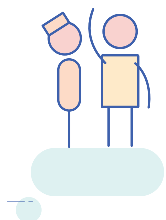
OECD Future of Education and Skills 2030

Conceptual learning framework

KNOWLEDGE FOR 2030



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IN BRIEF

KNOWLEDGE FOR 2030

As part of the OECD Learning Compass 2030, knowledge includes theoretical concepts and ideas as well as practical understanding based on the experience of having performed certain tasks. The OECD Future of Education and Skills 2030 project recognises four different types of knowledge: disciplinary, interdisciplinary, epistemic and procedural.

Knowledge and skills are both interconnected and mutually reinforcing. Researchers have emphasised the growing importance of being able to understand, interpret and apply knowledge and skills in various situations.

Over the past few decades, there has been growing emphasis on thinking of the world as made up of inter-related systems, rather than solely as a series of discrete units. Education systems around the world have been moving from defining subjects and required curriculum knowledge as collections of facts, towards understanding disciplines as inter-related systems.

Knowledge and skills are both interconnected and mutually reinforcing

KEY POINTS

- Disciplinary knowledge, or subject-specific knowledge, continues to be an essential foundation for understanding, and a structure through which students can develop other types of knowledge. The opportunity to acquire disciplinary knowledge is also fundamental to equity.
- Interdisciplinary knowledge can be integrated into curricula: by transferring key concepts, identifying connectedness, through thematic learning; by combining related subjects or creating a new subject; and by supporting project-based learning.
- Epistemic knowledge involves knowing how to think and act like a practitioner. It shows the relevance and purpose in students' learning and helps deepen their understanding.
- Procedural knowledge is the understanding of how a task is performed, and how to work and learn through structured processes. It is particularly useful for solving complex problems.

For the full concept note, click ***here***.

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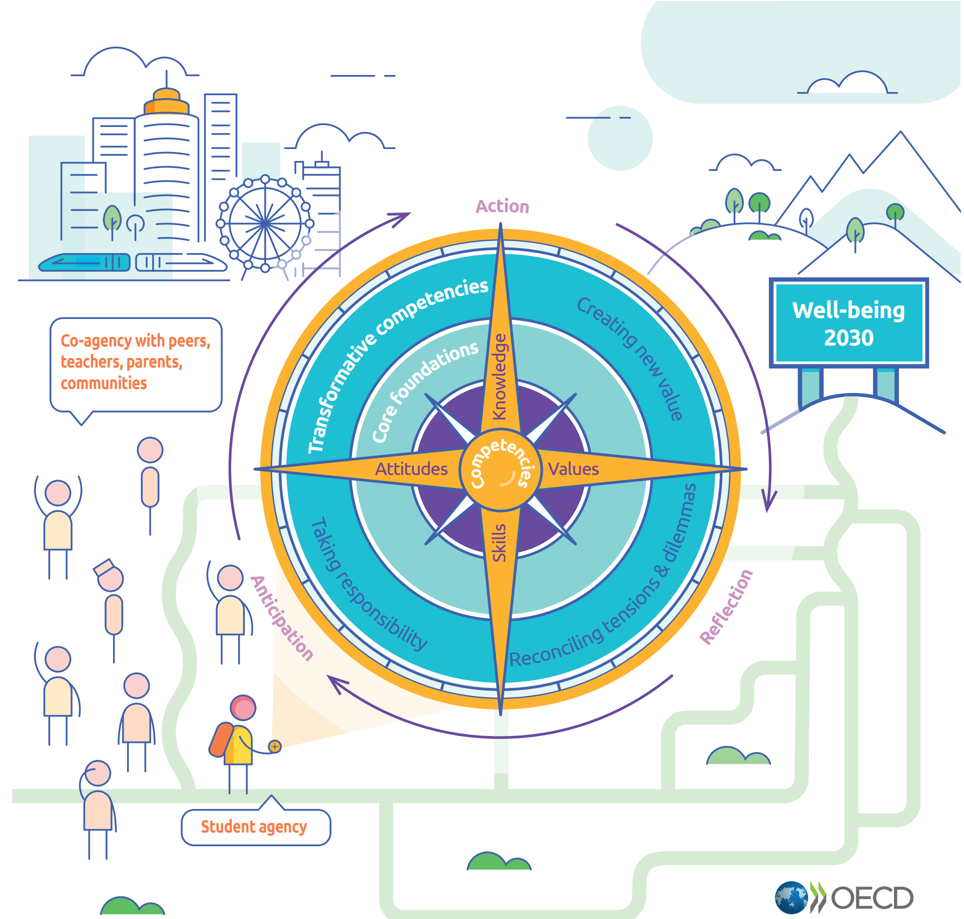
PROCEDURAL KNOWLEDGE

Procedural Knowledge, Australia, STEM
Source: *www.oecd.org/education/2030-project/learning/knowledge*

EPISTEMIC KNOWLEDGE

Epistemic Knowledge, Israel, Interdisciplinary learning
Source: *www.oecd.org/education/2030-project/learning/knowledge*

OECD LEARNING COMPASS 2030



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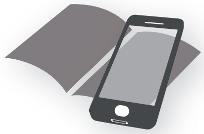

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Knowledge for 2030

Knowledge, a key component of the OECD Learning Compass, encompasses the established facts, concepts, ideas and theories about certain aspects of the world. Knowledge usually includes theoretical concepts and ideas as well as practical understanding based on the experience of having performed certain tasks. While there are many other definitions of knowledge, this one was tested and adopted by the international group of stakeholders involved in the OECD Future of Education and Skills 2030 project.

The OECD Learning Framework 2030, a product of the OECD Future of Education and Skills 2030 project, distinguishes four different types of knowledge: disciplinary, interdisciplinary, epistemic and procedural.

- **Disciplinary knowledge** includes subject-specific concepts and detailed content, such as that learned in the study of mathematics and language, for example.
- **Interdisciplinary knowledge** involves relating the concepts and content of one discipline/subject to the concepts and content of other disciplines/subjects.[1]
- **Epistemic knowledge** is the understanding of how expert practitioners of disciplines work and think. This knowledge helps students find the purpose of learning, understand the application of learning and extend their disciplinary knowledge.
- **Procedural knowledge** is the understanding of how something is done, the series of steps or actions taken to accomplish a goal. Some procedural knowledge is domain-specific, some is transferable across domains. The OECD Learning Compass 2030 highlights transferable procedural knowledge, which is knowledge that students can use across different contexts and situations to identify solutions to problems.

Knowledge, skills, attitudes and values are developed interdependently

The concept of competency implies more than just the acquisition of knowledge and skills; it involves the mobilisation of knowledge, skills, attitudes and values in a range of specific contexts to meet complex demands (see also the concept notes on Skills and on Attitudes and Values).

In practice, it is difficult to separate knowledge and skills; they develop together. As Klieme et al. (2004[1]) assert, "higher competency levels are characterised by the increasing proceduralisation of knowledge, so at higher levels, knowledge is converted to skills" (as cited in (Cedefop, 2006[2])).

Researchers have recognised how knowledge and skills are interconnected. For example, the National Research Council's report on 21st-century competencies (2012[3]) notes that "developing content knowledge provides the foundation for acquiring skills, while the skills in turn are necessary to truly learn and use the content. In other words, the skills and content knowledge are not only intertwined but also reinforce each other".

Similarly, UNESCO researchers have emphasised the growing importance of being able to understand, interpret and apply knowledge and skills in various situations. Scott (2015[4]) states that learning to know is not the only necessary skill for students. Also important are: learning to do, which includes problem-solving skills, critical thinking and collaboration; learning to be, which includes social and cross-cultural skills, personal responsibility and self-regulation; and learning to live together, which includes teamwork, civic and digital citizenship, and global competence.

Researchers note that over the past few decades there has been growing emphasis on thinking of the world as made up of inter-related systems, rather than solely as a series of discrete units (Ackoff, cited in (Kirby and Rosenhead, 2005[5])). Education systems around the world have been moving from defining subjects and required curriculum knowledge as collections of facts, towards understanding disciplines as inter-related systems.

Recent evidence from learning science research shows that the patterns of learner development vary widely, rather than following fixed, linear progressions or moving predictably through formal hierarchies of curriculum-based knowledge. A learner can display different levels of skill, competence or understanding at different moments, depending on the situation in which they are learning. Over time, however, learners do progress through recognisable stages of maturity and awareness of their learning, especially as they grow through childhood and adolescence and into adult maturity. They are guided and challenged by the social relationships and cultural values surrounding them.

As Fischer and Bidell (2006[6]) put it: “An examination of the evidence shows a familiar pattern: There is high variability in developmental sequences, but this variability is neither random nor absolute. The number and order of steps in developmental sequences vary as a function of factors like learning history, cultural background, content domain, context, co-participants, and emotional state.”

As students develop their competence and understanding in different areas of knowledge, they may go through rapid and repeated cycles of learning in which performance and skills level develop quickly and then fall back as the focus of the task or the context in which it is being performed vary. Over time, the cognitive development, self-awareness, attitudes and beliefs, and ability to adapt and transfer learning across different settings, can all reinforce each other, supporting both deeper levels of understanding and higher levels of competency among learners. The interactions between disciplinary, interdisciplinary, epistemic and procedural knowledge take place in this context, helping connect and integrate different aspects of knowledge with the ability of each learner to adapt and apply what they know to a changing landscape.

Box 1. A holistic understanding of knowledge and learning

Knowledge alone is smart. Knowledge interconnected with time, humanity and earth is wise. (Denise Augustine)

The knowledge of indigenous peoples (in this note, including peoples who originated in a particular place; nomads; and those who inhabited or existed in a land from earliest times) is complex. It encompasses culture, language, systems of classification, social practices, the use of resources, ritual and spirituality. These unique and holistic ways of knowing are facets of the world's cultural diversity.

Augustine et al. (2018[7]) report that indigenous peoples agree that indigenous knowledge cannot be defined from a Western orientation, and that there is no single definition. Indigenous knowledge is diverse and action-oriented, and considered to be neither a subject nor an object. Although indigenous knowledge is place-based and unique to a people, there are shared understandings of this knowledge, including:

- Interconnectedness: Everything is connected, nothing is excluded, and everything is related.
- Everything in the universe is fluid and in motion.
- Reciprocity, generosity, kindness, harmony, balance and beauty are words spoken about the world and contribute to the health and well-being of a community.
- Knowledge is expressed, transmitted, transferred and practiced in varied forms.

Disciplinary knowledge is a fundamental component of understanding, providing essential structure and foundational concepts through which other types of knowledge can also be learned and developed

Disciplinary knowledge is needed in order to understand the world, and as a structure through which other types of knowledge can also be learned and developed. Disciplinary knowledge contains subject-specific concepts and detailed content of what students learn in specific disciplines. As students acquire disciplinary knowledge, they also become able to connect knowledge across different disciplines (interdisciplinary knowledge), they learn how this knowledge is applied in different situations by practitioners (epistemic knowledge), and they learn about different processes and methods for using this knowledge (procedural knowledge). Thus disciplinary knowledge is the foundation of the conceptual structure leading to understanding and expertise (Gardner, 2006[8]). When students learn a basic level of disciplinary knowledge they are able to develop this knowledge further into specialised knowledge or to create new knowledge.

The subject-specific concepts and detailed content of disciplinary knowledge that students learn are also influenced by the knowledge, skills, attitudes and values that are prized in society at the time. One major trend shaping the economy and society is the increasing use of artificial intelligence (AI). Because of this technological development, researchers find that students will need to acquire different types of knowledge and understanding. According to Luckin and Issroff (2018[9]), people should understand basic AI concepts, be digitally literate, be data literate, know online safety, understand basic AI programming, understand the ethics of AI, and, for some people, know how to build AI systems (see the concept note on Core Foundations for more information on digital and data literacy).

Acquiring disciplinary knowledge is a step towards ensuring equity and opportunity to learn. Voogt, Nieveen and Thijs (2018[10]) define equity as when "*all* students have opportunities to access a quality curriculum to reach at least a basic level of knowledge and skills, and that the curriculum does not set barriers or lower expectations due to socio-economic status, gender, ethnic origin or location". They define opportunity to learn as when "the curriculum supports *all* students to realise their full potential. Opportunity to learn refers to the way the curriculum is organised to provide maximum opportunity for all learners to develop their talents and reach their potential". Young and Muller (2016[11]) refer to equity and opportunity to learn as the idea of "knowledge of the powerful".

Interdisciplinary knowledge is increasingly important for understanding and solving complex problems

Identifying multiple solutions to complex problems requires thinking across disciplines, or "connecting the dots" (OECD, 2018[12]). The OECD Future of Education and Skills 2030 project describes five approaches to designing curricula for students so they can acquire interdisciplinary knowledge:

- Students can learn to **transfer key concepts** or "big ideas" across different disciplines. Big ideas are broad, interdisciplinary concepts that transcend specific subject areas and address deeper understanding (Harlen, 2010[13]). Teaching big ideas can lead to deeper learning and more effective transfer of knowledge and skills. Key concepts or big ideas exist within each subject but they can be recognised across different subjects as "meta-concepts" or "macro-concepts" (Erickson, Lanning and French, 2017[14]) (Box 2).
- Students can learn to **identify interconnectedness** among various concepts across disciplines. In education as in life, everything is interconnected (see the OECD Future of Education and Skills 2030 project background). Since disciplines influence each other, it can be useful to present knowledge in an interconnected way, reflecting the complexities of the world in which we live.
- Students can learn to connect different disciplines through **thematic learning**. In an effort to avoid curriculum overload, some countries provide opportunities for students to explore inter-disciplinary issues/phenomena/themes by embedding them into existing curricula instead of creating new subjects.
- Interdisciplinary learning can be organised and facilitated by **combining related subjects or creating new subjects**. Subject regrouping is one of the strategies used to acknowledge the importance of interdisciplinary knowledge, while addressing the challenges of curriculum overload and competing subjects. One example of regrouping is to reorganise specific subjects into key learning areas (Box 3).
- Creating space in the curriculum for **project-based learning** can facilitate interdisciplinary studies as students need to combine knowledge from different disciplines to work on complex topics. Project-based learning does not only refer to pedagogy but also to an approach to the curriculum.

Box 2. "Big ideas" in British Columbia, Canada

Big ideas occupy a big place in the curriculum of British Colombia, Canada. Big ideas refer to the generalisations, principles and key concepts that are important in a certain area of learning. They reflect the "understand" component of the Know-Do-Understand model of learning. They represent what students are expected to understand at the completion of their grade and will contribute to future understanding.

Key or cross-cutting concepts can be thought of in two ways. First, there are concepts that are subject-specific and those that are found across subjects but within the same area of learning, such as in science or social studies. Second, there are cross-cutting concepts that provide links across several areas of learning. In the curriculum for British Columbia, these are defined as "macro concepts".

Source: Walt, Toutant and Allen (2017[15]).

Box 3. Combining related subjects into thematic areas

The movement towards STEM – science, technology, engineering and mathematics (with some variations, e.g. STEAM – stem + art and design) is another example of grouping certain subjects for a particular purpose. While combining subjects or creating new subjects might be beneficial as a way of avoiding curriculum overload, there is a chance that countries perceive the creation of new subjects as increasing, rather than reducing, curriculum overload.

Interdisciplinary knowledge can help students transfer knowledge from one setting to another. According to Mestre (2002[16]), "we can define transfer of learning broadly to mean the ability to apply knowledge or procedures learned in one context to new contexts". If this transfer occurs in relatively similar contexts, it is known as "near transfer"; if this transfer occurs in a different context, it is known as "far transfer".

Transferring knowledge to different situations seems more difficult than transferring knowledge to similar situations. In a comprehensive review of the literature on transfer and learning, Day and Goldstone (2012[17]) note that while near transfer is easy, what is actually difficult about far transfer is recognising that transfer is possible at all. A person must recognise structural or conceptual similarities in order to invoke previous knowledge to apply in the new context. Day and Goldstone warn: "The literature on similarity and transfer suggests that students may often fail to recognise the relevance of these ideas when they are confronted with analogous situations in the real world, particularly when the specific concrete details of those situations do not closely match those presented by teachers" (2012, p. 156[17]).

Given the challenge of far transfer, Dixon (2012[18]) suggests that it is important for teachers to help students see the more abstract conceptual and structural similarities between previous knowledge and new situations so that what is seen as far transfer can be perceived more like the easier near transfer (Benander, 2018[19]). Bereiter (1995[20]) notes that while knowledge and skills can transfer readily to new situations, it is more challenging to teach students to transfer conceptual orientations, such as scientific analysis or statistical problem solving, to novel situations (Benander, 2018[19]).

Knowledge that can be transferred across different contexts arguably has higher value for curriculum design. Many countries grapple with curriculum overload. Knowledge that is suitable for far transfer, such as the concepts used in big ideas, has the potential to reduce curriculum overload and encourage deeper understanding over time as it is inter-related with different topics or subjects. This means that there is a potential for reducing the amount of content if certain transversal knowledge is learned in multiple contexts.

Epistemic knowledge, or knowing how to think and act like a practitioner, is important for finding relevance and purpose in students' learning

Knowledge about different forms and uses of knowledge, or epistemic knowledge, allows students to extend their disciplinary knowledge and use this understanding to help solve problems and work purposefully towards valued future outcomes, contributing over time to well-being. This creates authenticity and a connection to their lives and concerns. Students are able to understand how they can use their knowledge and, with reflection informed by values and ethics, how they can make their community a better place.

Connecting knowledge to real-life issues can lead to greater student motivation. Many educators argue that in order to motivate students, it is important to link the teaching of content knowledge to an understanding of how the subject can be applied to students' daily lives and their possible future work. Among other things, this could involve learning what it means to think like a mathematician, an historian and an engineer. Epistemic knowledge can be stimulated by questions such as, "What am I learning in this subject and why?"; "What can I use the knowledge for in my life?"; "How do certain professionals from this disciplinary field think?"; "What kinds of ethical codes of conduct do professionals like doctors, engineers, artists and scientists follow?".

Ensuring that students recognise the relevance and purpose of their learning is not easy. Young and Muller (2016[11]) suggest that if curriculum designers and policy makers want students in 2030 to be critical thinkers, good problem solvers and able to develop the skill of "learning to learn", they need to focus on the pedagogies and curricula of the different knowledge domains. How far do they encourage these outcomes in their knowledge domain? And to what extent do formal curricula and assessments help students and teachers connect what they learn to the applications of knowledge in those domains? As one example, engineers learn to solve engineering problems, but their curricula rarely teach them to think about what problems engineers should be trying to solve.

Procedural knowledge – the knowledge of "how" – can be particularly useful for solving complex problems

Procedural knowledge about frameworks, such as systems thinking and design thinking, can help students develop thought patterns and structured processes that can enable them to identify and solve problems. For example, understanding how something is done or made may involve a series of steps, or actions, taken to accomplish a goal – which can be characterised as a strategy, production and interiorised action (Byrnes and Wasik, 1991[21]). Some procedural knowledge is domain-specific, such as that in mathematics, while other kinds of procedural knowledge are transferrable across different domains.

Mobus (2018[22])defines systems thinking for the classroom as "being able to see how the systems are organised for purposes and how, if they fail to serve those purposes, they will not be able to persist as systems". Mobus believes that when students learn systems thinking, they can transfer the disciplinary knowledge of what a system is and the procedural knowledge of how a system works, to recognise and understand the ill-defined systems of the real world (Benander, 2018[19]).

Design thinking, similar to systems thinking, also focuses on solving complex problems that resist neat definition. While it embraces a holistic view of the problem, it concentrates on specific perspectives (Benander, 2018[19]). Goldman (2017[23]) describes design thinking as “a process, a set of skills and mindsets that help people solve problems through novel solutions. The aim is to move beyond simply teaching the steps of the process and providing students with experiences, such as the development of empathy, participation in ‘team collaborations’, commitment to action-oriented problem solving, a sense of efficacy, and understanding that failure and persistence to try again after failure is a necessary and productive aspect of success”. Design thinking is concerned with the methods used to solve a problem; whether the solution actually works; what the potential users of the solution need; the contemporary social and cultural appropriateness of the solution; and the aesthetic appeal of the solution (Pourdehnad, Wexler and Wilson, 2011[24]).

In empirical studies of teaching systems thinking and design thinking in primary education, Kelley, Capobianco and Kaluf (2014[25]) find that students in a primary school science class who were asked to solve problems that were unfamiliar and ill-defined were able to come up with multiple design solutions (Benander, 2018[19]).

Procedural and disciplinary knowledge function together to create a mutually informed understanding of novel contexts. A challenge for education is to help students develop deeper understanding by facilitating both disciplinary and procedural knowledge, and connecting them with the skills, attitudes and ability to transfer knowledge (Benander, 2018[19]).

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Note

[1] UNESCO uses the term "transdisciplinary" which the organisation defines as "an approach to curriculum integration which dissolves the boundaries between the conventional disciplines and organises teaching and learning around the construction of meaning in the context of real-world problems or themes."
See: www.ibe.unesco.org/en/glossary-curriculum-terminology/t/transdisciplinary-approach.

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