

Technical Report: Curriculum Analysis of the OECD Future of Education and Skills 2030

1 Overview of the types of curriculum analysis in the Future of Education and Skills 2030 project

The series of volumes on curriculum analysis synthesise rich, mixed-methods data collected from a variety of sources and stakeholders. Working methods and sources of information include:

- Reviews of existing research
- Policy survey on curriculum redesign (PQC)
- Curriculum content mapping (CCM)
- Mathematic Curriculum Document Analysis (MCDA)
- Physical Education Curriculum Analysis (PECA)
- Consultation and discussion with policy makers and curriculum experts

Reviews of existing research

Research syntheses (traditional literature reviews, systematic reviews and meta-analyses) and landmark papers on curriculum were reviewed and their key messages and learnings extracted. Data from existing OECD data sources relevant to curriculum was also reviewed, including indicators from Education at a Glance (EAG), the Programme for International Student Assessment (PISA) and the Teaching and Learning International Survey (TALIS).

Policy Questionnaire on Curriculum

The aim of the PQC was to give countries and jurisdictions the opportunity to learn from peers about good practices in and challenges faced in the curriculum redesign process. It also provided an opportunity for self-reflection so that countries could position their curriculum (e.g. visions, educational goals and expected student outcomes).

Thirty-seven countries and jurisdictions are represented in the PQC data. Questionnaires were completed by government representatives in 33 countries/jurisdictions: OECD countries/jurisdictions Australia, British Columbia (Canada), Chile, Czech Republic, Denmark, Estonia, Finland, Hungary, Ireland, Japan, Korea, Lithuania, Mexico, Netherlands, New Zealand, Norway, Ontario (Canada), Poland, Portugal,

Québec (Canada), Scotland (United Kingdom), Sweden, Turkey, Wales (United Kingdom), and partner countries/jurisdictions Argentina, China, Hong Kong (China), Costa Rica, Kazakhstan, Russian Federation, Singapore, South Africa, and Viet Nam. Questionnaires were completed by 4 researchers from United Kingdom (Northern Ireland), United States, Brazil, and India.

Curriculum Content Mapping

The Curriculum Content Mapping (CCM) was a document analysis exercise in which countries/jurisdictions explored the extent to which different competencies are included in their current curriculum, and how. By mapping seven learning areas of the curriculum against a list of 28 competencies stemming from the Learning Compass 2030, countries explored how knowledge is intended to be taught together with skills (e.g. critical thinking, creative thinking, cooperation/collaboration) as well as attitudes and values (e.g. respect, empathy).

Sixteen countries/jurisdictions participated in the CCM exercise: OECD countries/jurisdictions Australia, British Columbia (Canada), Estonia, Greece, Israel, Japan, Korea, Lithuania, Northern Ireland (United Kingdom), Portugal, Saskatchewan (Canada), Sweden, and partner countries: China, Kazakhstan and Russian Federation for comparative analysis. One country, the Netherlands, participated in the self-reflection exercise.

Detailed information on the CCM methodology will be detailed below.

Mathematics Curriculum Document Analysis

The Mathematics Curriculum Document Analysis (MCDA) project investigates the extent to which countries have incorporated 21st century skills in their current mathematics curriculum. Participating countries identify one or more mathematics experts to take part in a weeklong workshop on coding relevant and desired mathematics curriculum documents, including curriculum guides and textbook materials, making use of the *21st Century Mathematics Framework* developed for MCDA in conjunction with PISA 2021. Benefits for participating countries include: 1) learning the extent to which the PISA 2021 concept of mathematics literacy is represented in one's current mathematics curriculum; 2) comparing one's own mathematics curriculum to contemporary international benchmarks; 3) informing ongoing reform efforts towards a 21st century vision of mathematics education; and 4) creating a contemporaneous mathematics curriculum profile to provide a relevant interpretive context for one's PISA 2021 mathematics literacy performance. MCDA coding workshops were held in February, March, June and September 2019. An MCDA expert meeting is being held in October 2020 to discuss the results of the coding workshop and prepare a report on the findings, which will be published mid-2020.

Government-nominated representatives participated from 16 countries and jurisdictions, including Argentina, Australia, Estonia, Greece, Hong Kong (China), Hungary, Israel, Kazakhstan, Korea, Latvia, Lithuania, the Netherlands, New Zealand, Norway, Portugal and Sweden. Researchers participated 3 countries and jurisdictions, including Japan, United States and Chinese Taipei: as their input was provided by independent researchers, it may not represent official views from government institutions.

Physical Education Curriculum Analysis

The stock-taking exercise on physical health education marks the first time that the OECD has focused on physical and health education as part of its policy analysis. It takes stock of research evidence on the effects of physical education/health education. It will also aim to uncover new knowledge on the state of physical education/health education policies, curriculum, practices and perspectives in various countries.

Eighteen countries/ jurisdictions participated: 15 with government representatives from Australia, Canada (Ontario), Chile, People's Republic of China, Estonia, Hong Kong (China), Japan, Kazakhstan, Korea, Portugal, Russia, Switzerland, Turkey, UK (Scotland, Wales); 3 with researchers from England, Luxembourg, Norway.

The results were synthesised into a publication "Making Physical Education Dynamic and Inclusive: international curriculum analysis".¹ It was launched at the project's meeting, hosted in IIsen, Korea, in November 2019

Consultation and discussion with policy makers and curriculum experts

As with all strands of activity of the Education 2030 project, the international curriculum analysis drew heavily on the expertise and experience of government representatives involved in the project. One valuable outcome of this collaboration was the identification of a series of principles that could be used to guide effective redesign of future-oriented curricula.

¹https://www.oecd.org/education/2030-project/contact/OECD_FUTURE_OF_EDUCATION_2030_MAKING_PHYSICAL_DYNAMIC_AND_INCLUSIVE_FOR_2030.pdf

2 Policy Questionnaire on Curriculum Redesign Methodology

What is the Policy Questionnaire on Curriculum Redesign (PQC)?

The aim of the PQC was twofold: to give countries/jurisdictions the opportunity to learn from peers about good practices in and challenges faced in the curriculum redesign process and to provide countries/jurisdictions with an opportunity for self-reflection to position their curriculum (e.g. visions, educational goals and expected student outcomes).

Notions of curriculum and approaches to curriculum redesign are particularly diverse across countries and jurisdictions. To capture this diversity, the PQC questionnaire was designed with an exploratory approach. With this purpose, the PQC questionnaire included open-ended questions intended to not limit responses to a discrete categorisation designed ex-ante. The resulting raw dataset is thus qualitative in nature and provides rich narratives of experiences in curriculum redesign.

The target of this questionnaire was the curricula provided for students who study at ISCED 2 (Lower Secondary) level general education institutions.

Questions in the PQC questionnaire were organised in 4 thematic blocks. Each of these blocks is further divided into subcategories exploring particular approaches and experiences regarding curriculum redesign. These blocks are:

1. Contextual information: designed to collect contextual information necessary to better understand country-specific circumstances regarding curriculum.

Questions include:

- Major government visionary policies, declarations or statements;
- Legal regulation/s;
- Education courses and curricula;
- Teachers' and students' autonomy;
- Extra-curricular activities;
- Curricula provided for specific student groups.

2. Current curriculum: designed to map the current curricula focusing on its scope.

Questions include various aspects of curriculum including goals, values, coverage, textbooks, instruction time and transition, and cover the following topics:

- Difference/similarity of education goals, including subject-specific goals, across nations;
- How values are described or embedded in curricula;
- Total intended instruction time;
- How countries make curricula at different education levels coherent, particularly in relation to learning progression for students through the education levels ISCED 1-3;
- How textbooks and/or other teaching/learning support materials are developed and made coherent with (or aligned to) a curriculum.

3. Trends in curriculum redesign: designed to grasp the recent trends of curriculum redesign.

Questions in this section cover the following topics:

- Trends in the frequency of changes (e.g. countries have changed their curricula more frequently in order to keep pace with societal change);
- Flexibility of changes (e.g. countries have changed specific subjects or content instead of periodically redesigning the whole curriculum);
- Interrelationship between changes in goals, subjects, content, instruction time etc.;
- Lessons learnt from past reforms and unintended consequences;
- Future planning of curriculum redesign; directions in which countries are moving;
- Challenges countries are facing and strategies they are applying/will apply to deal with these challenges.

4. Process of curriculum development, implementation and monitoring: focusing on the process of curriculum, from its development to implementation and monitoring.

Questions in this section cover following topics:

- Players involved in the process of curriculum development, implementation and monitoring;
- Strategies and key mile-stones in the curriculum development process;
- Strategies and the roles of stakeholders in the curriculum implementation process;
- How the implementation process is monitored.

How were PQC responses analysed?

Qualitative responses in the PQC questionnaire were analysed following a careful multi-stage coding and validation process. Figure 1 outlines key stages in this process. These include:

0. PQC questionnaire:

The questionnaire was based on the real policy needs when redesigning curriculum; i.e. the questionnaire itself was co-developed with participating countries/jurisdictions in an iterative process. Countries/jurisdictions first identified common curriculum redesign challenges (time lag dilemma, curriculum overload, quality of curriculum contents, balance between quality and equity of curriculum, planning for effective implementation), which were then translated into the questionnaire. It targeted governments or other agents who are responsible for designing curricula and implementation plans. National coordinators nominated by 33 countries/jurisdictions along with the academic experts from 4 countries/jurisdictions completed the questionnaire in an iterative process between 2017 and 2019. As the purpose of the questionnaire was also to facilitate discussion and peer-learning, raw country/jurisdiction responses were shared with other participating countries early on in the process.

1. Qualitative coding - Stage 1 (Framework definition):

The first stage in this analytical process consisted on a qualitative coding to identify key themes and categories emerging from PQC responses. The result of this stage was a mapping framework including key themes and categories. To facilitate cross-country comparability, categories in this framework are not completely exhaustive and in some cases not fully discrete. This has been highlighted wherever possible and suits the purpose of increasing comparability of the data while acknowledging the complexity of national contexts.

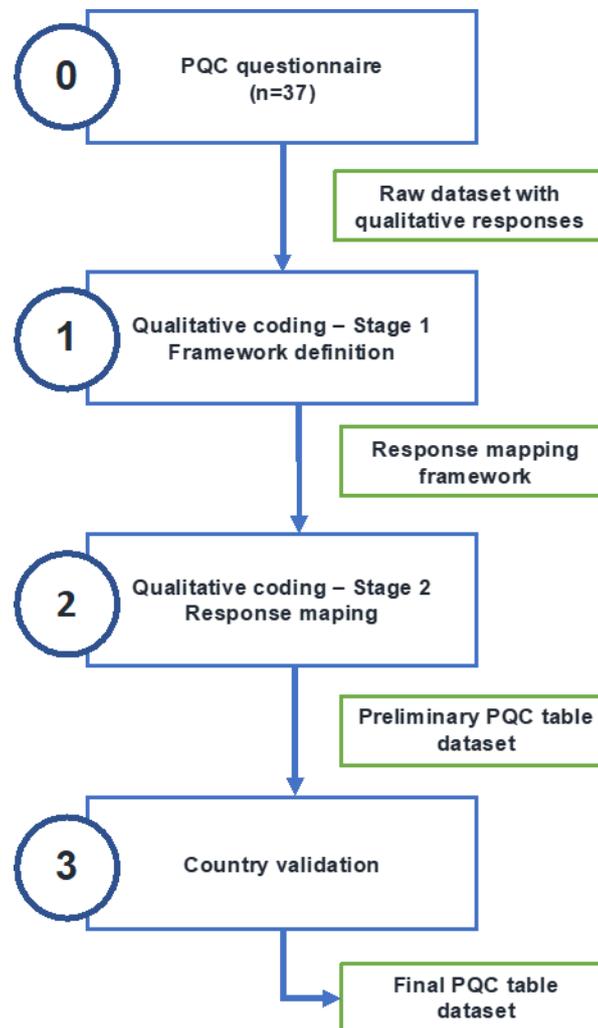
2. Qualitative coding - Stage 2 (Response mapping):

Country responses were then mapped to categories based on the framework defined under stage 1. This process was undertaken simultaneously and independently by two response-coders. Any discrepancies in the resulting code were then reconciled by a code reviewer. This approach was taken to address any challenges in inter-rater reliability. The result of this stage was a preliminary dataset comprising cross-country PQC tables addressing key themes in the questionnaire.

3. Country validation:

Preliminary PQC tables resulting from this coding exercise were then validated by countries/jurisdictions participating in the study. In this process, countries/jurisdictions validated the response mapping and provided complementary information to supplement the preliminary dataset. The result of this process was a final dataset comprising cross-country PQC tables validated by countries.

Figure 1. Multi-stage PQC analysis overview



3 Curriculum Content Mapping (CCM)

What is Curriculum Content Mapping (CCM)?

Background of the CCM exercise

The OECD Education 2030 project was proposed at the 17th meeting of the Education Policy Committee in April 2015. The project provides the opportunity to explore the bigger picture and the longer-term challenges of education. It aims to contribute to making the process of curriculum design and development more evidence-based and systematic.

The project was launched with two main strands of activities:

- Development of a future-oriented learning framework that sets out the types of knowledge, skills, attitudes and values which today's students will need to thrive and shape the future towards a better future in 2030, using the common language in the framework across different countries and across different stakeholders .
- International curriculum analysis that can build a knowledge base and contribute to making the process of curriculum design and development more evidence-based and systematic, in particular, to address commonly identified challenges among participating countries.

On the basis of these strands, the OECD Learning Compass for 2030 has been co-created with a wide range of stakeholders, building on a solid research base and theoretical underpinnings. Subsequently, three types of activities have been conducted: the Policy Questionnaire on Curriculum Redesign (PQC); In-depth subject-specific curriculum analysis (the selected subjects include Mathematics and Physical and Health Education.); and the Curriculum Content Mapping (CCM) exercise in comparison with the OECD Learning Compass for 2030. The CCM exercise is one of the key curriculum analysis activities, while at the same time drawing on the OECD Learning Compass for 2030.

Goals of the CCM exercise

A "competency" is a holistic and dynamic concept, which includes knowledge, skills, attitudes and values. However, when designing a competency-based curriculum, countries often face a false dichotomy of "knowledge" versus "skills, attitudes and values" regarding what students need to learn at school.

To avoid the false dichotomy and identify or confirm the extent to which and how competencies are included in their current curriculum and the curricula of other countries and with a more granular analysis, the CCM exercise aims to support countries to:

- Explore how knowledge is intended to be taught together with skills (e.g. critical thinking, creative thinking, cooperation/collaboration) as well as attitudes and

values (e.g. respect, empathy). This can help countries better understand how particular skills, attitudes and values are more/less relevant to certain learning areas/ subjects.

- Identify how emerging demands for interdisciplinary competencies (e.g. global competency, digital literacy) can be accommodated in existing learning areas. This can help countries to avoid further crowding the curriculum by adding new learning areas or subjects.
- Explore where today's intended curricula stand with respect to the increasingly important dimensions that are articulated as key concepts, competencies and constructs that are required for today's students to build a new future in the OECD Learning Compass for 2030. This can help countries to reflect on possible gap areas between today's curriculum and future needs.

Value of the CCM exercise

Countries that took part in this exercise have provided good opportunities for both **self-reflection** and **peer-learning among countries** (see Appendix *Self-reflection and insights from E2030 CCM participating countries and jurisdictions*). Following the completion of the mapping process, the CCM exercise enables countries to use comparative data:

- To monitor/ review their current curriculum in relation to the selected competencies.
- To inform future curriculum development/ redesign initiatives.

In addition, the data obtained from the CCM can provide data to support other analyses, including:

- valuable companion information to the OECD Learning Compass for 2030 as well as data obtained from the Policy Questionnaire on Curriculum (i.e. the written curriculum);
- contextual information for case studies on school practice (i.e. the implemented curriculum);
- contextual information for consideration with PISA data (i.e. the achieved curriculum); and
- overarching information on the inter-relationships between different aspects of knowledge, skills, attitudes and values, which can assist the further analysis of specific learning areas (e.g. physical education/ health; mathematics).

Scope of the CCM exercise

To ensure cross-country comparability, the scope is as following:

Educational Level

The scope of the target educational level for the CCM exercise is inclusive of all grades in ISCED 2, so as to explore how competencies² which are the target of the learning areas might differ across these grades in different countries.

Learning Areas

Seven learning areas are selected as the basis for the mapping of the competencies. This is to limit the amount of mapping for countries to a manageable number but also to ensure that an appropriate range of learning areas is included, reflecting the broad learning students typically undertake in schools.

These learning areas were suggested by international subject experts and the OECD, followed by discussions and agreement by countries who took part in the pilot study. Countries and jurisdictions were concerned with the potential workload and overall scope and depth of the project if all possible subjects taught in the ISCED 2 grades of participating countries/jurisdictions were to be included in the exercise.

Accordingly, it was agreed that a set of seven broad learning area coding frameworks, each inclusive of subjects typically undertaken within the mandatory curriculum in countries/jurisdictions, would be drafted. The learning areas selected for the CCM were:

1. National language(s)
2. Mathematics
3. Physical education/ health
4. Arts (inclusive of the subjects: visual art/art, music, dance, drama and media arts)
5. Humanities/ social science/studies (inclusive of the subjects: geography, history, civics/ citizenship, economics/ business studies)
6. Science/ natural science (inclusive of the subjects: biology, physics, chemistry, earth science/ space/ astronomy)
7. Technologies/ home economics inclusive of the subjects: craft/ design and technology, ICT, home economics.

Each of the subject experts appointed to undertake the mapping exercise have in-depth knowledge of the country/ jurisdiction's formal written curriculum in the relevant learning area.

The above names and the categorisation of learning areas may be different from the titles and the way learning areas are arranged in different countries. Accordingly, it is important that the subject experts of a country/jurisdiction undertaking the mapping collaborate with each other to identify where coded subject matter has been "located" across the seven draft learning area coding frameworks (for example, the content in dance may be located

² For ease of reading the term "competencies" is used in reference to the twenty eight competencies/ constructs/ concepts to be mapped in the CCM Main Study.

solely in the physical education/ health learning area/ subject in some countries while the same content may be included in the arts learning area of other countries).

There are several different ways that countries might expect some of the competencies to be fostered. Some countries, for example, expect particular competencies to be developed primarily in the family home or in the community rather than through the curriculum. Contextual information such as this were collected as part of the CCM exercise so that similar and different approaches can be appropriately recognised and acknowledged.

Phases of the CCM exercise

CCM was designed as a rigorous exercise with a pilot, a field trial and a main study phase. The coding process initially involved the participation of subject experts nominated by participating countries and other identified experts who contributed through scheduled webinars.

A revised CCM proposal from the 4th IWG was discussed at the 5th IWG. This discussion included consideration of the draft coding for Physical education/ health and mathematics and the phases of the CCM process. The coding frameworks for all seven learning areas were completed following the 5th IWG based on discussions at the IWG and advice from subject experts. Competencies relevant for each learning area were also recommended by the subject experts.

Pilot Phase (completed)

The mapping process was piloted with four countries/ jurisdictions to test the feasibility of the approach being undertaken and to identify where adjustments need to be made to the coding frameworks and/ or methodology prior to undertaking a Field Trial in early 2018.

Four levels of degree were used in the mapping process to identify the extent to which each competency is present (or not) within each learning area/subject. Criteria were developed for the four levels (these are outlined in the guidelines).

The data obtained from this exercise was provided by the participating countries through “heat maps” using the four-degree model. The heat maps were used to illustrate the breadth and depth that competencies are fostered in and across the curriculum of the participating countries.

Feedback from the countries involved in the Pilot Study was reported to the 6th IWG and taken into consideration in revisions of the competencies and learning areas coding frameworks.

Field Trial (completed):

Field Trial 1

Following discussion at the 6th IWG regarding the Pilot Study and through the further development of the OECD Learning Compass for 2030, adjustments were made to the coding frameworks and the CCM process.

The Field Trial was undertaken using the revised coding frameworks. As with the Pilot Study, nominated experts from each country/jurisdiction undertook the mapping process, again with the assistance of national coordinators. Feedback from the participating

countries has been used from Field Trial 1 to finalise the materials and processes for Field Trial 2.

Field Trial 2 (Completed)

Motivated by increasing interest of additional countries in joining the study, this extension of the field trial included a second wave of participating countries/jurisdictions. Following discussion at the 7th IWG regarding Field Trial 1 and through the further development of the OECD Learning Compass for 2030, adjustments were made to the coding frameworks and the CCM process.

Field Trial 2 was undertaken using the revised coding frameworks. As with the Pilot Study and Field Trial 1, nominated experts from each country/ jurisdiction undertook the mapping process, again with the assistance of national coordinators. Feedback from the participating countries/ jurisdictions is currently being used from Field Trial 2 to finalise the materials and processes for the main study, having taken place in 2018.

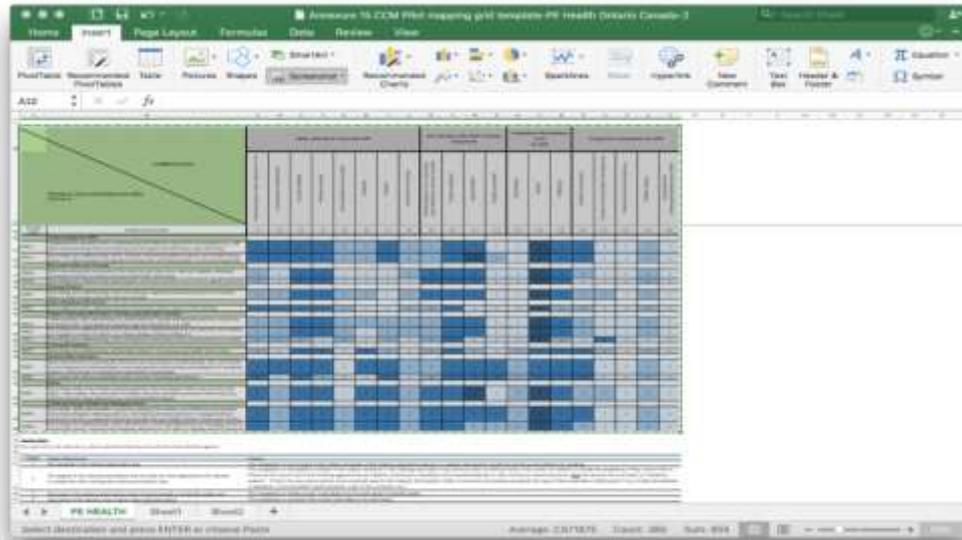
Main study

Following the conclusion of Field Trial 2 and CCM workshops involving the participating countries/ jurisdictions, adjustments were made to the coding frameworks and the CCM process. The coding frameworks for all learning areas were then finalised and the CCM Guidelines adjusted as required.

The mapping exercise was undertaken in all participating countries/ jurisdictions using the revised coding frameworks. As with the pilot study and field trials, nominated experts from each country/ jurisdiction undertook the mapping process, again with the assistance of national coordinators. Following the CCM exercise, verification of the heat maps was undertaken.

An example of what a heat map developed for physical and health education might look like is presented in the table below (Figure 2). Please note, this example is not meant to represent what the heat map should look like - it is provided to illustrate what the CCM exercise could actually reveal during the main study.

Figure 2. Heat map from the CCM exercise



The columns list the CCM competencies that are being mapped against a series of curriculum content items, which are listed in the rows. For each cell in table, countries' experts rated to which extent the corresponding competency is identified in their written curriculum on a scale that goes from not present to being a main target. Darker colours represent stronger representation of the given competency in the respective content items.

Tools of the CCM exercise

Scope of "documents" to be included in the exercise.

While the formal written curriculum provides the basis for teaching and learning, there are other factors, such as the actual learning experiences and opportunities that teachers provide in classrooms that contribute to student learning. However, for this part of the Education 2030 project the focus is on the written curriculum.

Since the scope of curriculum varies across countries, countries were given sufficient space to provide contextual information, which was used when interpreting and reporting the CCM data, to avoid any misunderstandings during data analysis. A CCM Main Study Report Form was provided to countries to gather this information.

Content Items/ Learning areas

To ensure *content validity* for international comparison, the drafting of the content items for each of the seven learning areas has been undertaken over the period of the CCM exercise using an iterative process. This process commenced with the selection of content items typically included in the relevant subjects of curriculum, drawing on the curricula of a sample of five countries/ jurisdictions. These countries were purposefully identified to ensure the selected items were inclusive of curricula models from different regions of the world (i.e. Asia, Europe, North America, and the Pacific).

When developed, the initial seven draft Learning Area Coding Frameworks were then distributed to subject experts nominated by the IWG members with advice and feedback on the content items sought from their subject experts³. The draft frameworks were then adjusted and developed further based on the feedback and advice from subject experts and utilised for the Pilot Study.

Following the completion of the Pilot Study, further feedback was obtained from the four countries that participated in the study regarding the draft Learning Area Coding Frameworks as well as feedback from countries/jurisdictions at the 6th IWG meeting in Paris during October 2017.

One of the key changes made to the content items based on this feedback was to ensure the content items were not duplicating the knowledge, skills, attitudes and values foregrounded in the competencies/ constructs. Therefore, the content items in the learning area frameworks were adjusted to be more reflective of topics, activities and subject matter rather than competencies. Additionally, some priority content items highlighted as being specifically addressed by a few countries in their curricula were added to assess the extent to which these areas are also being addressed by other countries/jurisdictions through their curricula.

Field Trials 1 and 2 were undertaken with the revised seven Learning Area Coding Frameworks. Further adjustments were made following the Field Trials to the mathematics learning area framework to provide an alignment between the materials being used in the CCM and the E2030 in-depth analysis of mathematics, called the Mathematics Curriculum Documents Analysis (MCDA) project.

To ensure the content validity for international comparison as well as to avoid duplication of contents, final fine-tuning took place based on the comments made during and after the CCM preparatory workshop for the main study, which was held in Paris on 4-5 September 2018.

Concepts/ Competencies/ Constructs

As with the development of the coding framework for the learning areas, the coding framework for concepts/ competencies/ constructs has also been developed through an iterative process.

Originally, twenty-four concepts/ competencies/ constructs were used for the 2017 Pilot Study based on the discussion at successive IWG meetings through the ongoing development of the OECD Learning Compass for 2030.

A working group of thought leaders was established by the OECD to develop papers and advice based on established literature, theoretical underpinnings and emerging ideas on various concepts/ competencies/ constructs proposed as the transformative competencies students will need in order to make the future we want a reality.

The definitions for these concepts/ competencies/ constructs and the categories in which they have been listed were developed and adjusted over time through the CCM process based on material developed by the working group, papers and presentations on different

³ The sample of subject experts engaged by the OECD for this task was based on the need to acquire advice from varied countries, the availability of experts and identified individuals with expert knowledge. Accordingly, not all of the experts nominated by countries have participated in the process.

competencies/ constructs discussed at IWG meetings in 2017 and 2018, feedback from participating countries/ jurisdictions involved in the CCM Pilot Study and Field Trials and refinements made to the OECD Learning Compass for 2030.

The number of concepts/ competencies/ constructs has fluctuated over this time based on feedback from various sources and the development of the OECD Learning Compass for 2030. There are currently 28 concepts/competencies/constructs in the draft CCM competencies/constructs coding framework listed under the following five categories that are in alignment with the OECD Learning Compass for 2030 (Table).

Table 1. Selected concepts/ competencies/ constructs

Key Concepts (concepts underpinning the E2030 Learning Framework)	<ul style="list-style-type: none"> • Student agency • Co-agency
Transformative Competencies and Competency Development for 2030	<ul style="list-style-type: none"> • Creating new value (including a construct "creative thinking") • Taking responsibility (including a construct "responsibility") • Reconciling dilemmas and tensions (including a construct "conflict resolution")
2030 Competency development cycle	<ul style="list-style-type: none"> • Anticipation • Action • Reflection
Foundational Literacies for 2030	<ul style="list-style-type: none"> • Literacy • Numeracy • ICT Literacy; Digital Literacy • Data Literacy • Physical/Health Literacy
Compound Competencies for 2030	<ul style="list-style-type: none"> • Global competency • Media literacy • Literacy for sustainable development • Computational thinking/programming/coding • Financial literacy • Entrepreneurship
Skills, Attitudes and Values for 2030 – Constructs	<ul style="list-style-type: none"> •
Cognitive skills	<ul style="list-style-type: none"> • Critical Thinking • Problem Solving
Social & emotional skills/ attitudes & values	<ul style="list-style-type: none"> • Cooperation/Collaboration • Self-regulation/self-control • Empathy • Respect • Persistence/resilience • Trust
Meta-cognitive skills	<ul style="list-style-type: none"> • Learning to Learn

Definitions for the selected concepts/ competencies/ constructs

Countries requested to avoid making a long list of constructs alphabetically without any explanation, but to frame the constructs in a structure for a purpose (Table). To respond to this request, constructs are listed under sub-categories. However, it is difficult to list some constructs in certain domains because some constructs are “multi-faceted” in nature; for example, empathy requires both cognitive (perspective taking) and social emotional skills.

Some constructs are context-dependent (e.g. self-efficacy in math cf. self-efficacy in life in general). It is recognised that a particular competency when applied in the context of learning in one learning area might involve a different set of behaviours in another learning area. For example, “persistence” exhibited in mathematics would include the capacity to maintain engagement in a complex word problem (involving many sub-calculations) to arrive at a conclusion. However, “persistence” in physical education might involve enduring physical effort over a period of time in a physical exercise or sporting activity.

Table 2. CCM Draft Competencies Framework for Main Study

Key Concepts (concepts underpinning the 2030 Learning Framework)		
1	Student Agency (e.g. motivation, purposefulness, growth mindset, self-directed learning, self-efficacy)	<p>Student agency is the capacity and propensity to take purposeful initiative—the opposite of helplessness. Young people with high levels of agency do not respond passively to their circumstances; they tend to seek meaning and act with purpose to achieve the conditions they desire in their own and others' lives. They have the belief that they can have impact and influence over their learning and future.</p> <p>Agency involves having a sense of purpose, planning and taking action to achieve goals, reflecting on feedback and advice, and taking responsibility for actions. This competency is acquired through the development of knowledge, skills, attitudes and values concerning goal setting, monitoring progress, coping with set-backs, reflecting and evaluating.</p> <p>Student agency is closely linked to:</p> <ul style="list-style-type: none"> • Having a growth mindset, which refers to the understanding and appreciation that one's learning potential is not limited or pre-determined and that abilities can be developed through both effort and persistence. • Student active participation in the direction of one's own learning (rather than passively sitting in the classroom) • Student motivation as part of student agency in the curriculum context is defined as being purposeful and behaving or taking action for intrinsic or extrinsic reasons and includes constructs such as pro-activeness, self regulation and curiosity. • Self-directed learning, which involves a process whereby students (either with or without assistance) take initiative, form learning goals, select learning activities, accept the associated risks and assess their achievements. • Self-efficacy, which is a key aspect of student agency in that it is related to self confidence and entails beliefs that one can understand what is required, make appropriate judgements, navigate the possible setbacks and influence and make a difference concerning learning pathways and trajectories
2	Co-agency (e.g. student-t	"Co-agency" refers to the interactive, mutually supportive relationships that help learners to progress towards their valued goals.

	eachers; student-peers; student-parents; student-community outside of school).	To help develop agency, educators must not only recognise learners' individuality, but also acknowledge the wider set of relationships – with their teachers, peers, families and communities – that influence their learning. In this context, everyone should be considered a learner, not only students but also teachers, school managers, parents and communities.
Transformative Competencies and Competency Development for 2030 : considered essential for transforming society for a better future and competencies necessary for the development of student agency		
3	Creating new value (including a construct “creative thinking”)	<p>Creating new value refers to the ability to add values to the society by identifying new sources of growth to prepare for 2030 such as developing new solutions, products and services, new jobs, new processes and methods, new ways of thinking and living, new enterprises, new sectors, new business models and new social models.</p> <p>Creativity is one of the key constructs underpinning the competency creating new value. Known as “outside the box thinking,” creativity is defined as the ability to approach problems or situations with fresh perspectives resulting in seemingly unorthodox solutions. Creativity can be approached from two perspectives: firstly, as the individual’s ability to produce a novel combination of thoughts and concepts that is subsequently expressed in the world (Sawyer, 2012); secondly, as the production of a work that is judged as original and socially valuable (useful) in some way by a knowledgeable social group (Sawyer, 2012; Sternberg and Lubart, 1999).</p>
4	Taking responsibility (including a construct “responsibility”)	Taking responsibility refers to the ability to act responsibly for a good cause, principles and integrity for individual and collective well-being. A responsible person demonstrates the willingness to accept praise, blame, reward, or punishment for an act or omission and to accept the consequences of their behaviour, they have a commitment to the group and others, they can be depended on, and they have integrity.

5	Reconciling tensions and dilemmas (including a construct “conflict resolution”)	<p>Reconciling tensions and dilemmas requires the ability to deal with tensions, dilemmas, trade-offs, nexus, ambiguity, non-simultaneity, and non-linear processes in a constructive, future-oriented way; take a long-term perspective, going beyond the either-or; avoid rushing to a single answer, to an either-or solution, but rather deal with tensions, dilemmas and trade-offs – for instance, between equity and freedom; autonomy and solidarity; efficiency and democratic processes; ecology and simplistic economic models ; diversity and universality; and innovation and continuity – by integrating seemingly contradictory or incompatible goals as aspects of the same reality.</p> <p>A person who can reconcile tensions and dilemmas can cope with tensions and dilemmas reflectively with multiple, dynamic and often conflicting aspects and recognising that there may be more than one solution or solution method.</p> <p>Conflict resolution requires purposeful listening, clarification of viewpoints, finding common understandings or viewpoints, identifying solutions and evaluating outcomes as methods and processes involved in facilitating the peaceful ending of conflict and retribution.</p>
6	Anticipation	<p>Anticipation is the ability to understand others' intentions, actions and feelings and anticipate short- and long-term consequences, but also the ability to widen one's perspectives and preparedness to create and influence the future.</p> <p>From a subject-specific perspective, in mathematics, for example, anticipation is a key competency for certain types of data analysis involving predictions, simulations and forecast; in sciences, it can be captured as part of the scientific process of hypothesis making.</p> <p>Anticipation enables individuals to reach a level of social maturity that allows them to adopt different perspectives, make independent judgments and take responsibility for their decisions and actions. Students should be able to feel excitement about real life and the future, instead of believing that the future is already determined by nature or by others outside of their control. Without this, students will have difficulty coping with challenges and opportunities of the world. They should feel prepared to anticipate and influence change with confidence. For this, they should have not only the knowledge base (such as history, environmental changes, current demographic changes, current news events), cognitive skills (such as analytical or critical thinking skills, or general problem-solving skills) to anticipate future needs or the consequences of today's action on future; but also social and behavioural components such as motivation, emotions, commitments, and values.</p>

7	Action	Action as a competency involves the ability to act with a willingness and capacity for a defined purpose. It involves the individuals' disposition to act on what they are learning or want to learn or in response to a situation; to utilise skills acquired to act or contribute to a situation or circumstances and to evaluate the impact of one's action/s. In a subject-specific context, as in science, for example, action can be captured as part of the scientific process of hypothesis testing and running experiments in a laboratory.
8	Reflection	<p>Reflection is the ability to take a critical stance before deciding, choosing and acting, such as, by stepping back from the assumed, known, apparent, and accepted, comparing a given situation from other, different perspectives, and looking beyond the immediate situation to the long-term and indirect effects of one's decisions and actions. This enables individuals to reach a level of social maturity that allows them to adopt different perspectives, make independent judgments and take responsibility for their decisions and actions. The reflective approach is based on a model of human development in which individuals are able to integrate increasing levels of complexity into their thinking and actions.</p> <p>It involves linking a current experience to previous learnings. Reflection also involves drawing forth cognitive and emotional information from several sources: visual, auditory, kinaesthetic, and tactile. To reflect, we must act upon and process the information, synthesising and evaluating the data. In the end, reflecting also means applying what we have learned to contexts beyond the original situations in which we learned something. The reflective approach is based on a model of human development in which individuals are able to integrate increasing levels of complexity into their thinking and actions. In a subject-specific context, as in science, for example, it can take place as part of the scientific process as one reflects on the research findings of an experiment.</p>
<p>Foundational Literacies</p> <p>The "essential foundations" required to thrive in 2030</p>		
9	Literacy	Literacy is defined as the ability to evaluate, use and engage with written, spoken, visual and multi-modal texts. Literate students are able to decode and construct different types of texts appropriate for life in and out of school. These texts will include subject-specific texts (such as those required in science or history) and visual texts such as diagrams and graphs. Literacy is understood as a foundation for communication.
10	Numeracy	Numeracy is defined as the ability to access, use, interpret and communicate mathematical information and ideas. Numerate students are able to apply mathematical understanding and skills appropriate for life in and out of school. This includes applying the knowledge and skills acquired in mathematics when engaging with subject-specific content in other subject areas, where appropriate.

11	ICT literacy/ digital literacy	<p>Digital literacy is defined as the ability to use information and communication technologies effectively and appropriately in school and beyond school. Students with this capability are able to access, create and communicate information and concepts. They are able to adapt to changing technologies and use technologies to achieve a purpose and to communicate with others using devices in an ethical and responsible way.</p> <p>Information and communication technologies (ICT) refer to all devices, networking components, applications, and systems that allow people and organisations to interact in the digital world.</p>
12	Data literacy	<p>Data literacy is defined as the ability to acquire meaningful information from and create and communicate using data based on mathematical understanding and skills and particularly in relation to statistics. Data literacy includes thinking critically about information presented in statistical formats or visualised format to analyse data and determine the accuracy of claims and objective interpretations made based on data.</p>
13	Physical/ health literacy	<p>Physical/Health literacy is defined as the ability and motivation to integrate physical, psychological, cognitive and social competencies for healthy and active living. This involves the acquisition of fitness and movement skills; positive attitudes towards movement and understandings regarding how and why to engage in movement activities.</p> <p>Physical/Health literate students have the knowledge, skills and attitudes (including motivation) to access, understand, evaluate and apply health information to make appropriate decisions regarding safe and healthy practices and behaviours.</p> <p>Health literacy tends to be linked to better access and use of health services, and with maintaining health and wellness (e.g. nutrition, mental health, relationships and keeping safe) throughout the life span.</p>
<p>Compound Competencies for 2030: competencies that are inclusive of knowledge, skills, attitudes and values essential for individual, social and environmental wellbeing in 2030</p>		

14	Global competency	Global competency is the capacity to examine local, global and intercultural issues, to understand and appreciate the perspectives and world views of others, to engage in open, appropriate and effective interactions with people from different cultures, and to act for collective well-being.
15	Media literacy	Media literacy is defined as the ability to think critically and analyse what one reads in the media, including social media and news sites. This includes recognising “fake news” or the ability to distinguish what is true from what is not as well as to be able to assess, evaluate and reflect on the information that is given in order to make informed and ethical judgements about it.
16	Literacy for sustainable development	Literacy for sustainable development refers to the knowledge, skills, attitudes and values needed to promote sustainable development. To be literate in sustainable development requires understanding how social, economic and environmental systems interact and support life, recognising and appreciating different perspectives that influence sustainable development and participating in activities that support more sustainable ways of living.
17	Computational thinking/ programming/ coding	Computational thinking involves formulating problems and developing solutions that can be carried out by computer-based technologies. Programming and coding involve the development of knowledge, understanding and skills regarding the language, patterns, processes and systems needed to instruct/direct devices such as computers and robots.
18	Financial literacy	Financial literacy is the ability to apply financial knowledge and skills to real-life situations involving financial issues and decisions. It involves knowledge and understanding of financial concepts and risks, and the skills, motivation and confidence to apply such knowledge and understanding in order to make effective decisions across a range of financial contexts. Financial decisions are part of everyone’s lives at all ages, from spending pocket money, to entering the world of work, managing one’s own budget, purchasing goods, saving for future expenses, understanding credit and loan payments, and to retirement planning. Financial literacy helps individuals to navigate these decisions and strengthens their individual financial well-being as well as that of society as a whole as it promotes inclusive growth and more resilient financial systems and economies.

19	Entrepreneurship	Entrepreneurship is defined as the ability to add value. It involves evaluating situations, organising resources, creating and developing opportunities for adding value. This value might be a product, service, idea or a solution to address an issue or satisfy a need.
<p>Skills, Attitudes & Values for 2030- Constructs</p> <p>Particular skills, attitudes and values young people need to thrive and shape their world</p>		
20	Critical thinking	Critical Thinking is defined as questioning and evaluating ideas and solutions (OECD 2016). This definition embodies components of metacognition, social and emotional skills (reflection and evaluation within a cultural context), attitudes and values (moral judgment and integration with one's own goals and values), as well as a combination of many cognitive skills including experiencing, observing, analysing, conceptualising, synthesising, evaluating, reflecting, and communicating. Critical thinking is a higher order cognitive skill and includes inductive and deductive reasoning, making correct analyses, inferences, and evaluations.
21	Problem solving	Problem-solving is defined as "the process of finding solutions to difficult or complex issues" (Oxford Dictionary). Problem-solving can refer to an individual's capacity to engage in cognitive processing to understand and resolve situations where a method or solution is not immediately obvious (OECD, 2016). Problem-solving is multi-faceted and multi-dimensional and can include a variety of forms including "interpersonal problem-solving," "intra-personal problem-solving," and "social problem-solving" as well as solving problems across a variety of disciplines (e.g. mathematics, science).
22	Cooperation/ collaboration	Cooperation/ collaboration refers to the ability to work well as member of a group or team, being loyal to the group, doing one's share. Teamwork is a strong predictor of wellbeing and of a fulfilled and successful life. Collaboration skills are character traits and skills (rather than moral values or attitudes).
23	Self-regulation/ self-control	Self-regulation/ self-control is defined as the ability to delay gratification, control impulses and modulate emotional expression. Self-control is an umbrella construct that bridges concepts and measurements from different disciplines (e.g. impulsivity, conscientiousness, delay of gratification, inattention-hyperactivity, executive function, willpower, intertemporal choice).
24	Empathy	Empathy is the capacity to share, understand, and respond with care to others. People tend to have more empathy with others who are more similar (with regard to culture and living conditions) to themselves and with people with whom they are more frequently interacting. Empathy is a multi-faceted construct, e.g. it involves perspective taking (cognitive skills) as well as social and emotional skills.

25	Respect	Respect is the valuing of self and others and the environment we are all in, and giving due regard for the feelings, wishes, or rights of self and others as well as those surrounding us that may not express wishes (e.g. environment, animals). Respect is demonstrated through behaviour and communication which will vary based on cultural context. Respect for cultural diversity, for example, means valuing the many differences and similarities of others that may be present. Respect for nature involves environmental ethics.
26	Persistence/ resilience	Persistence/ resilience is the disposition required to maintain effort or interest in an activity in the face of difficulties encountered, the length of time or steps involved or when opposed by someone or something. The American Psychological Association defines resilience as the process of adapting well in the face of adversity, trauma, tragedy, threats or significant sources of stress — such as family and relationship problems, serious health problems or workplace and financial stressors. It means “bouncing back” from difficult experiences.
27	Trust	Trust is an attitude developed towards individuals and institutions/ organisations based on a belief in the reliability and integrity of actions taken or planned. Trust is formed when one is confident that the actions of others are primarily based on good intentions and ethical considerations rather than being specifically aimed to impact negatively on individuals or groups. Trust is a multi-dimensional construct which is formed when care, competence and openness are exhibited by individuals and institutions/organisations. The degree of personal and/ or societal wellness is closely related to the level of trust held within a community.
28	Learning to learn	Learning to learn or meta-learning is defined as the awareness and understanding of the phenomenon of learning itself, which enables students to take control of one’s own learning. Implicit in this definition is the learner’s perception of the learning context, which includes knowing what the expectations of the discipline are and, more narrowly, the demands of a given learning task 2. Learning to learn strategies aim to equip each student with the ability to reflect on her/his own learning; the skills required to understand, analyse and regulate her/his thinking, attitude and behaviours when engaged in learning; the ability to set goals for learning, to monitor progress, and to take steps and adjust to improve learning.

Mapping process

Participants were expected to follow the 5-step process set out below and fill in the Report at the conclusion of the CCM Main Study (see Table 3). The first four steps of the CCM process (shaded in blue) were to be undertaken by each of the participating countries/jurisdictions. Step 5 was to be undertaken by the OECD Secretariat.

Table 3. CCM Main Study Report Form: mapping process

STEP	TASKS
1. Mapping the curriculum against the learning area coding framework	<p>Use the Learning Area Coding Frameworks as the base of the mapping/ the starting point. Map the country/jurisdiction's curriculum for each of the seven learning areas/subjects against the Learning Area Coding Frameworks for the corresponding learning areas/subjects to confirm alignment of the content codes with the content in your jurisdiction's written curriculum.</p> <p>Please report when the country/jurisdiction's curriculum differs from the coding framework:</p> <p>If the country/ jurisdiction's curriculum has additional content not included in the Learning Area Coding Framework, please report it in question number 2 of the CCM Main Study Report Form.</p> <p>If a content item is included in a different learning area in the country/ jurisdiction's curriculum to where it appears in the Learning Area Coding Framework, please report it in the mapping grid by using the dropdown menu in Column D (and also G if the content item is included in more than one learning area). If it is included in a learning area other than the ones targeted in the CCM exercise, please report it in the CCM Main Study Report Form.</p> <p>If a content item is not included in any learning area in your country/ jurisdiction's curriculum, please report it in the mapping grid by selecting "n.a." (not applicable) for all competencies.</p>
2. Identifying competencies within content items and assigning levels	<p>For each learning area, refer to the country/jurisdiction's curriculum and the Competencies Framework to indicate in the Mapping Grid whether each competency is present (or not) within each content item.</p> <p>For all those competencies that are present in a content item, mark each origin (the technical term for the box where x and y co-ordinates meet across the grid) with the relevant level from the 4 Level CCM Key (1, 2, 3 or 4) presented in Attachment 1 and Attachment 2.</p> <p>*As mentioned in step 1, a "not applicable" choice is also available in the dropdown menu to indicate that a particular content area is not included in your country/jurisdiction's curriculum.</p> <p>*Definitional mismatch: If you think some competencies have different definitions in your country's/ jurisdiction's curriculum from the definitions provided in the competencies framework please report on that in question number 3 of the CCM Main Study Report Form.</p>
3. Building the heat map	<p>Using the Mapping Grid completed for each learning area as the reference document determine the Levels (one of four shades of blue corresponding to the 4 levels or "n.a." as indicated above) and produce a "heat map" for each learning area illustrating the degree to which each competency is identifiable against each branch/strand or subject area</p>
4. Completing the CCM Main Study Report	<p>Countries/jurisdictions then completed the CCM Main Study Report Form with attached "heat maps" and forward them to the OECD Secretariat.</p>
5. Producing aggregated measures	<p>After receiving the submitted "heat maps" for each learning area aggregated measures illustrating the degree (in Levels) to which each competency is identifiable in and across the learning areas for each country/ jurisdiction were produced. This was then discussed (amended if required) and confirmed and validated by the relevant country/jurisdiction.</p>

Recommendations related to the mapping process in order to maximise inter-rater reliability

In order to maximise inter-rater reliability in and across countries when undertaking content mapping main study participants were requested to follow the recommendations described below.

Coding – to ensure intra-rater reliability

Coding experts who conducted the main study have read and understood the intentions and directions being proposed in the OECD Learning Compass for 2030 – refer to the position paper *The Future of Education and Skills: Education 2030*. They should also read the *General Information about Content Curriculum Mapping*. This is important as it provides the context for the CCM within the overall development and background of the E2030 project, the OECD Learning Compass, the CCM exercise, etc. and minimises the possibility that experts might interpret the task from personal or subjective perspectives.

Coding experts are already very familiar with the content of the country's/jurisdiction's curriculum in the relevant learning area – this avoids any need for the experts to familiarise themselves with the country's/jurisdiction's curriculum content.

More than a single expert for each learning area/ subject area undertakes the mapping of content and determines the rating of the content items, if possible as a team, for each of the country's/ jurisdiction's learning area curricula – this is important as it is a further mechanism for reducing subjectivity.

Discussion takes place between all involved in the mapping process regarding the definitions for the 28 concepts/competencies/constructs being mapped against your country's/ jurisdiction's curriculum content. This is an important part of the process as it enables all experts and those overseeing/managing the process to better understand how each concept/competency/construct would be identifiable within each and across the seven learning areas.

An individual with general curriculum responsibility at a suggested senior level is responsible for overseeing the process and ensuring each expert undertakes the process in the consistent way agreed to the CCM process, and for providing a further independent assessment of what has been mapped and determined by the relevant learning area/ subject matter experts.

To ensure accuracy and validity of data interpretation and reporting

Those coding experts involved in the mapping process are encouraged to contribute, as appropriate, to the development of the country's/jurisdiction's report on the CCM process to ensure that misalignments and exclusions of content are noted and other relevant alternative curriculum policy documents are referred to in the formal report submitted with the completed grid maps.

Detailed description and examples for the interpretation of the rating scale

In order to maximise the comparability of data across countries, detailed examples for each level in the rating scale were developed and included in the guidelines for Main study participants (Figure 3).

Given the diversity of documents that compose the written curriculum in different countries, a table linking types of documents with different levels of the rating scale was also developed to support main study participants (Figure 4).

Figure 3. Rating scale for CCM mapping exercise

Level	Category	Criteria	Examples
1	Not targeted in the curriculum content item.	The competency is not included in the written curriculum of this learning area/subject area and it is unlikely that teachers would include this as part of their own teaching.	<ul style="list-style-type: none"> Where a country/jurisdiction might have guidelines for teachers about teaching the selected competencies but the guidelines are <i>non-mandatory</i> and the majority of teachers are not using the guidelines
2	Not targeted in the subject-specific curriculum content item, but there are some opportunities for teachers to include this when teaching this content	The competency is not explicitly included in the written curriculum of a specific learning area/subject area, however, there is sufficient scope in the content for teachers to include the competency if they choose to do so. Please use this option only if such teaching opportunities are explicitly referenced in mandatory/recommended textbooks or other curriculum-related policy documents ² .	<ul style="list-style-type: none"> Where a country/jurisdiction might have the selected competencies embedded in the general goals (for any grades) in the curriculum, but <i>not</i> targeted for specific learning area/ subject area When a country/ jurisdiction might have the selected competencies embedded in the goals for specific grades in the curriculum, but <i>not</i> targeted for specific learning area/ subject area Where a country/jurisdiction have mandatory guidelines about teaching the selected competencies but <i>not</i> for specific learning area/ subject area Where a country/ jurisdiction have textbooks recommended by authority and the majority of teachers use these textbooks but <i>not</i> for specific learning area/ subject area Where a country/ jurisdiction have general guidelines, not mandatory but recommended by authority, and the majority of teachers follow the guidelines but <i>not</i> for specific learning area/ subject area
3	Targeted in the subject-specific curriculum content item, but not clearly articulated (e.g. sub-target)	The competency is included in the written curriculum but only as a sub-target or the selected competencies are not clearly articulated in the curriculum.	<ul style="list-style-type: none"> In a country/ jurisdiction that makes a distinction between main and sub-target in their subject-specific goals of the curriculum, the selected competencies are embedded in the curriculum as the sub-target of the curriculum content item In a country/ jurisdiction that <i>does not</i> make a distinction between main and sub-target goals in the curriculum, the selected competencies are not clearly articulated or only part of the definitions given in the coding competency framework are captured in the selected content item in the learning area In a country/jurisdiction that has mandatory guidelines about teaching the selected competencies/ textbooks recommended by authority, the selected competencies are articulated in their subject-specific goals of these guidelines even if they are not in the main curriculum document itself
4	Targeted in the subject-specific curriculum content item and clearly articulated (e.g. main target)	The competency is included in the written curriculum as the main target or the selected competencies are clearly articulated in the curriculum.	<ul style="list-style-type: none"> In a country/ jurisdiction that makes a distinction between main and sub-target in their subject-specific goals of the curriculum, the selected competencies are embedded as the main-target of the curriculum content item In a country/ jurisdiction that <i>does not</i> make a distinction between main and sub-target goals in the curriculum, the selected competencies are clearly articulated or a significant proportion of the definitions given in the competencies framework is captured in the selected content item in the learning area
n/a	Not applicable	This particular area is not included in your	

Figure 4. Rating scale for a typology of curriculum documents

Status of the document		Legislated curriculum	Other documents (mandatory guidelines or recommended by the authority)	Other documents (not mandatory and not recommended by the authority)	
Specificity	General goals/not subject-specific	2	2	1	
	Subject-specific	Sub-target	3		3
		Main target	4		

Technical note on processing and interpreting CCM data

Definition of terms used in this section:

In processing and interpreting country coded responses, the term “**subject**” is used to refer to “**learning areas**”. The term “**content items**” is used to refer to “**curriculum content items**”.

The expression “content items in the **overall mapped curriculum**” refers to content items *mapped across the seven CCM learning areas* rather than a country’s complete curriculum. This is an important distinction. Given the pioneering nature of this international curriculum analysis exercise, tools that allow for comparability of content across countries within given learning areas had to be developed. To this end, content learning frameworks for each learning area were developed with the input of curriculum experts in participating countries. Within a given learning area, content items that are typical across countries’ curricula at the lower secondary level were selected for the mapping exercise. As a result, a given country/jurisdiction’s curriculum may include a number of content items that were not mapped in CCM.

Alternatively, some CCM content items may not be present in a particular country’s/jurisdiction’s curriculum. For instance, the content item included in the Physical/health education learning framework “knowledge about stress management” is not present in the Netherlands’ proposed curriculum. Misalignments and exclusions reported by participating countries and jurisdictions were taken into account in the analysis of the mapping results.

Measures presented in the CCM analysis:

$$\begin{aligned} & \text{Proportion of curricula content items targeting a competency (as main target) in the overall mapped curriculum} \\ & = \frac{\text{Number of content items rated as 4 for this competency in the overall mapped curriculum}}{\text{Number of applicable content items in the overall mapped curriculum}} \end{aligned}$$

$$\begin{aligned} & \text{Proportion of curricula content items targeting a competency (as main or sub target) in the mapped curriculum} \\ & = \frac{\text{Number of content items rated as 3 or 4 for this competency in the overall mapped curriculum}}{\text{Number of applicable content items in the overall mapped curriculum}} \end{aligned}$$

Note: The two formulas above present calculations for the overall mapped curriculum, but the same calculation was made by learning area.

$$\begin{aligned} & \text{Distribution of content items in the mapped curricula targeting a competency (as main target), by learning area} \\ & \text{Percentage of content items targeting a competency (as main target) from Learning Area X (For each learning area)} \\ & = \frac{\text{Number of items rated as 4 in Learning Area X}}{\text{Number of items rated as 4 in the overall mapped curriculum}} \end{aligned}$$

Distribution of content items in the mapped curricula targeting a competency (as main or sub target), by learning area

$$\begin{aligned} & \text{Percentage of content items targeting a competency (as main or sub target) from Learning Area X (For each learning area)} \\ & = \frac{\text{Number of items rated as 3 or 4 in Learning Area X}}{\text{Number of items rated as 3 or 4 in the overall mapped curriculum}} \end{aligned}$$

Distribution of content items in the mapped curricula targeting a competency (as main target), by strand. For each strand s within Learning Area X:

$$\text{Percentage of content items targeting a competency (as main target) from strand } s = \frac{\text{Number of items rated as 4 in strand } s}{\text{Number of items rated as 4 in Learning Area X}}$$

Distribution of content items in the mapped curricula targeting a competency (as main or sub target), by strand. For each strand s within Learning Area X:

Percentage of content items targeting a competency (as main or sub target) from Learning Area X

$$= \frac{\text{Number of items rated as 3 or 4 in strand } s}{\text{Number of items rated as 3 or 4 in Learning Area X}}$$

Self-reflection and insights from E2030 CCM participating countries and jurisdictions

Countries and jurisdictions that participated in the CCM exercise had various opportunities for:

- reflecting on their own curriculum (e.g. consistency between goals and actual curriculum);
- gaining new perspectives with respect to their existing curriculum design (e.g. examine to what extent some future-oriented competencies are actually articulated within and across learning areas);
- deriving insights for future curriculum development (e.g. how to design a curriculum that integrates content and competencies and how to build in opportunities for interdisciplinarity);
- learning from other countries/jurisdictions different ways to incorporate future-oriented competencies in their curricula.

This appendix includes the self-reflection and insights reported by these countries and jurisdictions when answering the question: “What benefits/learning did you acquire from the CCM exercise?”

Australia

National Language (English)

The opportunity to consider the breadth of AC: English in terms of its facility to incorporate competencies – examining the curriculum through this lens confirmed that so much of the success or value of a curriculum is dependent on the way it is interpreted and implemented at the school level.

Mathematics

It provided an opportunity to place a lens over the curriculum content and discover how implementation decisions can have a dramatic impact on how students learn and teachers address the curriculum content, especially when Content Descriptions do not explicitly lend themselves to the targeting of competencies. Although best practice might mean teachers are providing opportunity for students to develop competencies through the learning of mathematics, the implementation may not support this when it is not explicitly stated within either the Content or the Standards.

Physical education/ Health

Time to reflect deeply on the structure of the AC: HPE – notably looking deeply into the words and phrases in the Content Descriptions and Achievement Standards. It highlighted some of the challenges the broad Content Descriptions may pose for some educators and the role the non-mandatory elaborations may have in supporting teaching decisions. We questioned whether teachers may be relying upon the elaborations to unpack the Standards and Content Descriptions. This also raised many questions about how teachers currently implement the broad Content Descriptions while fostering the propositions of the AC: HPE and intentions of the AC: HPE focus areas. It may appear in some Content Descriptions, if the elaborations are not viewed, that content is absent. However when cross-checking all focus areas and elaborations, the content was easily accessible. Once again, we questioned if teachers had the time to come to these conclusions and if not, what was potentially being missed in the implementation of the AC: HPE. This aligned with many enquiries we receive from the community in relation to focus areas and elaborations.

The Arts

Identifying that this mapping reveals many opportunities for arts educators to embed the development of competencies within arts learning, and recognising the current situations where the competence and the curriculum actually align in content and intent was a beneficial reminder of how the goals of Arts curriculum relate to Arts practice (through making and reflection) rather than using the Arts as vehicle to develop/teach the Capabilities.

Humanities

Greater insight into the nature of the Australian Curriculum, and potential differences associated with what is assumed within the Content Descriptions and what is indicated by the actual wording. For example, the lack of specific articulation of collaboration/teamwork throughout the HASS learning areas was noted yet this is a central competency associated with teaching and learning in the humanities. Also the differences in mapping which occurred between 'forward-looking' learning areas (that is, Geography, Economics and Business, Civics and Citizenship) and 'backward-focused' learning areas (that is, History). It was easier to identify the articulation of the competencies (which are all written with a future focus) in the former than in the latter.

Science

It provided an opportunity to discuss with other learning area specialists their interpretation of the AC and to reflect on and develop a deeper insight into the intent of the written curriculum. Specifically, it made us reflect on the way Cooperation/Collaboration is addressed in the AC: Science and prompted us to think more deeply on the notion of Trust as it applies to the Science learning area. It was also interesting to compare interpretations regarding the targeted competencies across learning areas, especially for closely related curriculum content, such as the inquiry skills strands of HASS and Science.

Technologies/ home economics

It provided an opportunity to interrogate the AC and to think deeply about the intent of the written curriculum. It highlighted the strengths of the curriculum and areas for improvement. The targeted activity provided an opportunity for rich and thoughtful discussion. Very useful professional learning.

British Columbia (Canada)

The CCM exercise has reinforced Canada BC's understanding of the importance of clearly defining the Core Competencies and working to embed them across all areas of learning. This ensures that each area of learning is working toward the same end – developing competent, educated citizens. Working through a mapping activity with a team helps to ensure a shared understanding of the competencies embedded within the curriculum. The map helped the BC experts see at a glance what is emphasised and where there are gaps. They realised that BC may wish to include a similar activity into their curriculum revision cycles focusing on our Core Competencies.

They discovered that taking part in the mapping activity reinforced what was already known about the new curriculum: the emphasis of BC's curriculum is on competency development rather than content. But what also came to light was how particular content can support the development of competency. E.g. "traditional and contemporary Aboriginal worldviews and cross-cultural perspectives communicated through the arts" – supports the development of respect, empathy, global competency, etc. Professional development activities that ask teachers identify where the competencies are embedded in the curriculum would support implementation because the act of identifying the Core Competencies deepens one's understanding of the structure and purpose of the new curriculum. The act of digging into the curriculum to mine the OECD

competencies was a useful exercise in that it broadened BC's view of the competencies addressed with the new curriculum. It is clear that they are teaching beyond the B.C. Core Competencies. In terms of science curriculum, the exercise has revealed that foundational literacies and some of the other skills defined by OECD have great weight in the BC Curriculum. This was an expected result. Those skills that do not have heavily explicit representations within the BC Curriculum might be focused on during upcoming revisions of the curriculum.

Saskatchewan (Canada)

Participation in the CCM Main Study exercise reaffirms that Saskatchewan curricula reflect important global learnings. It brings attention to the foundations of SK curricula is just as important as content, outcomes and indicators.

Ontario (pilot phase)(Canada)

The CCM pilot exercise was a good learning experience as it provided an opportunity for Ontario's curriculum team to review their existing curriculum, especially the consistencies between Ontario's intended curriculum, taught curriculum and learnt curriculum. The heat map highlighted valuable insights for Ontario's current curriculum reforms, it showed that the present curriculum included a larger number of competencies compared to previous curriculum prior to their reform.

The exercise also revealed that the scope of certain competencies covered in the current curriculum were relatively narrow. This helped provide Ontario with a direction on how teachers can influence the monitoring of the development of competencies in curriculum.

The CCM pilot exercise highlighted the importance of "big idea" and disciplinary thinking in curriculum design, an example of this is the focus on STEM subjects. In their new curriculum design process, the CCM mapping grids helped Ontario visualise the fact that the degree of relevance of different competencies varies from subject to subject. Ontario expressed their appreciation of how the CCM pilot exercise had helped them plan ahead for various curriculum activities.

China

The Deputy Director of the National Institute of Curriculum and Textbook Research and the National Centre for School Curriculum and Textbook Development, Ministry of Education of China, shared that it was their first time to conduct such a systematic and comprehensive international comparative study on curriculum. She shared that their biggest challenge was to how accurately understand the framework provided by OECD and how to reflect the actual situation of Chinese curriculum in China. She also shared that they had gained valuable lessons from their participation in the CCM activity. She elaborated that China, as a fast-growing developing country, they were concerned about what kind of students to develop and how to equip them to face the uncertain and complex challenges in the future and the participation in the CMM had given them a wider perspective and deeper understanding. She added that it also allowed them to deeply reflect on their curriculum to identify its strengths and areas of improvement such as the development of transformative competencies and compound competencies in their curriculum goals as well as how to reflect interdisciplinary knowledge in the curriculum content. She also shared their participation had broadened the view of their professional team which would better prepare them to carry out the curriculum reform in China. She highlighted that China would be renewing the curriculum for primary schools and secondary schools and their participation had provided them with frontier research findings towards the future which would be crucial for them to review, reflect and improve their curriculum for the future. She also highlighted that CCM provided a co-sharing, co-creating and co-benefitting platform for countries / jurisdiction to share and learn from one another.

Overall benefits from CCM exercise: First, it deepens our understanding of international education development (1) In terms of the philosophy, first, we can fully understand the trend of the development competency-oriented curriculum. The Education 2030 learning framework sets out the basic capabilities that young people should possess to survive and develop in the future; these include such as, global competency, media literacy, and financial literacy, etc., which as known as “integrated ability”. This goes beyond the boundaries of the traditional disciplines. Second, the design of the CCM analysis has deepened our understanding that “the learning of knowledge and the cultivation of abilities, attitudes and values should not be desegregated.” (2) In terms of content, first, the CCM analysis focuses our attention on the integration of subject content based on core competencies. Second, cross-disciplinary knowledge such as “moral and ethical issues”, “sustainable development and international understanding, cooperation and peace education”, and “global citizenship”, as well as cognitive knowledge like “thinking like (artists, scientists, etc.)” all point to the importance of interdisciplinary learning. All of these are all important issues worth our attention.

Second, we learn a useful way to compare curriculum. Based on the learning and research framework provided by OECD, we analysed the content of Chinese curriculum documents, the competency required and the interrelations between them, and we also drew the heat maps. This is an international comparison research method based on a common standard, which definitely exemplifies a feasible way for curriculum comparison

Curriculum design principles: First, we have changed our emphasis from knowledge-based to competence-based, and we focused more on the comprehensive development of people. For example, the History experts propose to avoid designing courses from the perspective of the discipline alone, and we should rather base on developing student competencies in selecting the most important content for the subject.

Secondly, we focus more on the top level structural design of the course. (1) To overall plan the subject learning discipline and curriculum, and clearly understand their individual need to cultivate and integrate the competencies. (2) Based on core educational value of the discipline and subject, integrate the curriculum contents with the discipline's "big ideas." (3) On this basis, to further combine competency development with the “big ideas”.

In terms of the relations between contents and competencies, we need to enhance the connection between competencies and subject contents/learning areas, to provide practical methods by setting up the environment, activities and missions. It is also noted that a certain competency may show up in different forms and in different extents when applied to different subjects/learning areas. We will take more care in future curriculum revision, in order to support our teaching and evaluation design.

Self-reflection tool/what changes to current approach: Through the CCM analysis, we will make full use of the system of core competencies development, the organic integration of contents, and the relations between core competencies and contents, so as to improve and enhance the design of curriculum revision in the future.

First, in terms of the competencies, the CCM competency framework provides a clear definition of each competency for our reference. We also pay more attention to the special contribution of each discipline to the development of 28 students' competencies. It focuses on the development of interdisciplinary and composite skills, such as global competence, media literacy, computational thinking / programming / coding, financial literacy and entrepreneurship. Besides, we identify subject/discipline that requires further strengthening of competencies, such as the need to add the requirements on Empathy, Trust, Global Competencies, Media Literacy, etc. on the Physical Education standards.

Second, we will enrich the subject content. Thus, for example, the Chemistry experts believe that in the future, Chemistry curriculum have to enhance the safe use of chemicals, investigative activities, thinking like scientists, ethics in chemistry, global citizenship, etc., and the thinking and research on these contents. Physical education experts suggest that the traditional curriculum concentrates too much on knowledge

related to the subject, and pays insufficient attention to “relation between human and the nature”, “human sexuality and reproduction”, “the ethical and moral issues arisen from person behavior and how it affect other people”.

Effective implementation: First, we should insist on the direction of our correct belief. Curriculum revision and implementation should be based on the own national practical environment and the international reform trends. The curriculum design and development should highlight future-oriented citizen development and is implemented with an evidence-and-competency based orientation.

Second, to choose adequate contents for students' learning, OECD Education 2030 project “What we want” has collected students' ideas worldwide. It is worthwhile to design the curriculum taking note of students' perspective.

Third, we should clarify the course contents to match the competency requirements. The course document not only specifies the overall objectives, but also sets clear objectives for specific content, concepts or thoughts. We should develop practical and feasible academic quality standards, in order to help teacher focus on developing students' competency/literacy effectively.

Fourth, we should focus on and to innovate the curriculum transformation methods. The CCM study helps us reconsider the core content of subject, interpret clearly the connotation and training methods related to competencies, study more deeply the key steps required in developing competency, and achieve the goals related to appropriate situations, activities and tasks.

Unexpected results: First, we will consider adequately the interdisciplinary competencies proposed by OECD; strengthen research on this in China, so as to improve in the future curriculum revision.

Second, we will strengthen the integration of curriculum contents based on key concepts, rethink and focus on systematic design of interdisciplinary content and cognitive knowledge, rather than just adding or removing of knowledge points.

Third, we should focus on the link between competence/literacy development and contents, and to improve and enhance the style and quality of the curriculum demanded transformations.

In general, we have seen the strengths and weaknesses of in our analyses of the Chinese basic education curriculum reform from an international perspective. It provides a practical guidance and direction for curriculum revision so as to enhance student development.

Second, after comparing the core concepts and competency requirements of subjects/learning areas, we got an overall judgment of Chinese compulsory education objectives and the requirements for student development in the future. This forms an important basis for future curriculum revision.

Third, this study helps us reconsider the implementation of curriculum and remind us how to enhance the process of curriculum planning and design from different perspectives, such as ways to combine content learning with competency/literacy development, and how to transform our curriculum better, etc.

Fourth, this study provides new research ideas for international curriculum comparison.

We conducted the CCM project with clear top-level design with a strong result-orientated approach, using appropriate analytical tools, and in a friendly research atmosphere. All of our experts adhered to a rigorous attitude in advancing the work. Therefore, the whole process is tough yet stills a journey of study full of happiness.

Estonia

Shared that it was useful for the Estonian national Ministry and Institute to participate in the CCM exercise, as the country is currently undergoing curriculum renewal. Estonia highlighted that they would like to

incorporate the competencies for 2030 and that they were motivated to implement these competencies. They have learnt about planning for implementation of the National curriculum the description and the importance of Transformative Competencies and Competency Development for 2030 (considered essential for transforming society for a better future). Based on the CCM exercise, they have realised that most of the agreed competences are already incorporated in Estonia's National Curriculum. They have realised that in future curriculum development process more emphasis should be placed on some subject areas competences. They have learnt about planning for implementation of the National curriculum the description and the importance of Transformative Competencies and Competency Development for 2030 (considered essential for transforming society for a better future). The exercise is a good challenge to develop national curricula.

Ireland

Ireland stated that the CCM Main Study exercise allowed them to reflect on their current curriculum, on its structure, breadth, balance and interconnectedness. The exercise enabled them to reflect on how to further develop an effective curriculum should the need arise. The starting point would be to establish desired outcomes and agree competencies required for future life and work. This was the approach taken to the revision of the current curriculum which was introduced in 2007. Effective implementation: curriculum monitoring (more details needed here). They found the exercise useful and in the event of any future curriculum revision or review we would be able to use the framework to scaffold our thinking and to conduct a thorough analysis of how improvement could be achieved.

Israel

The CCM exercise provided Israel with a useful self-reflective and analytical tool to examine their current curricula, as well as the curriculum content that are under development.

The exercise has helped them identify competencies that are not sufficiently explicit in their curriculum and the need of being more explicit. The Israeli curricula has a unique set of competencies, and the exercise helped them realise the potential need to redefine the sets of high-order thinking competencies. Israel is considering to include additional content, including activities that represent different competencies and skills into their curricula, they stated that this will be helpful for the teachers.

Japan

Japan ensured coherence across subjects by participating in the CCM exercise. Japan highlighted that it was important to contextualise the CCM framework within Japan's education system such as definitions of competencies (e.g. "global competency" and "co-agency") and provide instructions regarding general rules and common stipulations across subjects. Japan shared that they had revised their national curriculum standards in 2017, 2018 and one of the emphasis was on solving problems. Japan shared that they had selected some processes in solving problems to be included in the curriculum guidelines. Japan explained that one of the processes was to find the problem and find solution to the problem using the AAR cycle. Japan shared that this concept of problem solving was embedded in all subjects. Japan also added that solving social problems would be creating new values in society.

Korea

National language

It shows a direction of future education.

Mathematics

We could learn how to construct theme-based curriculum by using the general description, where relevant.

Physical education/ Health

The experts involved in this project were able to capture issues that could be used in revising or designing the next curriculum (e.g., what kinds of competencies supposed to be included in primary or secondary school curricula).

Music

By linking the contents of each music with competencies, we were able to examine which contents are more specifically related to which competencies.

Visual Arts

We learned about what competencies can be considered when designing national visual art curriculum.

Humanities/ Social studies

We can have an opportunity to review the structure and emphasis of our subject curriculum more thoroughly.

Technologies/ Home economics

1. It was very nice to have a chance to think about the competencies that students should possess in the near future of 2030.
2. If we can get a final report from the OECD countries, we could get benefits of identifying trends and issues of international education. Also, we can get good and advanced ideas about curriculum design and implementation.

Lithuania

The CCM exercise provided Lithuania with a meaningful opportunity for self-reflection towards embedding the E2030 competencies in their future curriculum.

Russia (field trial)

The CCM exercise allowed Russia to reflect on their current curriculum, highlight priorities in the curriculum and reflect on the inconsistencies within the same subjects. The exercise allowed them to learn from the experience of other field trial participating countries. Russia pointed out that there were challenges during the mapping process, as the analysis was based on written curriculum, and there exists gaps between written and taught curriculum. This could potentially affect the outcome and presentation of analysis.

Sweden

For Sweden, the CCM exercise has brought along fruitful discussions about competencies related to learning areas. The discussion about the distribution of competencies within the Swedish curriculum has been a benefit for their experts. Insights regarding curriculum design principles have been related to where competencies best be placed and relevant questions have been raised. The exercise could change the Swedish current approach of curriculum design in a long-term perspective

4. Mathematics Curriculum Document Analysis (MCDA)

What is the Mathematics Curriculum Document Analysis (MCDA)?

The Mathematics Curriculum Document Analysis (MCDA) project investigates the extent to which countries have incorporated 21st century skills in their current mathematics curriculum. Because of the increasing centrality of the role that mathematical and statistical thinking plays in our lives, mathematics is considered as a highly-relevant subject for the future of education, requiring deeper analysis, and has been chosen as one of the E2030 project's subject-specific analyses as per the request of participating countries. MCDA sets out to answer the question: *What will count as basic quantitative literacy for all 21st century students?*

Participating countries identify one or more mathematics experts to take part in a weeklong workshop on coding relevant and desired mathematics curriculum documents, including curriculum guides and textbook materials, making use of the *21st Century Mathematics Framework* developed for MCDA in conjunction with PISA 2021. Benefits for participating countries include: 1) learning the extent to which the PISA 2021 concept of mathematics literacy is represented in one's current mathematics curriculum; 2) comparing one's own mathematics curriculum to contemporary international benchmarks; 3) informing ongoing reform efforts towards a 21st century vision of mathematics education; and 4) creating a contemporaneous mathematics curriculum profile to provide a relevant interpretive context for one's PISA 2021 mathematics literacy performance. MCDA coding workshops were held in February, March, June and September 2019. An MCDA expert meeting is being held in October 2020 to discuss the results of the coding workshop and prepare a report on the findings, which will be published mid-2020.

Curriculum documents analysed

Two types of curriculum documents were analysed during the MCDA coding workshops: 1) the official mathematics curriculum standards (grades 1 – 9), and 2) at least one 8th grade mathematics textbook. These were coded over two five-day working sessions. The key phrase in the coding exercise was, low inference. Participants were asked to code only that which is *explicitly asked or stated*; not what could, would, or should be asked or otherwise “generally understood”.

Standards analysis

The framework, guiding both the work of MCDA and PISA 2021, includes a dimension for content and dimensions focusing on quantitative reasoning, 21st century skills, and the employment of real-world applications.

For each area of the MCDA conceptual framework, a scale was developed. The scale is bounded between 0 and 40 with the larger numbers indicating greater breadth and intensity in support of implementation. This enables us to determine which countries put the greatest amount of focus and energy toward realising

the goal of including various types of reasoning, various 21st century skills, and the degree to which there is support for including real-world applications.

The intensity scale was also developed for the individual skills and types of reasoning so as to determine which 21st century skills were more frequently called for and with greater support in terms of implementation as evidenced in textbooks.

Textbook analysis

The textbook analysis focused on the narrative sections if included, as well as the student exercises. These were analysed according to the MCDA content framework. This analysis produces a portrait of what 8th grade mathematics textbooks look like, especially with respect to the types of exercises students are expected to undertake.

Such a portrait in essence, defines the types of opportunities to learn students studying in those textbooks will receive. Previous studies indicate that the order and amount of emphasis (through the number of pages) of the textbook was found to predict very closely the amount of time teachers allocated to the various topics.

The scale developed for this purpose was based on the percentage of the total number of exercises that were of a certain type – the same three types as described in the curriculum standards including 21st century skills, quantitative reasoning, and the inclusion of real-world applications.

Relationship between content standards and textbooks

One of the key policy issues confronting school systems is the degree to which the policy directives, as found in the curriculum standards, are correlated with the instructional materials provided to the teachers. MCDA will help countries determine whether the textbooks analysed match, in a relative sense, the intensity their standards suggest.

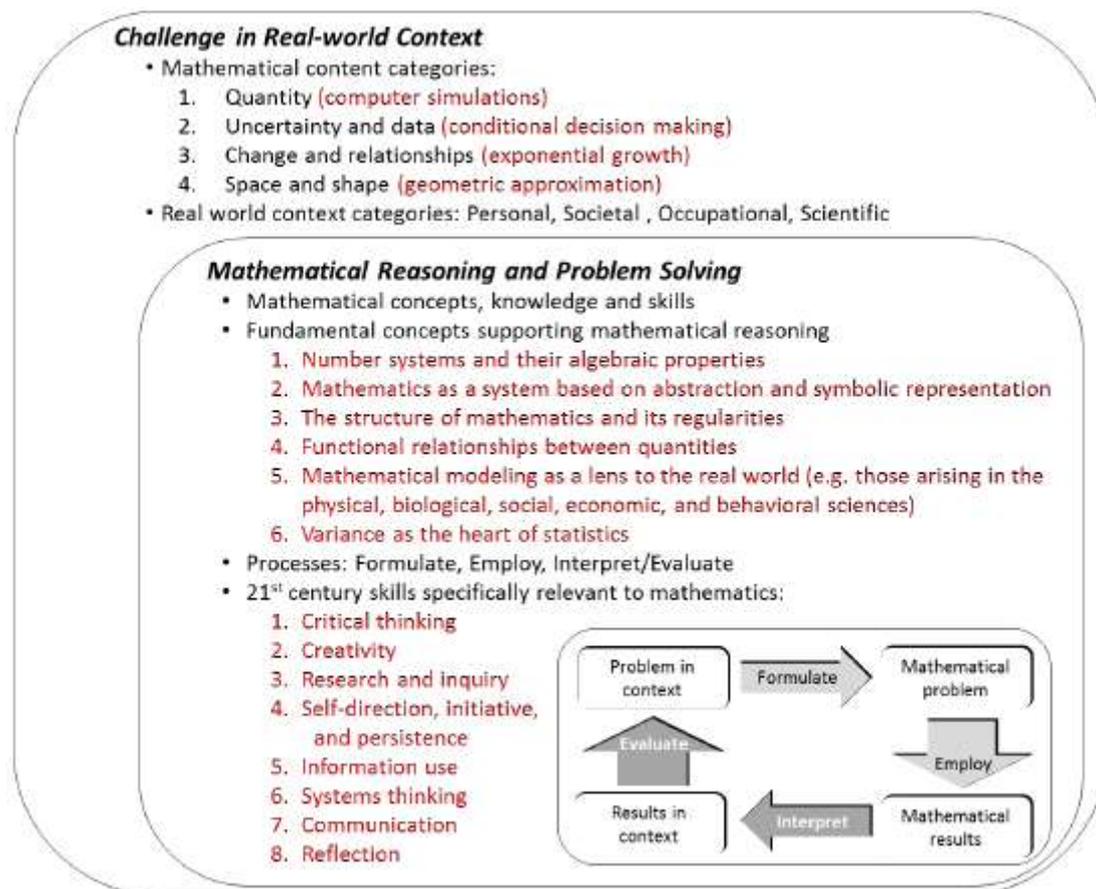
MCDA conceptual framework

The MCDA conceptual framework not only includes a dimension for content but also includes dimensions focusing on quantitative reasoning, 21st century skills, and the employment of real-world applications:

1. Mathematics content
 - a. Comprehensive and exhaustive
2. Fundamental mathematics concepts
3. Math-relevant 21st century skills
4. Quantitative reasoning
 - a. Mathematic
 - b. Algorithmic
 - c. Geometric
 - d. Statistic
5. Higher order applications
 - a. In the real world
 - b. In the world of mathematics

The MCDA conceptual framework is designed to be compatible with the PISA 2021 Mathematics Literacy Model and is designed specifically for the 2021 Model.

Figure 5. PISA 2021 Model of Mathematics Literacy: A new kind of assessment



Note: The mathematical content category topics listed in parentheses are subtopics from each of the content categories that should receive greater emphasis given their relevance to important societal issues and the nature of the new economy.

Source: Adapted from the PISA 2021 Mathematics Framework, <https://pisa2021-maths.oecd.org/>.

MCDA content framework

MCDA participants coded their mathematics curriculum standards for grades 1-9 and selected mathematics textbook(s) according to the MCDA content framework.

Table 4. MCDA content framework

Quantity	
Number	1 Whole Number
	1.1.1 Meaning (place value, ordering, comparison)
	1.1.2 Operations (meaning and computations)
	1.1.3 Properties of Operations (order of operation, relationship among operations)
	1 Fractions & Decimals
	1.2.1 Common Fractions
1.2.2 Decimal Fractions & Percentages	

	1.2.3	Properties and Relationships of Common & Decimal Fractions
	1	Number Sense & Estimation
	1.3.1	Measurement Units, Estimation, & Errors
	1.3.2	Rounding & Significant Figures
	1.3.3	Estimating Computations
	1.3.4	Orders of Magnitude (scientific notation)
Systems	2	Number Systems
	2.1.1	Integers, Negative Numbers & Their Properties
	2.1.2	Rational Numbers & Their Properties
	2.1.3	Real Numbers, Their Subsets & Properties
	2.1.4	Complex Numbers
	2	Other Number Concepts
	2.2.1	Simple Number Patterns and Sequences
	2.2.2	Binary Arithmetic &/or Other Number Bases
	2.2.3	Exponents, Roots, and Radicals
	2.2.4	Combinatorics (permutations and combinations)
	2.2.5	Computational Thinking: Algorithmic Mathematics & Computer Simulations
	2.2.6	Computer Coding (including both formal and informal (pseudocode) syntax)
Space and Shape		
Position	3	Position, Visualization & Shape
	3.1.1	2-D Geometry: Basics (points, lines, segments, rays, angles)
	3.1.2	2-D Geometry: Polygons & Circles (formulas, properties, perimeter, area)
	3.1.3	3-D Geometry (shapes, volume, surfaces, cross-sections)
	3.1.4	Coordinate Geometry (Analytical Geometry)
	3.1.5	Trigonometry of Right-Angled Triangles including the Pythagorean Theorem
	3.1.6	Vectors and Matrices
	3.1.7	Geometric approximation for irregular shapes
Symmetry	4	Symmetry, Congruence & Similarity
	4.1.1	Symmetry
	4.1.2	Transformations (including Geometric Patterns)
	4.1.3	Congruence & Similarity
Algebra	5	Algebra Foundations
	5.1.1	Rates and Ratios
	5.1.2	Proportionality
	5	Beginning Algebra
	5.2.1	Algebraic Sequences and Patterns
	5.2.2	Expressions
	5.2.3	Simple linear equations
	5.2.4	Slope and intercept
	5	Algebra
	5.3.1	Linear Equations and Inequalities
	5.3.2	Trigonometric equations and identities
	5.3.3	Other Equations and Inequalities (quadratics, polynomials, including factorization and expansion)
	5.3.4	Linear Functions
	5.3.5	Exponential Functions
	5.3.6	Other non-Linear Functions
5	Change	
5.4.1	Infinite Processes (e.g. Sequence, Series, Limits, and Convergence)	
5.4.2	Calculus and Analysis	
5.4.3	Linear, non-Linear, and Exponential for modeling growth and change	
Summaries	6	Descriptive Statistics
	6.1.1	Mean, mode, median, variance, etc.

	6.1.2	Displays of distributions
Probability	7	Probability Distributions
	7.1.1	Definition of discrete probability and related theorems
	7.1.2	Conditional probability and Independent Events
	7.1.3	Bayes Theorem
	7.1.4	Discrete and continuous random variables and their distributions
Inference	8	Statistical inference
	8.1.1	Populations and their parameters
	8.1.2	Sampling from the Population/Random Sampling
	8.1.3	Estimation of parameters (e.g., mean, variance)
	8.1.4	Sampling distributions (standard errors, bias)
	8.1.5	Confidence intervals
	8.1.6	Hypothesis testing
	8.1.7	Definition of Correlation Coefficient
	8.1.8	Relationship among categorical variables (Contingency Tables)
	8.1.9	Relationship involving continuous variables (Regression)
	8.1.10	Relationship involving categorical and continuous variables (ANOVA)
9	History of Mathematics as a Human Activity	
10	Other Content	

Fundamental mathematics concepts

The six fundamental concepts supporting mathematical reasoning include: (a) number systems and their algebraic properties, (b) mathematics as a system based on abstraction and symbolic representation, (c) the structure of mathematics and its regularities, (d) functional relationships between quantities, (e) mathematical modelling as a lens to the real world (e.g. those arising in the physical, biological, social, economic and behavioural sciences) and (f) variance as the heart of statistics.

Mathematics-related 21st-century skills

The PISA 2021 Mathematics Framework focuses on eight 21st century skills:

- Critical thinking
- Creativity
- Research and inquiry
- Self-direction, initiative, and persistence
- Information use
- Systems thinking
- Communication
- Reflection.

All of these skills, except research and inquiry, are coded in this project.

Quantitative reasoning

Quantitative reasoning which include mathematics, computational, geometric and statistic. It goes beyond solving problems in the traditional word problem sense in which all the relevant information is given and the student simply decides on the mathematics to be used. Higher order quantitative reasoning occurs in contexts in which the available information is not organised narrowly to address the issue but represents the messy and unorganised nature of the real world. The nature of such problems requires more analytical and conceptual thinking.

Higher order applications

Higher order applications – both in the real world and in the world of mathematics – are a focus for the MCDA study.

- **Higher order applications in the real world:** Problems presented in a realistic, authentic, real-world context that require more than identifying the mathematics needed to arrive at an acceptable solution. The problem needs to simulate the real-world in its messy, complex way requiring the student to conceptualise, organise, and extract the relevant information before formulating.
- **Higher order applications in the world of mathematics:** Problems are situated only within Mathematics (not the Real-World) but require the student to conceptualise, organise, extract the relevant information, and develop a logical approach before finding a solution. A good example is a proof in Geometry where it is necessary to determine the relevant information and construct a logical approach to solving the problem.

MCDA will provide information, such as the emphasis on higher order applications in textbooks, which content areas have more higher order real-world applications, and statistics on how countries would compare to one another on areas such as students' exposure such to higher order applications.

MCDA results

An MCDA expert meeting is being held in October 2020 to discuss the results of the coding workshop and prepare a report on the findings, which will be carefully validated with countries while considering the time necessary for the participating countries and jurisdictions to do so even during the challenging Covid19 pandemic context. To this end, the report is planned to be published in 2021, in close consultation with participating countries and jurisdictions.

The complete MCDA methodology, framework dimensions and definitions will be included in this report, along with an international comparative analysis of country-specific finding.

Another possible output of this study could be some prototypes depicting the characteristics of the experiences students should have to encourage the development of mathematical reasoning such as quantitative reasoning. These dimensions will be also discussed with the participating countries and jurisdictions to ensure the maximum impact of this report to inform decisions on mathematics curriculum reforms.