

## Technology in the PYP

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#### Summary

- Technology includes both digital and nondigital tools and resources that facilitate and expand learning possibilities
- Schools provide students with multiple, authentic and purposeful opportunities to learn technology, learn about technology and learn through technology.
- The learning community supports students to be responsible and ethical digital citizens.

### Technology integration and implementation

Technology brings change to our world and our schools, and evolves our ways of thinking and doing. Technological change brings new environments to navigate, new skill sets to learn, new tools to innovate, and new opportunities to connect learning communities worldwide.

Similar to language, technology has the power to bring the learning community closer together and overcome boundaries. It is a means to investigate ideas, communicate findings, connect people and innovate solutions. Purposeful technology integration and implementation in authentic contexts can excite, invite, support and extend learning in multiple ways.

Integration is about pedagogy and ways of thinking, and is practised most often by teachers and students. Implementation is about the tools, infrastructure and other resources used to support learning and teaching. For more ideas on integration and implementation, see *Teaching and learning with technology: A guide of basic principles* (International Baccalaureate Organization 2015). Effective integration and implementation of technology considers:

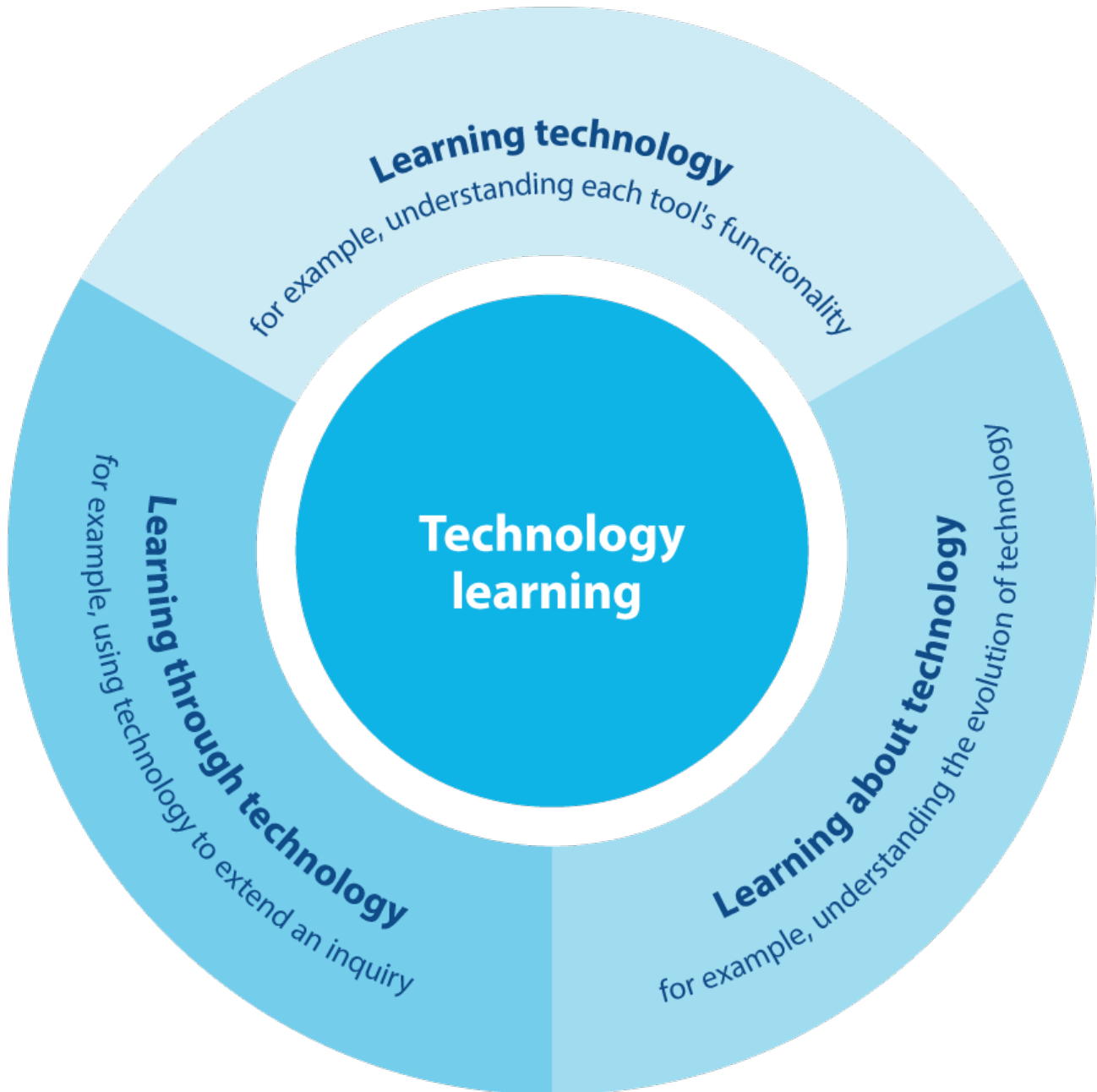
- the shared understanding about the value of technology in learning and teaching
- the agency of all members in technology decisions
- its accessibility to all learners
- its adaptability across contexts—cultural, physical and educational

- its support of intercultural understanding, global engagement and multilingualism
- its enhancement in the collection, creation, design and analysis of significant content.

## Technology learning

Building on the IB's technology guidance, the Primary Years Programme (PYP) focus of technology aims to support students in developing:

- literacy
- competency
- confidence



PYP technology learning and teaching immerses students in the interplay between learning technology, learning about technology and learning through technology.

Viewed broadly, as a tool or resource, technology facilitates and expands learning possibilities. It refers to devices such as a pencil, a laptop, an iPad, a camera, as well as resources such as a book, a website,

a game, an interactive story. As a concept, it incorporates coding, communication, information, design and innovation. As a learning extension, it supports the development of critical, creative and transfer thinking, in addition to systems and computational thinking.

Technology learning and teaching in the PYP is best supported, strengthened and extended within the transdisciplinary programme of inquiry where students can apply technology in purposeful and authentic contexts. Seamless integration of technology enhances student agency, enabling students to learn in any context—formally and informally, through individual and social learning, and in any time and place (Looi et al. 2010). Therefore, all members of the learning community are technology teachers responsible for both the learning and teaching of technology, as well as its integration.

## Technology, learner profile and approaches to learning

Children are often avid users of technology. However, this does not signify that they understand the implications of technology use on societies or environments. Learning communities support students in becoming responsible digital citizens, who make informed, ethical choices while acting with integrity. In a globally connected digital world, students are responsible for their actions, value the rights of others, exercise academic integrity, and practise safe and legal behaviours. Effective integration and implementation of technology aids the development of the attributes of the learner profile and approaches to learning (ATL).

## Technology and young learners

Young learners in a play- and inquiry-based environment approach technology in a similar way to how they approach any novel objects. According to Bird and Edwards (2015), they begin engaging with the object/device—digital or non-digital—with exploration in mind to investigate, learn and test their theories about its functionalities. When they believe they have understood its functionalities, they move to the innovation phase where they use the object/device in a new context.

Teachers can support young learners' understanding and use of technology by making appropriate technological devices available in order to appeal to their natural curiosity. Such devices could include an old camera, radio, smartphones, tablets, recorder, colouring applications, and so on. The aim for young learners is not so much about mastering technology, but about using technology to extend their investigations through touching, seeing and hearing. During this exploration process, young learners develop thinking skills and learn to make connections in subsequent play activities.

## Technology in learning and teaching

### Technology in an inquiry-based programme

Technology plays a key role in an inquiry-based programme that aims to support the development of international-mindedness and attributes of the learner profile. Schools offering the PYP create opportunities for students to develop explicit knowledge and skills relating to technology, apply technology to facilitate and extend learning, and adapt it in new ways to create solutions to challenges and opportunities.

- understanding the functionalities of different technological tools/resources
- operating technological tools/resources
- using technology to communicate, solve problems and create new opportunities
- understanding and applying social and ethical protocols surrounding the use of technology.

Technology poses unique opportunities for the learning community to co-construct knowledge and develop conceptual understandings with members and experts within and outside the school community.

### Learning technology

Technological tools have intended functionalities. For example, cameras are for picture-taking. Developing general capability in technology involves learning and understanding the functionality of available technological tools and resources. Supporting students in developing technology capability enables them to make use of traditional and digital technologies to effectively engage with opportunities and challenges, and find creative solutions in school and beyond. The table below provides examples of technology-related capabilities that schools may choose to focus on, modify or add to—based on their contexts.

Skill categories	Sub skills
Managing and operating technology	Understand: <ul style="list-style-type: none"> <li>• functionality of a range of hardware or software</li> <li>• components, commands and safety operating procedures, and so on</li> <li>• how to store, save and share digital information.</li> </ul>
Understanding and applying social and ethical technology use	Be aware of: <ul style="list-style-type: none"> <li>• ownership rights of all manually and digitally created information, and cite sources accordingly</li> <li>• online security protocols and apply them in all learning contexts</li> <li>• the legitimacy of online resources</li> <li>• the distinctions between different types of information.</li> </ul>
Researching with technology	Learn how to: <ul style="list-style-type: none"> <li>• formulate and plan how technology could be used to investigate and deepen inquiries</li> <li>• gather and record data using a variety of primary and secondary digital resources</li> <li>• use various technology tools to document learning, create charts, surveys and presentations, and so on.</li> </ul>

Explicit demonstration of technology and its functions are most effective within the programme of inquiry or subject-specific inquiry, as in the following example.

### Learning example 1

A class of 5–6 year olds inquires into the central idea:

“Awareness of our characteristics, abilities and interests supports learning”.

As part of the inquiry, students collect data from their peers about sporting interests, after-school activities, and the kinds of activities they enjoy. They use tally sheets and make pictographs. The teacher takes this opportunity to introduce them to software applications with graphic functionality on an iPad. Students then explore the applications on their own to determine how to enter and represent their data. They collaborate with each other about how they might display this data in multiple ways (pie chart, bar graph, and so on). Analysing the results presented in graphical formats, students discuss similarities and differences in characteristics, abilities and interests of their class. They use this collective data to suggest to the teacher how and what they might be interested in learning as a group, and individually, to support all variabilities.

**Technology learning:** managing and operating with technology, literacy, design

**ATL:** research, communication skills

**Learner profile:** inquirer, thinker, caring

## Learning about technology

As a concept, technology helps learners inquire into the world. Just as learning about biology helps students understand how the human body functions, exploring the evolution of existing technologies helps to make sense of how things work. For example, “electricity” is a technology with which people found ways to advance society by creating generators and light bulbs. This reinforces the definition of technology as a concept and acknowledges that technologies change as well as emerge.

There are multiple opportunities for students to learn about technology concepts, both digital and non-digital, for example, through robotics, machining and coding, or non-digital advancements in the sciences, individuals and societies, arts and physical, social and personal education (PSPE), such as papers, sports equipment telescopes, textiles and transport.

## Technology literacy

Technology literacy is achievable irrespective of the tools available and is demonstrated through ways of thinking when exploring the transdisciplinary themes or subject-specific inquiries. What technology may be depends on school context. For example, protractors and rulers may be more appropriate for learning about measurement than digital measuring tools; colouring pencils for early learners to colour with may be more appropriate to support fine motor development than a colouring application on a tablet.

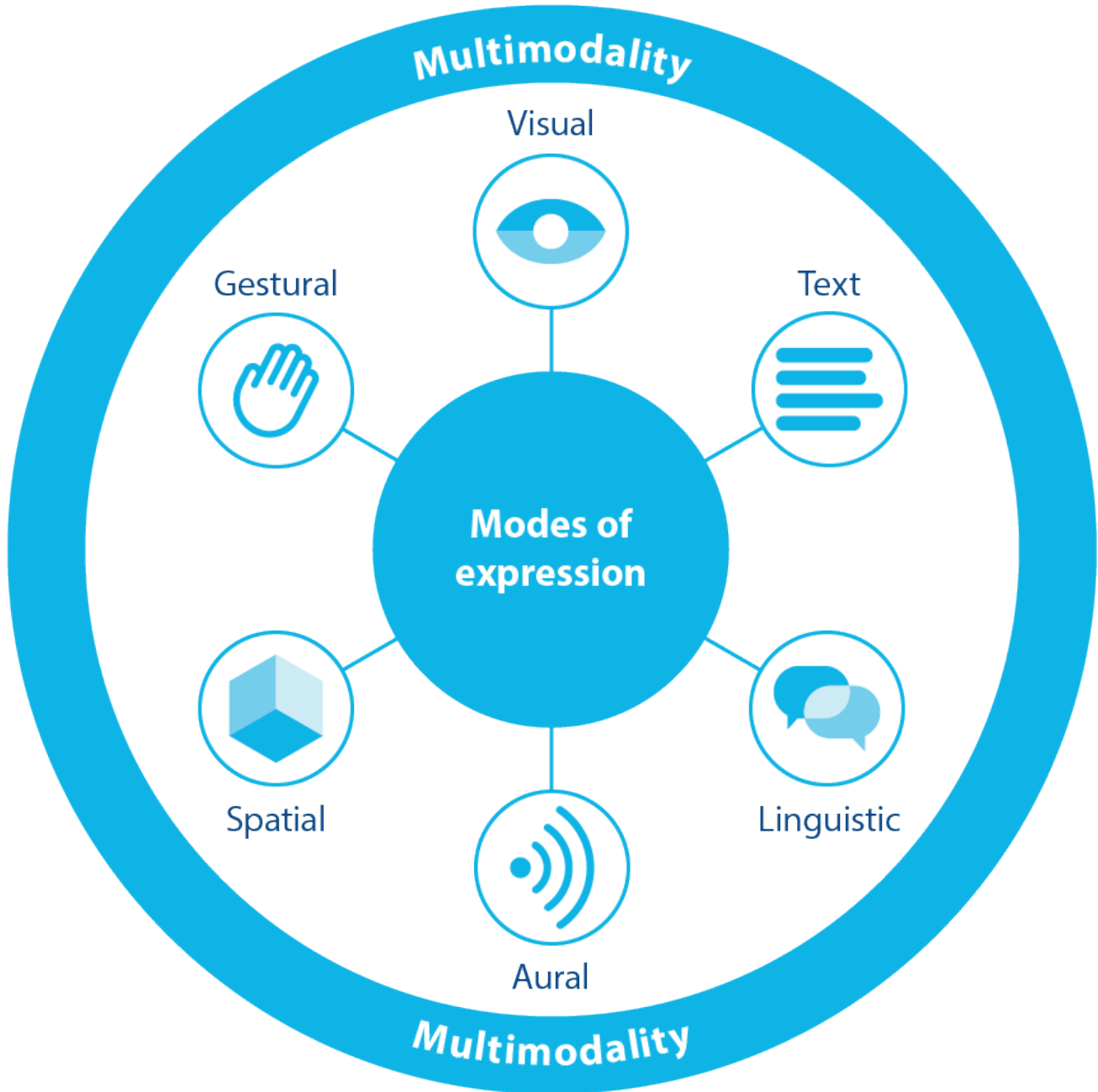
Members of the learning community actively choose and use multiple technologies in the classroom. This supports a key aspect of technology literacy: the capability to discern appropriate technologies based on the desired outcomes of the learning activity or inquiry (Davies 2011).

## Multiliteracies

Technology supports the IB position on language, literacy and multiliteracies, that develop students' ability to engage with multiple texts in multiple modes.

Examples of multiliteracies include:

- **digital literacy:** knowing and using a range of digital devices, including networking, as well as computing devices such as tablets, laptops, smartphones, and so on
- **media literacy:** knowing how to access, analyse, evaluate and create media
- **information literacy:** collecting, exploring and using information, data and evidence
- **critical literacy:** critical thinking through digital technologies, questioning and comparing what aids, extends and hinders learning
- **design literacy:** knowing that the world has been designed to aid and extend. For example, maintaining the focus on play by structuring early learning spaces with technological design choices that aid or extend children's play.



## Multimodality

Technology literacy also encourages multimodality. This is the ability to understand and communicate effectively using universal design “modes” of expression, including visual, textual, linguistic, spatial,

aural and gestural. With technology, today's classrooms are considered multimodal. Teachers and students call upon many modes of expression (prints, images, sounds, gestures and animated images) in the process of learning and teaching to make meaning of, and communicate, content (Ryan et al. 2010). See learning example 2.

## Learning example 2

A class of 8–9 year olds inquires into the central idea:

“Changes in the Earth and its atmosphere influence the way people live their lives”.

The students decide to investigate monsoons and their influence on families in their town, which had experienced serious flooding in the previous year.

One group of students is interested in how and whether monsoons could be predicted. These students decide to look at weather patterns, and connect the monsoons to the difference in temperature over the land and sea. They collect temperature data and graph the difference over several weeks using Excel spreadsheets.

Another group is interested in learning about weather changes over the years from people who have lived in the area for a long time. They decide to visit elderly people in the community centre and interview them about weather changes overtime, and how those changes affect the way they live. They record these interviews using an MP3 recorder.

A third group decides to learn from an expert—a meteorologist—about how monsoons work. The students request an interview with a professor in a nearby university through email and conduct the interview using Skype. After the conversation, the professor also shares video footage of the damage left by past monsoons with the students.

The final group wishes to learn about the possibilities of lessening the damage from flooding. These students find a parent who is involved in planning engineered solutions. Learning and collaborating with this parent, they take pictures of the local rivers, use them to draw a flow chart of their local river to suggest places where flooding could be controlled. They also find a parent who does relief work to learn about safety tips for families during a monsoon.

At the end of the inquiry, students from all four groups work collaboratively to consolidate their learning by creating a joint presentation that includes:

- a timeline of facts represented graphically (visual)
- short recordings of the stories from the elderly (audio)
- short clips of past monsoon damage (video)
- a poster of safety tips for families (print).

Through this inquiry, students learn about multiple technologies and their functionalities when the opportunities arise. They also exercise their agency to discern and select which form of technology is most appropriate to aid their learning.

**Technology learning:** operations, multiliteracies, multimodality

**ATL:** thinking, research, communication, social skills

**Learner profile:** inquirer, thinker, knowledgeable, caring, reflective, risk-taker

## Computational thinking

Technology literacy also includes an understanding of the fundamental concepts of computational thinking. This is a term coined by Wing (2006) and adapted here for early and primary learners. It refers to the thought processes involved in formulating a problem and expressing its solution in precise steps that a person or a machine can effectively carry out. For example, exploring coding to determine how to move a robot in different directions. The steps involved in computational thinking are quite similar to those involved in solving a mathematic challenge (Sedlacek 2016).

- State a problem clearly.
- Break the problem down into a number of well-defined smaller problems.
- Devise a step-by-step solution to solve each of the smaller problems.

(Adapted from Lee et al. 2014.)

Supporting young learners' development of computational thinking skills begins with algorithmic thinking—the ability to follow a series of ordered steps to solve a problem. For early learners, teachers and parents might consider introducing students to algorithmic thinking using tangible objects, which students could manipulate by following symbols or sounds or basic coding principles (Futschek and Moschitz 2011). For primary years learners with a slightly more developed algorithmic skill, the learning community might consider suitable programming environments such as Logo, Alice, Scratch, and so on.

By applying computational thinking, learners “become not merely tool users but tool builders” (Barr and Stephenson 2011). They also innovate as they use critical and creative thinking skills to combine,

adapt to and develop new technologies, as needed, to identify solutions and to create real and virtual artifacts.

### Learning example 3

Students aged 11 and 12 in a state school are required to complete a course in computer coding. The specialist teacher collaborates with the year 6 team to identify a mathematics central idea to consolidate students' understanding of "shape and space" through the context of programming Lego robots:

"Consolidating what we know of geometric concepts allows us to interact with our world".

The inquiry focuses on computational thinking: how to change descriptions of shape, position and direction into mathematical symbols and then "translate" the algorithm into coding. Individually, students devise criteria for moving the robot in circles, squares, rectangles and triangles of different sizes. In teams, students work through a design process to meet the criteria in innovative ways.

**Technology learning:** computational thinking, design thinking

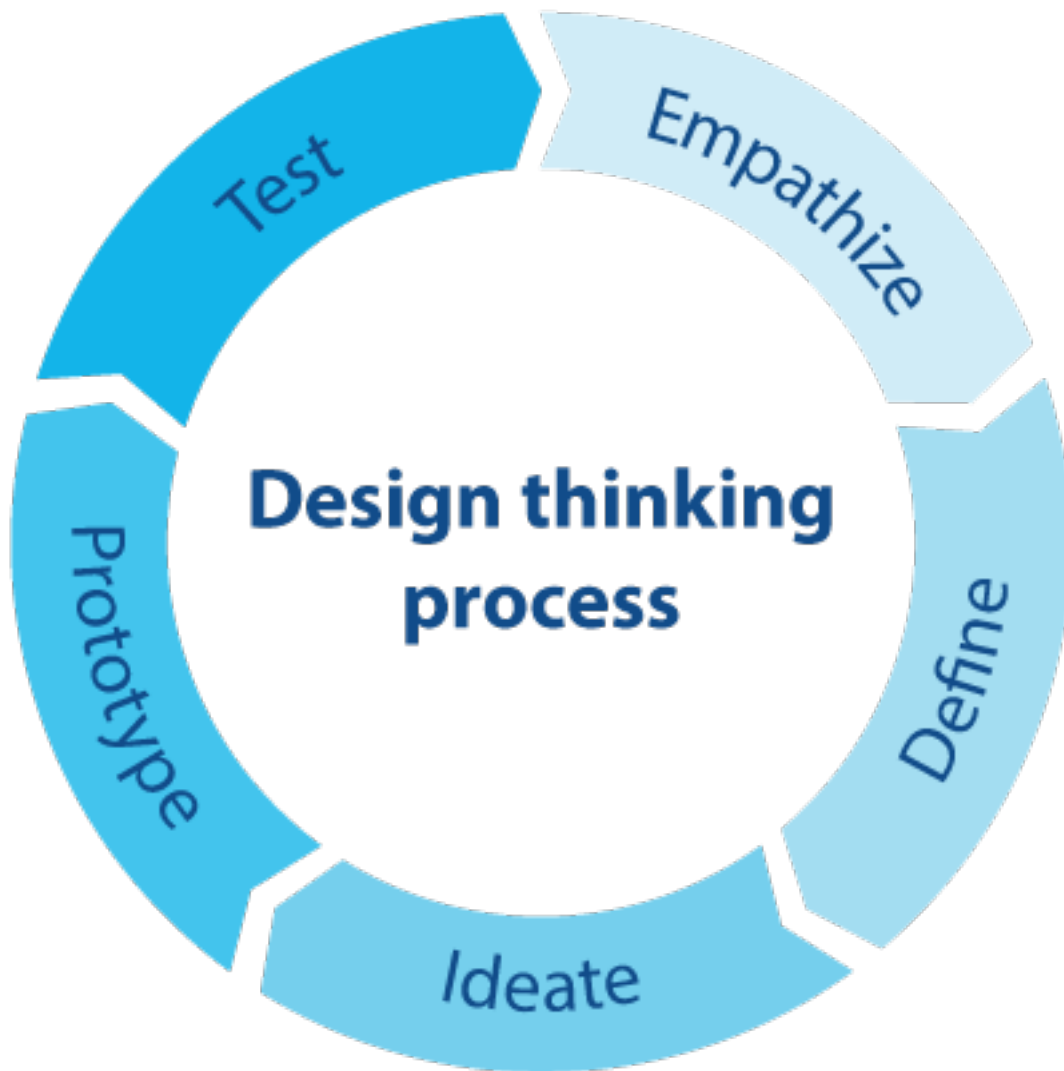
**ATL:** thinking, research, communication, social skills

**Learner profile:** inquisitive thinker, knowledgeable thinker

## Design

Design involves ideating and creating products or artifacts relating to an inquiry. Design thinking, an approach integral to the design process (Koh et al. 2015) moves students beyond following directions and replicating a given procedure to applying their knowledge and skills to find creative and innovative solutions to address opportunities and challenges. Characteristic of constructivist learning, the process of design encourages students to explore and to be open to new ideas (Scheer et al. 2012). Through the process, students build metacognitive skills (Koh et al. 2015).

Figure TE03 shows the steps involved in a design thinking process (Institute of Design at Stanford University).



The design thinking process develops the skills to construct a solution based on:

- analysis of information and evidence
- logical and critical reasoning
- collaboration to negotiate solutions
- self-organization to internalize understanding.

These skills support student agency as they develop confidence to find workable solutions to issues through design. Because the design process encourages independent and group thinking, it builds trust and reciprocity between students and teachers.

There are multiple ways the learning community might consider creating a design spaces. Makerspaces, junk yards, design corners and robotics rooms can be incorporated into the curriculum to connect “real-world” experiences with conceptual learning. In these spaces, members of the learning community make available digital and non-digital tools, an array of purpose-made materials and open-ended materials for prototyping. Sample materials include the following.

### **Sample materials**

Bottle caps, boxes, buttons, pipe cleaners, popsicle sticks, wires, hand and power tools, electric circuits, consumable art supplies, solar panels, batteries, toy motors, and so on.

Inquiring designers ask questions and analyse the opportunity or challenge to determine parameters and the criteria for success. They reflect, collaborate and develop those ideas and act to create products, processes or systems. Design decisions are supported by research, investigation and collaboration. Students reflect upon their final solution against the original description of the problem and the indicators for success.

Returning to “Learning example 2”, students may decide to extend their learning using the design thinking process to minimize damage to people’s homes from monsoon flooding.

#### Learning example 4

A kindergarten class listens to a story entitled *In the Night Kitchen* by Maurice Sendak. The students are fascinated by the creative solution of the main character, Mickey, to get milk for the bakers. They discuss Mickey's approach in depth and the teacher wonders out loud if there are other approaches Mickey could use to solve the bakers' problem. Students take on the teacher's challenge and begin to consider alternative solutions using the design thinking process to prototype their solutions.

**Technology learning:** technology literacy, design thinking process

**ATL:** thinking skills, social skills

**Learner profile:** communicator, reflective thinker, risk-taker

#### Technology in a global society

Technology can transform, enrich or cause harm to cultures and environments. By supporting students in their understanding of the evolution of existing technologies, and the rights and responsibilities of being a digital citizen, students are better able to make informed and ethical choices about the technologies they use.

#### Evolution of technology

Through learning about the evolution of technology, learners develop systems-thinking capacity. While less applicable to early learners, supporting primary years learners to understand the complexity of systems, both natural and technological, prepares them to solve tomorrow's challenges.

Systems can be static or dynamic, simple or complex. Exploring the concept of systems enhances students' understanding of connection and causation—everything is connected to a single system or multiple systems. A solution or an action carried out in one community may create problems for another or for the environment—some problems may be on a small or personal scale, while others may be far-reaching. For example, exploring the evolution of the automobile, students will come to understand its contribution to commerce as well as its detrimental effect on the environment.

By learning about the systemic impact of technology, learners:

- develop an appreciation of the impact of technological innovations for personal and community well-being, cultures and environments
- appreciate past, present and emerging technology within cultural, social, historical, aesthetic and environmental contexts
- develop respect for others' viewpoints and appreciate alternative solutions to problems
- act with integrity and honesty, and take responsibility for their own actions.

The PYP transdisciplinary themes provide a powerful basis from which students can develop their systems-thinking skills. These themes support learning about non-digital advancements in the sciences, individuals and societies, arts and physical, social and personal education (PSPE) not as a set of stand-alone events but as interconnected ones.

### The basics of digital citizenship

Technology offers unprecedented opportunities to connect schools and learning communities locally and globally. These opportunities also come with responsibilities. Digital citizenship refers to the norms of appropriate and responsible behaviours when engaging with technology (Ribble 2011).

To support learners in becoming digital citizens of character and integrity, the learning community works collaboratively with parents and students to define and implement a shared understanding of appropriate digital practices, including:

- codes of conduct
- policies
- rights and responsibilities
- health and well-being
- protection.

By learning about these elements of digital citizenship, students not only become responsible users of technology but they can recognize inappropriate technological behaviours that might impact themselves or others.

## Learning through technology

Through technology as a tool, resource and infrastructure, students understand information and find solutions to seize opportunities and address challenges that transcend subjects to which the opportunities/challenges are related. It is “through” these digital and traditional devices that students explore and extend their questions and inquiries. Technology offers boundless opportunities to seamlessly integrate subjects, extend inquiries beyond the confines of the school, and communicate and share newly constructed knowledge and understandings in innovative ways.

### **Approaches to learning**

Through technology, students have unlimited opportunities to develop and practise the approaches to learning (ATL). For example, communication skills include the sub-skills of:

- participating in, and contributing to, digital social media networks
- collaborating with peers and experts using a variety of digital environments and media
- sharing ideas with multiple audiences using a variety of digital environments and media.

The following sample technology sub-skills are relevant to all learners which schools may choose to focus on, modify or add to—based on their contexts.

<b>Examples of technology sub-skills</b>	
Investigating	To carry out a purposeful inquiry or research to test existing understanding, discover new information and create new understanding. Through investigation, students access digital resources, critically evaluate a variety of primary and secondary sources, make connections and synthesize findings to apply knowledge to real-life contexts.
Ideating	A process through which students are provided with an opportunity to innovate and test boundaries. Students construct meaning, apply critical thinking and original ideas to real-world situations, and share ideas through a variety of media for self-expression, problem-posing and problem-solving, and reflection.
Communicating through multiliteracies	The exchange of information with various audiences using a range of media and formats, including physical, digital and virtual. Effective communicators contribute to cross-cultural understanding, make informed choices when deciding on tools to articulate meaning, and provide relevant, significant feedback to others.
Collaborating in online spaces	The process through which students validate and negotiate ideas, and reach a deeper understanding and a global perspective. This is the active participation of creating and sharing knowledge through digital media and online spaces.

### Organizing

The ability to structure or arrange connected items. Students understand that technology can be used to inform, adapt, manage and problem-solve during their creative, communicative, collaborative and investigative processes. Students make connections, transfer existing knowledge and independently explore new technologies.

### Inside and outside the programme of inquiry

Technology, particularly digital technology, affords myriad opportunities for networking, sharing of initiatives and partnerships, to learn, to connect and to transcend subject knowledge. Digital media gives users the opportunity to interact, not only with peers and adults but also with content, in order to further their understandings. Text, images, videos and audio files are not only consumed and shared, but are also integrated and re-purposed (Palfrey and Gasser 2013) to create new knowledge and conceptual understandings.

Through technology, students learn about multiple perspectives, the origins of a concept or even experience a concept through modelling, simulation or visualization technology—all forms of experiential learning (Kolb 1984). For example, students can experience the effect of a 6.5 Richter-scale earthquake through simulation at a local museum.

### Learning example 5

A year 5 class explores the central idea:

“Digital media changes the way in which people access information and connect to each other”.

From the perspective of individuals and societies they look at the history of how people accessed information prior to, and after, the invention of the personal computer. From the perspective of mathematics, they consider the rise in individual computer ownership and graph the data by global region. They also inquire into the meaning of “digital” and why the numbers describing the power of computers is related to the binary numeral system. Through the computer science lens, they look at network maps and nodes, and how these have changed in the students’ lifetime. In language, they analyse text from twitter, emails and blogs, and consider how meaning can be misunderstood. Well-being and issues of cyber-bullying are also researched and reflected on. Finally, they apply the concept of multimodality to share what they find by making connections among various aspects of technology and media to determine their impacts on how people access information and connect with each other today.

**Technology learning:** technology literacy, multiliteracies, multimodality, design

**ATL:** research, creative thinking, communication

**Learner profile:** knowledgeable, reflective thinker

### Conceptual understandings

Through technology, students have the opportunity to develop conceptual understandings. In technology, there are clusters of ideas relating to the seven specified PYP concepts and the six PYP transdisciplinary themes. Figure TE04 provides examples of specified and additional concepts, and gives suggested questions that may be adapted to guide inquiries. There are many other possibilities for additional concepts and these may also be sourced from national/state curriculums.

In the following questions, “technology” may refer to digital applications, but it could equally include technology relating to medicine, transport, food and textile production, electricity, and so on.

	<b>Examples of additional concepts</b>	<b>Sample learning considerations</b>
Form	Materials, coding, product, components	<ul style="list-style-type: none"> <li>• How can I describe and classify the characteristics of different materials?</li> <li>• What can we learn from a tool's component?</li> <li>• Why are there different symbols and words in coding?</li> <li>• How can I break this big problem into bits I can understand?</li> </ul>
Function	Inventions, algorithm, coding, logic	<ul style="list-style-type: none"> <li>• What is this mathematical rule telling me to do?</li> <li>• Can I "read" this coding and work out what the robot will do?</li> <li>• Can I "debug" this coding so that it does what I want it to do?</li> </ul>
Change	Development, systems	<ul style="list-style-type: none"> <li>• How has this particular technology developed since it was invented?</li> <li>• What are the changes as a result of this technology innovation?</li> <li>•</li> </ul>

		How has this technology changed social or environmental systems?
Connection	Systems, communities, communication	<ul style="list-style-type: none"> <li>• How has this technology met the needs of a community?</li> <li>• What systems were important in the development of this technology?</li> <li>• What systems will my design solution affect?</li> <li>• How can I plan multimodal communications to meet a range of audiences?</li> </ul>
Causation	Development, innovation, process, needs, opportunity, challenges, consequences	<ul style="list-style-type: none"> <li>• What provoked the development of this technology?</li> <li>• What needs did an innovation meet?</li> <li>• What were the immediate benefits or consequences of the solution?</li> </ul>
Perspective	Safety, consequences, communication	<ul style="list-style-type: none"> <li>• What are the safety issues with this technology, and what are the consequences if it is not used properly?</li> <li>• What were the different points of view of designers?</li> </ul>

		<ul style="list-style-type: none"> <li>• Did the prototype meet the initial design brief?</li> <li>• How did our team communicate through the product development?</li> </ul>
<p>Responsibility</p>	<p>Safety, ethics, sustainability</p>	<ul style="list-style-type: none"> <li>• How does this technology affect the health and well-being of a community?</li> <li>• What was my responsibility as a designer?</li> <li>• Did I consider issues of culture, health, well-being and the environment when I used this technology?</li> <li>• How do we interpret “caring” and “principled” when collaborating with others who are not in the same place or who may not have access to the same information?</li> <li>• What does responsible digital citizenship look like when we step outside our boundary?</li> </ul>

Figure TE04 *Concepts in technology*

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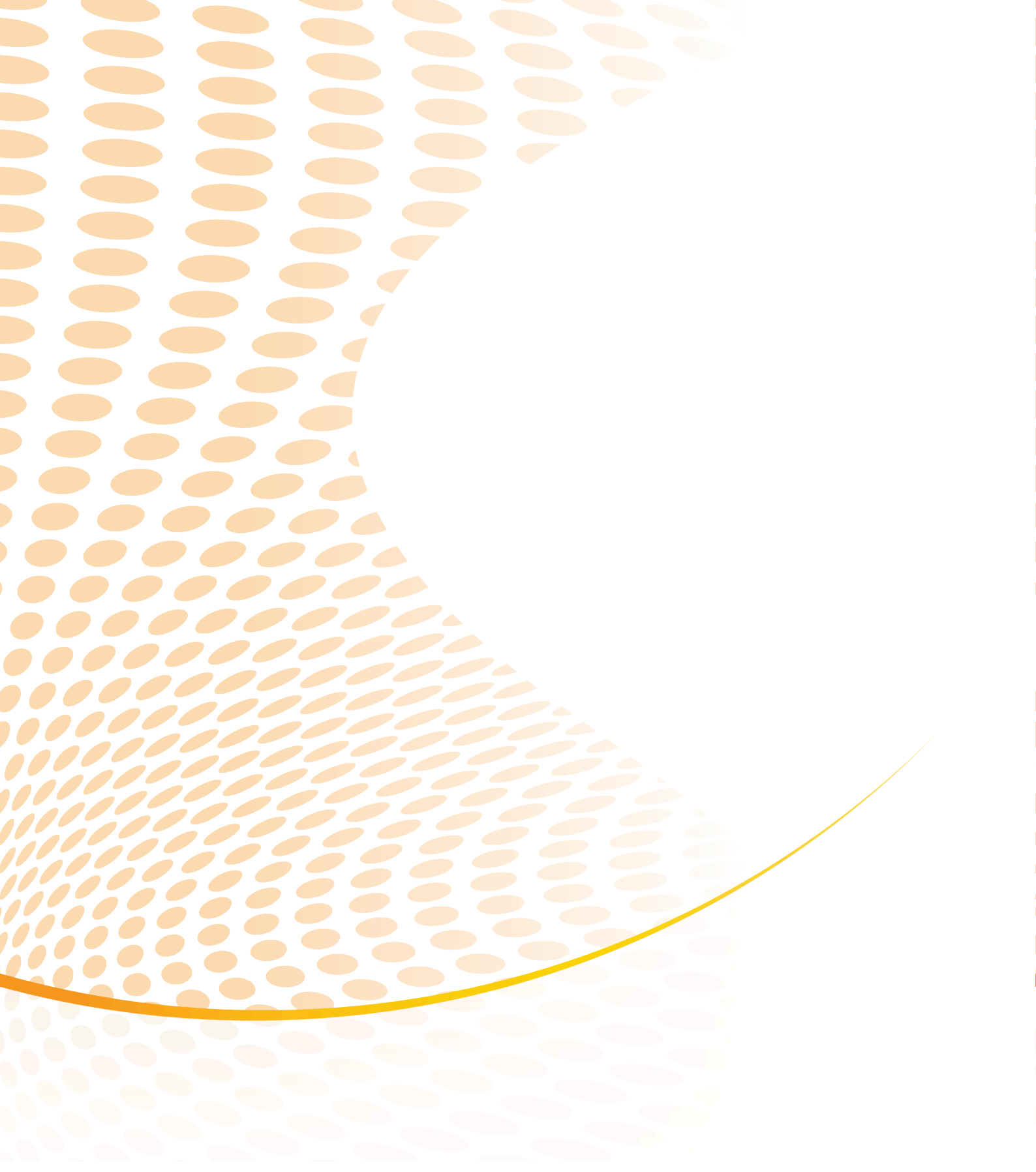
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