changing society, and new frontiers of academic disciplines.

Curriculum standards serve as the basis for educational contents at each school and for textbook development. The government has undergone seven curriculum revisions to meet national and social needs as well as to keep up with the changes in consideration of various factors related to research development.

To prepare students for the 21st century, the era of globalization and knowledge-based society, the Seventh Curriculum is a new approach in the classroom to produce human resources capable of facing new challenges. Study loads for each subject has been reduced to an appropriate level, while curricula that accommodate different needs of individual students were also introduced. Independent learning activities to enhance self-directed learning required in the knowledge-based society have either been introduced or expanded.

The Seventh Curriculum is a student-oriented curriculum emphasizing individual talent, aptitude, and creativity.

The Seventh Curriculum consists of the Basic Common Curriculum and the Selected Curriculum at the high school level. The Seventh Curriculum covers ten years from the first year of primary school through the first year of high school. The general public is able to receive the necessary basic education required for everyday life.

During the 11th and 12th grades in high school, students are given the opportunity to choose their curriculum and courses they wish to take so that they may benefit from education that facilitates their future path.

Textbooks

Textbooks and teachers' manuals are developed within the framework of the national curriculum. The textbooks compiled within the framework of the curricula are classified into three types. Type one are those which copyrights are held by the Ministry of Education. The textbooks which are authorized by the Minister of Education and published by private publishers comprise type two. Type three is recognized by the Minister of Education as relevant and useful.

School subjects at the high school level are largely divided into regular subjects designed for academic high schools and specialized subjects for vocational and other specialized high schools. High school textbooks are largely divided into basic course textbooks and textbooks for the advanced level. Most regular course textbooks, with the exception of the Korean language, ethics, and Korean history must be authorized by

the Ministry of Education. Most textbooks for the advanced level are developed by research organizations and universities commissioned by the Ministry of Education. Plans to convert government authorized textbooks into those approved by the Ministry of Education are currently under consideration.

II. Role and functions of the Korea Institute for Curriculum and Evaluation

The Korea Institute for Curriculum & Evaluation (KICE) was established in January 1998 as a government funded research institute. Since its foundation, KICE has actively participated in educational policy making and implementation procedures and international research projects.

The mission of KICE is to support the national curriculum framework through research and development of curricula and assessment of those achievements at the elementary and secondary school levels.

One of the primary functions of KICE is to undertake research on elementary and secondary school curricula thereby contributing to the development of the National Curriculum. KICE also conducts research on educational curriculum and evaluation.

KICE is also involved in developing and implementing a variety of educational tests including: national level achievement tests; psychological tests; and diagnostics tests for basic skills of elementary students.

KICE plays a leading role in carrying out international comparative studies of student achievement, conducting studies on developments in educational evaluation and long term planning, and providing training on educational evaluation.

KICE supervises the College Scholastic Ability Test (CSAT) and is responsible for the development and administration of national tests, including the primary and secondary school teacher selection tests and the high school entrance examination.

Key functions

Curriculum

KICE is committed to engaging in and promoting research projects that assist curriculum developers, teacher leaders, school administrators and policy makers to better understand the critical design and implementation factors that enable curriculum materials to support student learning.

Teaching and learning

KICE sets long term teaching and learning improvement plans and develops exemplary teaching and learning materials for elementary and secondary education.

Educational evaluation

In order to improve the quality of education, KICE conducts research on educational curriculum and evaluation. Along with this research orientation, the Division of Educational Evaluation Research is extensively involved in developing and implementing a variety of educational tests.

Textbook authorisation

KICE conducts research on the assessment standards and quality control systems of textbooks, authorization and approval of textbooks submitted by publishing companies and basic research for the improvement of textbook systems and structures.

College Scholastic Ability Test

KICE develops and implements College Scholastic Ability Test Research and Management (CSAT), which is designed to measure the students' scholastic ability required for college education, commissioned by the Ministry of Education.

National level test

KICE conducts the planning, developing, printing and scoring of national-level tests in a fair and systematic manner.

Sources:

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III. Overview of the education system in New Zealand

Education in New Zealand is student-centred. It is focused on supporting students to become confident, connected, actively involved, life-long learners with the skills to problem-solve, process information, work with others, create and innovate. Each student is able to develop their potential along a number of possible pathways, academic and/or vocational.

All aspects of education in New Zealand have undergone transformation in the past two decades, including the areas of governance, curriculum, assessment, qualifications, and teaching and learning. As a result, a range of new ideas and methods have been adopted, based on evidence and research.

New Zealand has educational agencies, providers, managers and teachers with a good and growing understanding of what works and why, and a commitment to using that understanding to lift the achievement levels of all students – especially those groups who have lower achievement rates.

New Zealand's education system has four levels – early childhood education, primary schooling, secondary schooling, and tertiary education – across which students can follow a variety of flexible pathways.

The system is designed to recognise different abilities, religious beliefs, ethnic groups, income levels, ideas about teaching and learning, and allows education providers to develop their own special characters.

National policies and frameworks for regulation and guidance, requirements and funding arrangements are set by central government and administered through its agencies. Administrative authority for most education service provision is devolved to education institutions, which are governed by individual Boards or Councils.

New Zealand has quality assurance systems which ensure consistent, high quality education across all levels of the education system, both public and private.

New Zealand has an education system that reflects its unique and diverse society.

Māori and Pasifika Education Strategies

Woven throughout New Zealand's strategic planning for education is Ka Hikitia – Accelerating Success (Māori Education Strategy) 2013-2017 and the Pasifika Education Plan 2013-17.

Māori-medium education

Most schools teach in English, but some also teach partly or mainly in the Māori language. Kura Kaupapa Māori are schools in which the principal language of instruction is Māori and education is based on Māori culture and values.

Special education

There is additional support for students with special education needs. This includes children with disabilities, vision and hearing impairments, those who have difficulty learning, communicating or getting along with others, or who have emotional or behavioural difficulties. Most students with these needs attend their local school. Additional funding is available, as well as teacher aide time and specialist support. There are also a number of special schools including two for deaf and hearing impaired students, and one for blind and vision impaired students.

Home and distance learning

New Zealand's Correspondence School (Te Aho o Te Kura Pounamu) has more than 24,000 students studying full and part-time who, for a variety of reasons, cannot attend a local education provider. It provides distance learning using multimedia and online learning for early childhood, primary, secondary and special needs students. At tertiary and adult levels, full and part-time learning programmes are available for self-directed learning at home and in the workplace.

School Education

Schools provide the second and third level of education. Free education is provided to New Zealand citizens or permanent residents in state (government owned and funded) schools between the ages of five and 19.

The education system for schools comprises 13 Year levels. Schooling is compulsory from ages six to 16 (which for most students is Year 11) although most students carry on to Years 12 and 13.

Both single-sex and co-educational secondary schooling options are available and state schools are secular. Most students attend school close to where they live.

There is a compulsory National Curriculum for Years 1 to 10. Most schools are English language, but some schools teach in the Māori language.

There are over 2,500 state schools in New Zealand. School rolls range from ten to over 2,000 pupils. Most school-aged children attend state schools (85%). The remainder attend state integrated schools (11%), which are operated as a state school but with the particular religious or learning philosophy of their owner, and the remainder (4%) in private and boarding schools, schools that cater for special education needs (such as impairments, learning or behavioural difficulties), or are schooled at home.

Partnership Schools (Kura Hourua) are a new type of school in the New Zealand education system, which bring together education, the business sector and community groups to provide new opportunities for students to achieve education success. The Government is rolling out a small number of Partnership Schools in areas of significant educational challenge and underachievement. The first Partnership Schools opened in 2014.

Primary education

Children may start school at age five and the majority do so, although schooling is not compulsory until age six. Primary education starts at Year 1 and continues until Year 8, with Years 7 and 8 mostly offered at either a primary, or a separate intermediate school.

Primary education focuses on strong foundation learning, especially in literacy and numeracy.

Secondary education

Secondary education covers Years 9 to 13 (ages 13 to 18/19). State secondary schools are usually known as secondary schools, high schools or colleges. In secondary schools the timetable is arranged around subjects and although students continue to experience a broad and balanced curriculum some specialisation is possible especially in Years 11 to 13. Students are provided with professional career information and guidance. Secondary students may begin courses of a more employment related nature while at school but there is no direct separation of programmes into employment related and tertiary study related streams.

The New Zealand Curriculum

New Zealand has a national curriculum which applies to all state schools and state integrated schools. It covers all the years of schooling and is compulsory from Year 1 to the end of Year 10. The national curriculum comprises the New Zealand Curriculum for English medium schools and Te Marautanga O Aotearoa for Māori language medium schools.

The New Zealand Curriculum is a statement of official policy relating to teaching and learning in English-medium New Zealand schools. Its principal function is to set the direction for student learning and provide guidance to schools as they design and review their curriculum. It is a framework rather than a detailed plan. This means that while every school curriculum must be aligned with the intent of the New Zealand Curriculum, schools have considerable flexibility when determining the detail. In doing this, they can draw on a wide range of ideas, resources, and models.

A parallel document, Te Marautanga o Aotearoa, serves the same function for Māori medium schools.

Although they come from different perspectives, both documents start with visions of young people who will develop the competencies they need for study, work, lifelong learning and go on to realise their potential. Together, the two documents will help schools give effect to the partnership that is the core of New Zealand's founding document, Te Tiriti o Waitangi or the Treaty of Waitangi[3].

The New Zealand Curriculum specifies eight learning areas: English; the arts; health and physical education; learning languages; mathematics and statistics; science; social sciences; and technology. The learning associated with each area is part of a broad, general education and lays a foundation for later specialisation. While the learning areas are distinct, it does not limit the ways in which schools structure learning experiences offered to students.

Through their studies, students work to develop five key competencies:

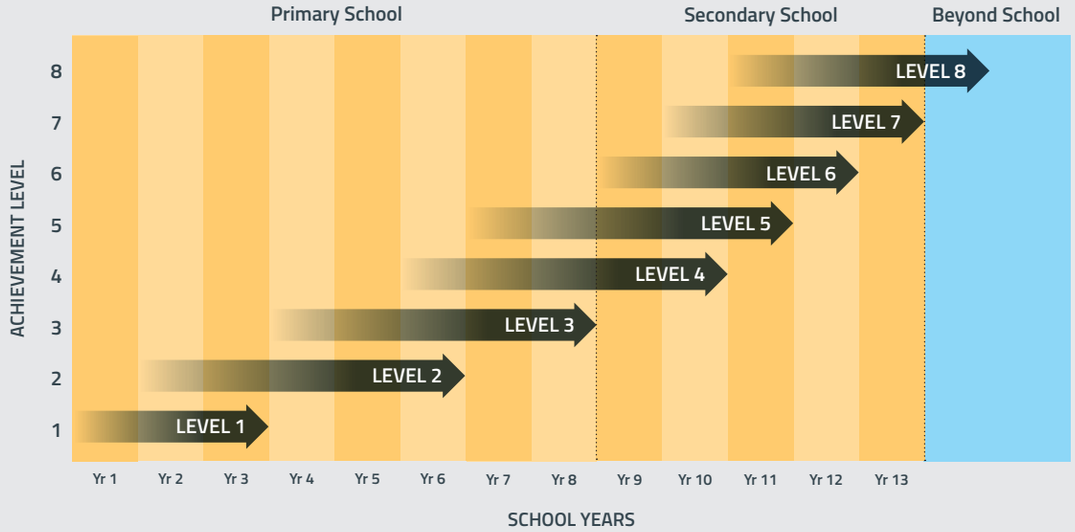
- thinking
- using language symbols and texts
- managing self
- relating to others
- participating and contributing.

The curriculum gives teachers flexibility to apply their professional knowledge. They can personalise learning to the needs of their students and communities.

[3] The Treaty of Waitangi is a written agreement made in 1840 between the British Crown (the monarch) and more than 500 Māori chiefs. After that, New Zealand became a colony of Britain and Māori became British subjects. However, Māori and Europeans had different understandings and expectations of the treaty.

Resources for Secondary School Teachers

Achievement Objectives by Level



School Assessment and Qualifications

New Zealand measures and monitors students' achievement throughout their schooling.

Teachers and schools are supplied with examples of best-practice material and assessment tools linked to the New Zealand Curriculum and benchmarking data. They are expected to make use of these tools for both student development and reporting purposes.

Information from the results of assessment is then able to be used to provide feedback to students, parents and teachers so that learning needs are addressed.

National Standards Policy

New Zealand's National Standards came into effect in 2010 for English-medium schools and 2011 for Māori medium schools.

National Standards are descriptions of what students should know and be able to do in reading, writing and mathematics at each year of their schooling from Years 1 to 8 (ages 5 to 13).

They are a tool to help schools, teachers and parents understand the expected levels of achievement at stage/year-appropriate levels, to help improve teaching and learning for better student outcomes in all areas of the curriculum.

National Certificates of Educational Achievement (NCEA)

NCEA is the national senior secondary school qualification. NCEA allows schools to develop learning programmes to suit students' needs and then assess their achievement against national standards.

Students are able to achieve the NCEA at three levels via a wide range of courses and subjects, both within and beyond the traditional school curriculum. For most students, the three levels of the NCEA correspond to the final three years of secondary schooling (Years 11 to 13). To gain an NCEA the student must achieve 80 credits on the New Zealand Qualifications Framework (NZQF), 60 at the level of the certificate. They must also meet the literacy (10 credits) and numeracy (10 credits) requirements.

International Recognition of NCEA

A number of international agreements ensure NCEA results are understood and accepted overseas. The New Zealand Qualifications Authority (NZQA) is part of the National Academic Recognition Information Centres (NARIC) network. NARIC is consulted by tertiary providers and deals with academic recognition of diplomas and periods of study in the member states of the European Union, the European Economic Area, and Central and Eastern Europe.

NZQA has equivalency arrangements with many countries and regions. Including:

- Australia
- Britain
- Europe
- Germany
- India
- Thailand

New Zealand's international connections have been reinforced in recent years. In 2008 NZQA joined the network established by United Nations Educational, Scientific and Cultural Organisation (UNESCO) and the Council of Europe to improve the international recognition of qualifications. NZQA also has the role of New Zealand's National Education Information Centre. The National Education and Information Centre provides information and advice on the New Zealand education system, secondary and tertiary qualifications, and recognition of overseas qualifications.

Sources:

http://seniorsecondary.tki.org.nz/

http://www.minedu.govt.nz/NZEducation/EducationPolicies/InternationalEducation/ForInternationalStudentsAndParents/NZEdOverview/School_Education.aspx

IV. Role and functions of the New Zealand Qualifications Authority

The New Zealand Qualifications Authority (NZQA) was established in July 1990 under the Education Act 1989. NZQA is a Crown Entity[4] which reports to a Board. The Board is appointed by the Minister for Tertiary Education, Skills and Employment.

NZQA reports to the Minister of Education and the Minister for Tertiary Education, Skills and Employment and works closely with the Ministry of Education (policy) and the Tertiary Education Commission (funding).

The role of NZQA

NZQA's role in the education sector is to ensure that New Zealand qualifications are regarded as credible and robust, nationally and internationally, in order to help learners succeed in their chosen endeavours and to contribute to society in New Zealand and in other countries.

NZQA's services span the secondary and tertiary education sectors. NZQA administers the National Certificates of Educational Achievement (NCEA) for secondary school students and is responsible for the quality assurance of non-university tertiary training providers. NZQA sets the rules for the approval and accreditation of programmes used by non-university tertiary education organisations and Universities New Zealand.

NZQA's functions

NZQA's core functions are outlined in the Education Act 1989, and include:

- managing the New Zealand Qualifications Framework and the Directory of Assessment Standards
- setting the rules for quality assurance in the tertiary sector
- independent quality assurance of non-university education providers
- maintain mechanisms for the recognition of learning
- administering the secondary school assessment system
- qualifications recognition
- standard-setting for some specified unit standards
- administering the Code of Practice for the Pastoral Care of International Students.

Subject choice under NCEA

In 2002, NCEA was introduced as the main secondary schools qualification, beginning with NCEA Level 1 in Year 11. These NCEA qualifications replaced School Certificate and Bursary qualifications, which during the 1990s had progressively been adjusted to become more flexible in subject choice and assessment.

NCEA was regarded as a natural progression to a qualification that is outcomes-based and recognises a wider range of competencies and skills, which were often not taken into account by the old system.

As part of this reform, schools and students were given greater flexibility in the course design and assessment. This reflected that many students have different learning needs and different beyond-school pathways in mind. For senior students (Years 11-13), NCEA only requires a basic level of numeracy and literacy at Year 11, leaving schools to decide which subjects to provide and which to make compulsory.

Currently, secondary schools in New Zealand provide students a mix of compulsory and elective subject choices. For Year 9 and 10 students, 'core' compulsory subjects include mathematics, English, science, social sciences, technology, the arts, health and physical education (as outlined in the National Administration Guidelines, with some variation). From Year 11 onwards, schools are free to choose which subjects are compulsory. It is common for schools to make mathematics, English and science compulsory for Year 11 students, English only for Year 12, and no compulsory subjects by Year 13.

[4] Crown Entities are government agencies and are part of the State Sector.

V. Comparison of senior secondary school curricula for Mathematics

Comparison table for mathematics I

Concepts	Korean National Curriculum (revised 2009)	New Zealand Curriculum		
	Mathematics I	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Polynomials	Operation on Polynomials	Addition, subtraction and multiplication	Division (by factorisation)	
	The Remainder Theorem			Remainder Theorem for factorising a cubic can be used
	Factoring polynomials	Straightforward factorisation	More complex factorisation. Synthetic division not covered	Synthetic division could be used for factorising a cubic
Equations and Inequations	Complex numbers and quadratic equations	Quadratics equations that can be factorised	Root of quadratics, relationship between roots and coefficient	Complex numbers
	Quadratics equations and quadratic functions		Quadratics equations and quadratic functions	
	Equations	Simple exponential equations	Forms and use pairs of simultaneous equations, one of which may be non-linear	Simultaneous linear equations in 3 unknowns. Does not cover simultaneous quadratic equations in 2 unknowns
	Inequations	Solving linear inequations	Solving linear inequalities Graphs of absolute value functions, and their transformations	Quadratic inequalities Simultaneous quadratic inequalities not covered
Plane Coordinates of Shape Equation	Plane coordinates		Distance between 2 points Internal division of a line	
	Equations of Straight Lines		Linear equations	
	Equations of Circles		Circle equations	
	Movement of shape		Movement of graphs all covered except reflection in y = x	Reflection in y = x is covered in graphs of inverse functions
	Area of inequalities			

Significant differences

REPUBLIC OF KOREA

Remainder Theorem

Synthetic division

COMMON concepts for mathematics I

Both curricula cover the concepts of polynomials, factorisation, linear, circular and quadratic equations and functions, and movement of graphs

Significant differences

NEW ZEALAND

Remainder Theorem not explicitly covered but is likely to be part of solution of cubic equations with a complex root

Simultaneous linear equations in 3 unknowns

Comparison table for mathematics II

Concepts	Korean National Curriculum (revised 2009)	New Zealand Curriculum		
	Mathematics II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Sets and Propositions	Sets			No formal coverage of set theory. However knowledge of this can be used where relevant
	Propositions			The concept of formal proof is covered
Functions	Functions			Functions
	Rational and irrational functions		Graphs of rational and irrational functions	Composite functions are not formally covered
Sequences	Arithmetic and geometric sequences		Arithmetic and geometric sequences and series	
	The sum of sequences		Summation	
	Mathematical induction			
Exponents and Logarithms	Exponents	Properties of exponents	Indices	
	Logarithms		Manipulating logarithmic algebraic expressions	Logarithms

Significant differences

REPUBLIC OF KOREA

Concept of sets and mathematical induction

COMMON concepts for mathematics II

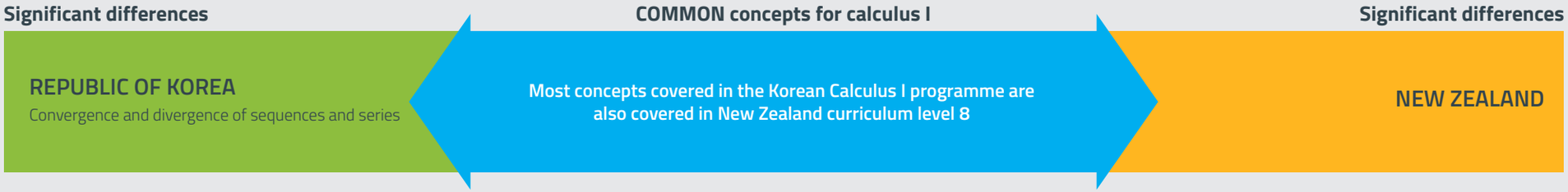
Both curricula cover the concepts of functions (rational and irrational), arithmetical and geometrical progression, summation, indices and logarithms

Significant differences

NEW ZEALAND

Comparison table for calculus I

Concepts	Korean National Curriculum (revised 2009)	New Zealand Curriculum		
	Calculus I	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Limits of sequences	Limits of sequences			Limits of a sequence
	Series		Associated concepts and limits are covered.	Convergence and divergence not covered
Limits and continuity of functions	Limits of functions			Limits of a function
	Continuity of functions		Introduced at this level	Balance covered at this level
Differentiation of polynomial functions	Differential coefficients		Introduced at this level	Covered at this level
	Derivative functions		Derivative of y=xn	Derivative functions
	Applications of the derivative		Equation of a tangent, graph of some functions, problems involving velocity and acceleration	Balance covered. (Note that Mean Value Theorem is not covered)
Integration of polynomial functions	Indefinite integrals			Indefinite integrals
	Definite integrals			Definite integrals
	Applications of the integral			Utilisation of definite integrals



Comparison table for calculus II

Concepts	Korean National Curriculum (revised 2009)	New Zealand Curriculum		
	Calculus II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Exponential and logarithmic functions	Meanings and graphs of exponential and logarithmic functions		Graphs and solving problems using the graphs	Meanings and graphs of exponential and logarithmic functions
	Differentiation of exponential and logarithmic functions			Differentiation of exponential and logarithmic functions
Trigonometric functions	Meanings and graphs of trigonometric functions		Meaning of general angle and radians. Graphing of simple sine, cosine and tangent functions	Meanings and graphs of trigonometric functions
	Differentiation of trigonometric functions			Differentiation of trigonometric functions
Differentiation	Various differentiations			Various differentiations
	Applications of the derivative			Use of derivative
Integration	Various integrations			Various integrations
	Applications of the integral			Area under and between curves is covered. Volume of solids (3D diagram) is not covered

Significant differences

REPUBLIC OF KOREA

Volume of a 3D diagram

COMMON concepts for calculus II

Both curricula cover the concepts of exponential and logarithmic functions, trigonometric functions, various differentiations and use of derivatives, various integrations and use of these

Significant differences

NEW ZEALAND

Comparison table for probability and statistics

Concepts	Korean National Curriculum (revised 2009)	New Zealand Curriculum		
	Probability and Statistics	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Permutations and combinations	Addition and multiplication rule for counting and use of this rule			Not formally covered
	Concepts of, and computing, permutations and combinations			Concepts of, and computing, permutations and combinations
	Partitions – numbers of cases of finite sets in unions of multiple sets			Partitions – numbers of cases of finite sets in unions of multiple sets
	Binomial Theorem – concept and use in solving problems			Students are familiar with the binomial distribution and the application of it

Significant differences

REPUBLIC OF KOREA

The probability and statistics strand has a more mathematical approach to statistics than the New Zealand Curriculum.

Probability:
- Concept and usage of probability
- Conditional probability

Statistics
- Probability distribution
- Statistical estimation

COMMON concepts for probability and statistics

There is little in common between the Korean and New Zealand curricula in probability and statistics

Significant differences

NEW ZEALAND

The New Zealand Curriculum at levels 7 and 8 covers:

Statistical Investigations:

Statistical investigations using the statistical
- enquiry cycle
- making inferences from surveys and experiments

Statistical Literacy:
- evaluating statistically based reports

Probability:
- investigating situations that involve elements of chance

Most of the above is not covered in the Korean Probability and Statistics strand

Concepts and usage of probability, conditional probability, probability distribution and statistical estimation are all covered at levels 7 and 8 of the New Zealand Curriculum.

Comparison table for geometry and vector

Concepts	Korean National Curriculum (revised 2009)	New Zealand Curriculum		
	Geometry and Vector	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Plane curves	Quadratic curves			Not formally covered
	Tangents of quadratic curves			
Plane vectors	Vector operations	Understanding of a vector as a description of a transformation in the coordinate plane		Not formally covered
	Components forms and dot product of plane vectors			Not formally covered
	Motion in a Plane			
Space figures and space vectors	Three dimensional figures			Not formally covered
	Three dimensional coordinate system			
	Vectors in three dimensional space			

Significant differences

REPUBLIC OF KOREA

Plane curves, plane vectors, and space figures and space vectors

COMMON concepts for geometry and vector

The concept of a position vector is common to both. Also the concepts of, and determining equations of, ellipses and hyperbolas

Significant differences

NEW ZEALAND

VI. Comparison of senior secondary school curricula for Science

Comparison table for physics

Concepts	Korean National Curriculum (revised 2009)		New Zealand Curriculum		
	Physics I	Physics II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Measuring time, measure distance, velocity, acceleration, momentum, kinetic energy, potential energy	Space, time and the universe			Time space and movement Relativity, cosmological models part of ESS. (astronomy component)	Newton's laws in depth
Kepler's law of planetary motion, Newton's gravitational law, theory of relativity, cosmological models of universe	New understanding of space and time				
Electric field, electric lines of force, role of electrostatic induction and dielectric polarization, magnetic fields, magnetism influenced by electron spinning motion and orbital motion, induced current – Faradays law	The electromagnetic field			Matter and the electromagnetic field	Electric and magnetic fields Spinning motion not specifically covered
Atoms and quantized energy levels, differences between conductors, semi -conductors and insulators, theory of PN diffusion, and uses, diodes, LED, transistors	Structure and characteristics of matter Theory of PN diffusion, and uses, diodes, LED, transistors		Atomic structure	Structure and characteristics of matter	Theory of PN diffusion, and uses, diodes, LED, transistors
Sound waves, ultra sonic waves, harmony and noise, microphone electronic signals, colour, photoelectric effect	Sound and light		Implications of waves	Harmonics Light	Sound and light waves Photo electric effect
Spectrum of electromagnetic wave, antenna and wireless communications, optical cable, alternating current and signal control, data storage device	Transmission and storage of information				
Electromotive source, electric energy, generators, nuclear power generation, nuclear fusion and solar energy	Energy generation			Electricity formation	Electricity generation
Transformation of force and torque energy, force stability, thermodynamic laws, heat energy, heat transfer, changing states of matter, use of electrical energy	Use of force and energy		Heat transfer Changing states of matter	Torque energy	Transformation of force

Comparison table for physics (continued)

Concepts	Korean National Curriculum (revised 2009)		New Zealand Curriculum		
	Physics I	Physics II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Position vector, force and law of motion, parabola and circular motion, conservation of momentum, inertia, simple harmonic oscillation (pendulum), kinetic energy		Force and motion			Force and motion
Absolute temperature, kinetic theory of gases, ideal gas equation, internal energy, thermodynamic processes, entropy		Heat energy	Implications of heat energy		
Electric potential, electric dipoles, parallel plate capacitors, capacitance, dielectric substances		Electric charge and field	Implications of electrical energy	Electrical charge and field	Electrical charge and field
Magnetic fields due to electric currents, magnetic flux, Faradays law, Lorentz force, magnetic dipoles, magnetic substances, mutual induction, self-induction, RLC circuit		Electric current and magnetic field		Magnetic fields Faraday's law Induced currents	Magnetic fields RLC circuits
Huygens principle, standing waves, resonance, refraction, reflection, diffraction, interference, the Doppler effect, shock waves amplitude		Waves	Implications of waves	Waves Doppler effects	Waves Huygens principle
Reflection in a mirror, lens optical devices, x-rays, gamma rays, microwaves, lasers, polarised light, applications		Use of light		Use of light	Electromagnetic spectrum
Wien's Law, Stefan-Boltzmann law, Planks quantum theory, particle nature of light, Compton scattering, waves properties of light, de Broglie's matter wave theory, Davisson-Germer's experiment, calculate wave length of matter waves, electron microscope		Duality of matter			Duality of matter Not specifically covered but could be part of an optional internal component
Uncertainty principle, Schrodinger's equation – wave function energy levels, Probability distribution for atoms based on the electrons wave function, quantum tunnelling effects, and STM		Quantum Physics			Not specifically covered but could be part of an optional internal component

Significant differences

REPUBLIC OF KOREA

Energy band theory, semiconductor
Thermodynamic processes
Quantum physics

COMMON concepts for physics

Sound waves and their properties ▪ Light and its properties ▪ Electricity and magnetism ▪ Force and motion

Significant differences

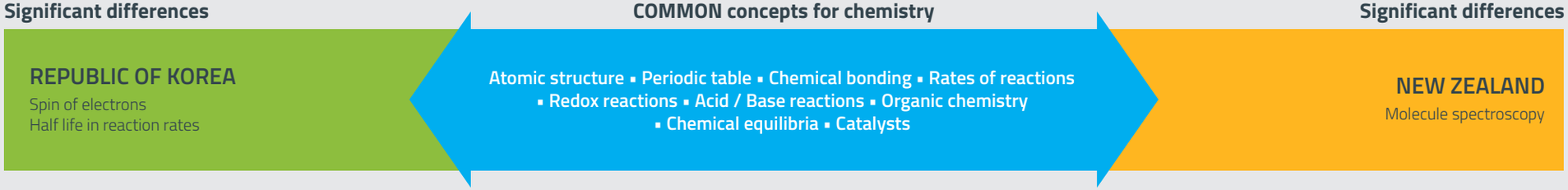
NEW ZEALAND

Comparison table for chemistry

Concepts	Korean National Curriculum (revised 2009)		New Zealand Curriculum		
	Chemistry I	Chemistry II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Elements, compounds, atoms, molecules, atomic weight, molecular weight, moles, chemical reactions and formulas	Language of chemistry	Language of chemistry	Language of chemistry	Language of chemistry	Language of chemistry
Atom parts, Bohr's model, orbit, spin, energy levels, Lewis diagrams	Atomic structure		Introductory atomic structure	Atomic structure	Atomic structure
Periodic table, electron configuration, atomic radius, ionisation energy, electronegativity	Periodical properties		Introductory periodical properties	Periodical properties	Periodical properties
Molecular shape, structure, functions.	Molecular architecture			Molecular architecture	Molecular architecture Molecule spectroscopy
Chemical bonds, octet rule, dipole moment, bond polarity	Chemical bonds		Introductory chemical bonds	Advanced chemical bonds	
Electron pair repulsion theory, molecular structure, carbon compounds	Molecular structure			Molecular structure	Molecular structure
Photosynthesis/respiration, iron smelting, ammonia synthesis, oxidation number	Oxidation - reduction			Oxidation - reduction	Advanced oxidation - reduction
Elements, compounds, atoms, molecules, atomic weight, molecular weight, moles, chemical reactions and formulas	Language of chemistry	Language of chemistry	Language of chemistry	Language of chemistry	Language of chemistry
Atom parts, Bohr's model, orbit, spin, energy levels, Lewis diagrams	Atomic structure		Introductory atomic structure	Atomic structure	Atomic structure
Periodic table, electron configuration, atomic radius, ionisation energy, electronegativity	Periodical properties		Introductory periodical properties	Periodical properties	Periodical properties
Molecular shape, structure, functions.	Molecular architecture			Molecular architecture	Molecular architecture Molecule spectroscopy
Chemical bonds, octet rule, dipole moment, bond polarity	Chemical bonds		Introductory chemical bonds	Advanced chemical bonds	
Electron pair repulsion theory, molecular structure, carbon compounds	Molecular structure			Molecular structure	Molecular structure
Photosynthesis/respiration, iron smelting, ammonia synthesis, oxidation number	Oxidation - reduction			Oxidation - reduction	Advanced oxidation - reduction
HCl, NH3, amino acids, nucleic acid, neutralisation reactions	Acid-base			Introductory acid-base	Advanced acid-base
Organic chemistry	Organic chemistry			Introductory organic chemistry	More advanced organic chemistry

Comparison table for chemistry (continued)

Concepts	Korean National Curriculum (revised 2009)		New Zealand Curriculum		
	Chemistry I	Chemistry II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Intermolecular interaction, gases, ideal gas equation, liquids, solids, phases changes, molecular structure of water, bonding characteristic of hydrogen		Forms of matter and bonding		Introductory forms of matter and bonding	Forms of matter and bonding
Energy, enthalpy, energy conservation, Exothermic reaction, endothermic reaction, Hess's law, direction of spontaneous change, solubility		Changes in matter and energy Heat of reaction		Changes in matter and energy Heat of reaction	Changes in matter and energy Heat of reaction Hess's law
Chemical equilibrium, equilibrium constants, transition in equilibrium, phase equilibrium, equilibrium of dissolution, Henry's law		Equilibrium principles		Equilibrium principles	Equilibrium principles
Acid-base balance, electrochemical cell, fuel cell, electrolysis, potential difference in Redox reactions		Equilibrium principles			Equilibrium principles
Rate equation, order of reaction, half-life, energy barrier, activation energy, effect of temperature on rate		Reaction rate	Simple investigations	Reaction rate	Reaction rate
Types of catalysts, enzymes, use of catalysts-ammonia, macro-molecules		Types of catalysts		Introductory types of catalysts	Types of catalysts
Chemistry and its effects on humans and the environment		Human welfare and chemistry.		Introductory Human welfare and chemistry.	Human welfare and chemistry.



Comparison table for life science/biology

Concepts	Korean National Curriculum (revised 2009) Life Science		New Zealand Curriculum Biology		
	Life science I	Life science II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
MRS GREN and life structures	Life characteristics		Life characteristics at level 5		
Cells, cell division, mitosis and meiosis, genes, chromosomes	Cells and division			Cells and cell division	
Mendelian inheritance, mutations	Heredity		Introduction to 3:1 Mendelian genetics	9:3:3:1 Mendelian genetics	Advanced genetics
Cells energy, digestive, circulatory, respiratory, and excretory systems	Life and energy			Cellular Biology	
Nervous system, muscle functions, body temperature control, blood sugars, osmotic pressure	Homeostasis			Body systems	
Pathogens, antigens, antibodies, immunity	Defence mechanisms		Introduction to disease organisms		
Link life to the environment, populations, communities, material and energy flow	Ecosystem function and constituents		Introduction to ecology	Ecology	Inter/intra specific competition
Conservation, sustainable development	Biodiversity and the environment		Introduction to ecology	Conservation	Conservation
Nucleus, prokaryote, eukaryote cells Cell membranes, diffusion, osmosis, enzymes Conversion of energy, fermentation, ATP, mitochondria, TCA circuit, electron transport, photosynthesis, chloroplast, light/dark reactions		Cell characteristics, metabolism, processes and energy		Cell Biology Cell energy production and use Role of mitochondria	
Genetic information, DNA replication, phenotypic traits, regulation of gene expressions		Expression and characteristics of genes		DNA replication	Genetic information
Utilisation of biotechnology		Biotechnology		Utilisation of biotechnology	Utilisation of biotechnology
Abiogenesis, biological classification		Origin and diversity of life Origin and diversity of life.		Biological classification	
Variations, natural selection, genetic equilibrium, speciation		Principles of evolution		Introductory speciation	Advanced speciation
Human evolution					Human evolution

Significant differences

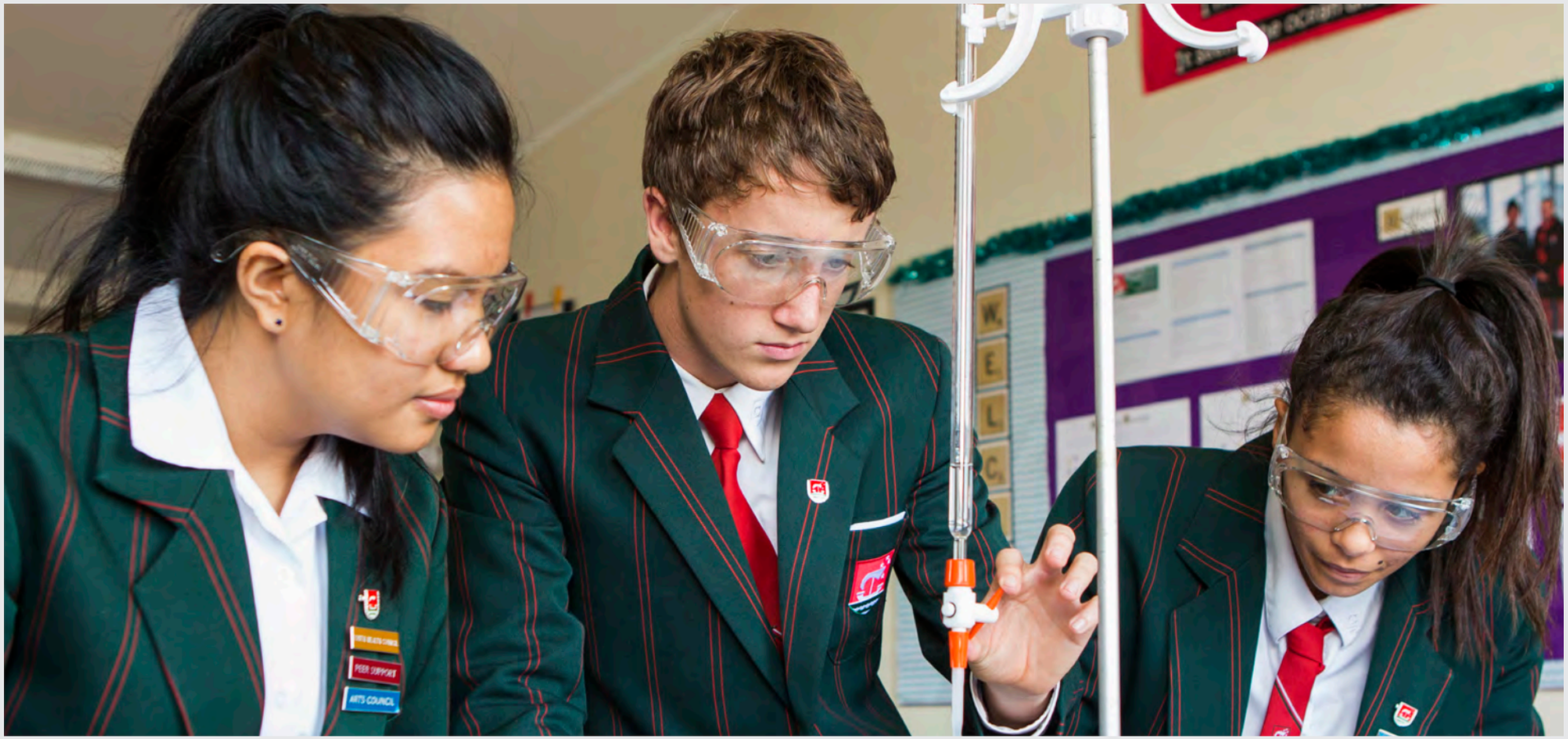
REPUBLIC OF KOREA
Relevant biotechnology

COMMON concepts for life science/biology

Life characteristics ▪ Cells ▪ Cell processes ▪ Ecology ▪ Genetics ▪ Speciation ▪ Conservation

Significant differences

NEW ZEALAND
Advanced evolution
Human evolution



Comparison table for earth science/earth and space science

Concepts	Korean National Curriculum (revised 2009) Earth science		New Zealand Curriculum earth and space science		
	Earth science I	Earth science II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Internal structure, seismic waves, magnetic field	Earth as a planet		Earth as a planet is covered in level 5		
Rock forming processes, crustal origin	Importance of earth		Major rock types	Local rock types	Local rock types
Korean/New Zealand geology	Features of the Korean peninsula		Features of New Zealand geology	Features of New Zealand geology	Features of New Zealand geology
Earthquakes, volcanoes, plate tectonics	Changes of the Earth-solid		Earthquakes, volcanoes, plate tectonics covered in level 5	Local geological events	Local geological events
Weather, oceans, typhoons, tsunami, sea level changes	Changes of the earth-liquid			Extreme events	Oceans and atmosphere
Pollution: air, marine, soil, water, space junk, carbon dioxide	Contamination of the environment			Geological issues	Oceans/atmosphere issues
History of El Nino, greenhouse effect, ozone hole	Climate change over time				Ocean/ atmosphere investigations/ research
Constellations, planets, suns, solar atmosphere moons, eclipses, seasonal changes, tides	Observations of celestial bodies		Introductory astronomy	Solar system	Astronomy research
Telescopes and their types, space probes	Space exploration		Introductory astronomy		
Internal structure of the earth, cause of magnetic field		Structure of the Earth	Earth as a planet is covered in level 5	Plate tectonics	
Rock forming minerals, rock types and formation		Materials of the crust	Rocks in the local area	Advanced rocks in the local area	
Internal energy, volcanoes, earthquakes, plate tectonics		Disturbance of Earth		Extreme earth events	New Zealand as a plate boundary
Relative ages, absolute ages, fossils, geological age		History of Earth			How geologists age rocks and geological events
Korean/ New Zealand geology		Geological features of Korea	Local New Zealand geology	Local New Zealand geology	Local New Zealand geology
Energy and matter circulation in the atmosphere		Motion and circulation of the atmosphere			Matter and energy in the atmosphere
Energy and matter circulation in the oceans		Motion and circulation of sea-water			Matter and energy in the oceans

Comparison table for earth science/earth and space science (continued)

Concepts	Korean National Curriculum (revised 2009) Earth science		New Zealand Curriculum earth and space science		
	Earth science I	Earth science II	Level 6 Achievement Standards	Level 7 Achievement Standards	Level 8 Achievement Standards
Circulation in the atmosphere and ocean surface El Nino and La Nina, southern oscillation, climate change		Interactions of oceans and atmosphere			Global warming
Distance, H-R diagram, structure/ evolution of stars		Characteristics of stars		Stars	Astronomical event or discovery
Structure, qualities, interstellar medium		Our galaxy		Space	
Hubble's law, big bang, dark matter and energy, structure		Galaxy and space			

Significant differences

REPUBLIC OF KOREA

Korean geology
Hubble's Law
Magnetic field of the earth
Deep space

COMMON concepts for earth science/earth and space science

« Korean geology ▪ New Zealand geology »
Internal structure of the earth ▪ Rock forming processes ▪ Types of rocks ▪ Plate tectonics ▪ Atmosphere (weather) ▪ Oceans ▪ Geological ages ▪ Solar system and stars ▪ Galaxies

Significant differences

NEW ZEALAND

New Zealand geology

VII. Glossary of terms

Republic of Korea	
School year	March to mid February (2 semesters)
College Scholastic Ability Test (CSAT)	CSAT is a standardised test administered by KICE and recognized by Korean higher educational institutions for admission.
New Zealand	
School year	End January to mid December (4 terms)
Achievement Standards	A nationally registered, coherent set of learning outcomes and associated assessment criteria, together with technical and management information that supports delivery and assessment; Achievement Standards specify three different standards of performance and the method of assessment, which may include national external assessment. Achievement Standards are derived from the New Zealand Curriculum.
Comparable	Comparable qualifications are qualifications that are similar enough to be compared and recognised. Comparability of qualifications means qualifications are similar in terms of the qualification level, intent, purpose and content. In other words, taking into account the diversity of education systems, they are not substantially different.

Level	The ten levels of the New Zealand Qualifications Framework. Levels are based on complexity, with Level 1 the least complex and Level 10 the most complex. All qualifications on the NZQF are assigned on the 10 levels.
National Certificate of Educational Achievement (NCEA)	NCEA is New Zealand's main national qualification for senior secondary school and is available in three levels.
Standards	Standards provide defined learning outcomes, together with performance or assessment criteria examples of their interpretation and application, and associated quality assurance processes. There are two types of standards – unit standards and Achievement Standards, which are collectively known as assessment standards.
Unit standard	A nationally registered, coherent set of learning outcomes and associated performance criteria, together with technical and management information that supports delivery and assessment. All unit standards are registered on the Directory of Assessment Standards assigned a level and a credit value, and may contribute to the award of a qualification.

University Entrance (UE)	The common educational standard established, after consultation with the universities and the New Zealand Vice-Chancellors' Committee, and maintained by NZQA as a minimum prerequisite for entrance to a New Zealand university.

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