THINKING OUTSIDE THE BOX

The PISA 2022 Creative Thinking Assessment

OECD
BETTER POLICIES FOR BETTER LIVES

WHAT IS PISA ?

Created by the Organisation for Economic Co-operation and Development (OECD), PISA refers to the Programme for International Student Assessment (PISA).

PISA tests the skills and knowledge of 15-year-old students around the world in reading, mathematics and science because they are foundational to a student's ongoing education. Since 2000, PISA has involved more than 90 countries and economies and around 3 million students worldwide.

PISA also collects valuable information on student attitudes and motivations, and since its 2012 cycle, formally assesses important '21st century skills' such as problem solving (2012), collaborative problem solving (2015), and global competence (2018).

For the first time, in its 2022 cycle, PISA will assess creative thinking in over 60 participating countries and economies. To find out more about innovation in PISA, visit our innovation webpage at www.oecd.org/pisa/innovation.

ACKNOWLEDGEMENTS

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FOREWORD by Andreas Schleicher

In a world in which the kinds of things that are easy to teach and test have become easy to digitise and automate, the capacity of individuals to imagine, to create, and to build things of intrinsic positive worth is rising in importance. Today's youngsters will likely be employed in roles that do not currently exist, responding to societal challenges that we cannot possibly anticipate, and using technologies that we cannot yet imagine. It is likely that future work will pair computer intelligence with humans' cognitive, social and emotional skills, attitudes and values. It will be our capacity for innovation and sense of responsibility that will enable us to harness the power of artificial intelligence, create new value, and shape the world for the better.

However, this global context has not automatically led to corresponding changes in intended, implemented, and achieved curricula. Too much of what happens in today's classroom is geared towards having students reproduce what they have learned, rather than extrapolating from it and applying their knowledge creatively to novel situations. Indeed, a striking but not unexpected finding from the OECD's Survey on Social and Emotional Skills (OECD, 2021) was that 15-year-old students reported lower creativity and curiosity on average than their 10-year-old counterparts. While developmental factors may play a role here, this finding might also partly derive from the fact that education systems often expect students to be compliant with the expectations from teachers and the curriculum, with the potential consequence of driving out curiosity and creativity as students grow older and stay longer in the education system.

We need to do more to support educators in recognising, promoting, and rewarding creative thinking, as well as thinking creatively about their own work. Creativity or creative thinking are often viewed as intangibles that we can observe in their impact and consequences, but that are intrinsically hard to define and assess. Some might even argue that assessments, which traditionally focus on students' capacities to replicate and refine pre-defined answers, stand in direct opposition to efforts to strengthen creativity in the classroom. Yet what we cannot see is hard to improve, and what we cannot measure will fail to get deserved attention. Most education stakeholders agree that creative thinking is a key competence that young people need to be prepared for the future, and for some years now almost all future-oriented educational frameworks or skills rankings place creative thinking near the top of priorities. The question therefore arises whether we can make creative thinking visible, comparable, and amenable to policy action in a similar way that traditional tests do with disciplinary knowledge and skills.

For this reason, the OECD Programme for International Student Assessment (PISA) has built a novel assessment that captures elements of creative thinking and that will be administered in its 2022 cycle. Assessing creative thinking represents a natural progression for PISA – the global yardstick for educational success – which has always focused on measuring young people's ability to apply their knowledge to novel situations. The major innovation of this new assessment lies in the open-ended nature of the tasks, with students encouraged to express their imagination and suggest creative solutions in a variety of open contexts. It is their capacity to think flexibly and propose original answers that will be rewarded on the test, not the extent to which their answer is 'right' or 'wrong'. This illustrated brochure summarises the thinking underpinning the PISA 2022 creative thinking assessment and sets forth its design.

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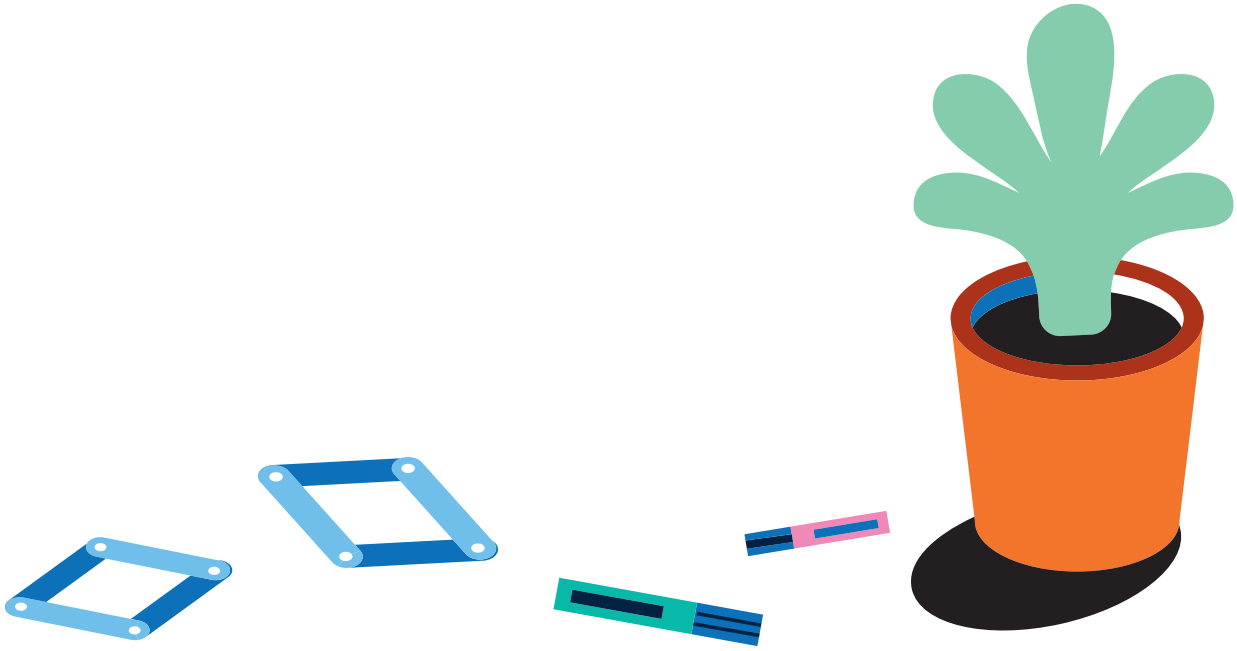
Why assess creative thinking in PISA?

Creativity drives forward human culture and society. Organisations and societies around the world depend on **innovation and knowledge creation** to address emerging challenges (OECD, 2010).

Despite entrenched beliefs to the contrary, **every person has the potential to think creatively** (OECD, 2017). Creative thinking is more than coming up with unexpected ideas: it is a tangible competence grounded in knowledge and practice that supports individuals (and groups) to achieve better outcomes, especially in constrained or challenging environments. Experts agree that **engaging in creative thinking can also improve a range of other skills**, including metacognitive, inter- and intra-personal, and problem-solving skills, as well as promoting identity development, academic achievement, and career success.

Assessing creative thinking in PISA can **encourage a wider debate on the importance of supporting the development of creative thinking through education, as well as encourage positive changes in education policies and pedagogies** around the world. PISA data will provide policy makers with **valid, reliable, and actionable measurement tools** that can support evidence-based decisions.



Why develop creative thinking in school?

A fundamental role of education is to equip students with the competences they need to succeed in life and society. Being able to think creatively is a critical competence that young people need to develop – including in school – for several reasons:

1 Creative thinking **helps prepare young people to adapt** to a rapidly changing world that demands flexible workers. Children today will be employed in jobs that do not yet exist, using new technologies to solve novel problems and emerging challenges. Developing creative thinking will help prepare young people to adapt, undertake work that cannot easily be replicated by machines, and address increasingly complex challenges with innovative solutions.

2 Creative thinking **helps students to discover and develop their potential**. Schools play an important role in students' development beyond preparing them for success in the labour market. Schools must also help young people to discover and develop their talents, including their creative talents (Lucas and Spencer, 2017).

3 Creative thinking **supports learning** by helping students to interpret experiences and information in novel and personally meaningful ways, even in the context of formal learning goals (Beghetto and Kaufman, 2007; Beghetto and Plucker, 2006). Student-centred pedagogies that engage with students' creative potential and encourage exploration and discovery can also increase students' motivation and interest in learning, particularly for those who struggle with rote learning and other teacher-centred schooling methods.

4 Creative thinking is **important in a range of subjects**, from languages and the arts to the STEM (science, technology, engineering, and mathematics) disciplines. Creative thinking helps students to be imaginative, develop original ideas, think outside the box, and solve problems.

Defining creativity and creative thinking

Chapter 1


x4

What is creativity?

Creativity is multidimensional

The literature broadly understands creativity as "the interaction among **aptitude, process and environment**, by which an individual or group produces a perceptible **product that is both novel and useful as defined within a social context**" (Plucker, Beghetto and Dow, 2004). Several theories of creativity acknowledge the importance and interaction of relevant **knowledge and skills, divergent and convergent thinking processes, task motivation, and a rewarding environment** for supporting creative engagement with a given task (Amabile, 1983; Amabile and Pratt, 2016; Lucas et al., 2013; Lucas, 2016; Sternberg and Lubart, 1991, 1995; Sternberg, 2006).

Creativity can manifest in many different ways

The literature on creativity generally distinguishes between **'big C' creativity and 'little c' creativity** (Craft, 2001; Kaufman and Beghetto, 2009). 'Big C' creativity refers to intellectual or technological breakthroughs or artistic or literacy masterpieces, requiring significant expertise, dedication, and recognition from society that the product has value. Conversely, **all people are capable of demonstrating 'little c' creativity** by engaging in creative thinking. This type of everyday creativity might include arranging photos in an unusual way, combining leftovers to make a tasty meal, or finding a solution to a complex scheduling problem at work. Overall, the literature agrees that 'little c' creativity can be developed through practice and honed through education (Kaufman and Beghetto, 2009).

What is creative thinking?

The PISA definition of creative thinking

While intrinsically related to the broader construct of creativity, **creative thinking refers to the cognitive processes required to engage in creative work.** It is a more appropriate construct to assess in the context of PISA, which assesses 15-year-olds around the world, as it is a malleable individual capacity that can be developed through practice and does not place an emphasis on how wider society values the resulting output.

PISA defines creative thinking as **"the competence to engage productively in the generation, evaluation, and improvement of ideas that can result in original and effective solutions, advances in knowledge, and impactful expressions of imagination".**

This definition **focuses on the cognitive processes and outcomes associated with 'little c' creativity** in everyday contexts. It reflects the types of creative thinking that 15-year-old students can reasonably demonstrate, and underlines that students need to learn how to engage productively in generating ideas, reflecting upon ideas by valuing their relevance and novelty, and iterating upon ideas until they reach a satisfactory outcome.

Domain-general or domain-specific?

Researchers in the field have long debated whether individuals are creative in everything they do, or only in certain domains. The term 'domain' here refers to a specific area of knowledge or practice. This domain-general versus domain-specific debate naturally extends to creative thinking and raises an important question: **is creative thinking in science or writing different to creative thinking in the visual arts?**

The first generation of creative thinking tests reflected the notion of domain generality – in other words, that a set of general and enduring attributes influenced creative endeavours of all kinds and that an individual's capacity to be creative in one domain would readily transfer to another. However, more recent work tends to reject this generalist assumption.

Researchers now recognise that, **to some extent, the internal resources needed to engage in creative work differ by domain.** While the number and nature of 'domains of creativity' remain an open question, several researchers do agree that an individual's capacity to produce creative work does not necessarily readily transfer across different domains. In particular, research has found that creativity in the arts and creativity in maths/science draw upon a distinctly different set of internal resources (e.g. knowledge, skills, and attributes).

Chapter 2

Creative thinking in the classroom

What internal resources do students need to think creatively?

Schools can nurture the **knowledge, skills, and attitudes** that students need in order to engage in creative thinking.

Cognitive skills

Convergent and divergent thinking (Guildford, 1956) are both widely recognised as important cognitive skills for creative thinking. Convergent thinking refers to the ability to apply conventional and logical reasoning to information. As such, **convergent thinking aids in understanding the problem space and identifying good ideas.** Divergent thinking refers to the ability to follow new approaches, think of original and different ideas, and discover new methods of 'doing' by making flexible connections between ideas and pieces of information, taking different perspectives, and generating lots of ideas (Cropley, 2006). In essence, **divergent thinking brings forth novel, unusual, or surprising ideas.**

Domain readiness

Domain readiness conveys the idea that **some prior domain knowledge and experience is needed to successfully produce creative work** (Baer, 2016). A better understanding of a domain is more likely to help with generating and evaluating ideas that are both novel and useful. However, this relationship may not be strictly linear – well-established routines for deploying knowledge or skills within a domain may also result in idea fixation and a reluctance to think beyond those established routines.

Openness to experience and intellect

Several studies have shown that creative people share a core set of tendencies, particularly related to the personality dimension of '**openness/intellect**'. 'Openness to experience' describes an individual's **receptivity to engage with novel ideas, imagination, fantasy, aesthetics and emotions,** and predicts creative achievement in the arts; '**openness to intellect**' describes an individual's **receptivity to appreciate and engage with abstract and complex information** and, in contrast to openness to experience, seems particularly correlated with scientific creativity (Kaufman et al., 2016).

Goal orientation and creative self-beliefs

Persistence, perseverance and creative self-efficacy influence creative achievement by providing a strong sense of goal orientation and the belief that creative goals can be achieved. **Investing effort towards a goal and overcoming difficulty** are essential for engaging in creative thinking, as they enable individuals to maintain concentration for long periods and deal with frustrations that arise. Creative self-efficacy describes an individual's **beliefs that they are capable of successfully producing creative work**, and these beliefs in turn influence whether individuals will sustain effort in pursuit of their creative goals (Beghetto and Karwowski, 2017). These beliefs are shaped by various factors, both historical (e.g. prior performance) and contextual (e.g. mood, social environment) (Bandura, 1997; Beghetto, 2006).

Collaboration with others

Creative work often results from interactions between an individual and their environment – which also includes interactions with other people. Collaboration can help individuals to **explore and build upon the ideas of others, as well as improve weaknesses** in those ideas. This can drive forward knowledge creation by facilitating the development of solutions for complex problems beyond the capabilities of any single person (Lucas et al., 2013; Warhuus et al., 2017).

Task motivation

People are unlikely to produce creative work unless motivated to do so. Intrinsic task motivation drives individuals to complete a task because they find it inherently rewarding, for example experiencing enjoyment or a desire to be challenged. The experience of '**creative flow**' – being fully immersed in and persisting with a task, disregarding other needs – **is a powerful driver of creativity** because individuals in flow are intrinsically motivated to engage in a task.

Extrinsic task motivation refers to external incentives, goals, or pressures that motivate people to engage in a given task. Although the research emphasises the importance of intrinsic motivation for creative engagement, extrinsic motivators can also encourage individuals to persist in their creative endeavours (Eisenberger and Shanock, 2003; Amabile and Pratt, 2016).

What type of social environments support creative thinking?

Several features of a student's educational environment can incentivise or hinder creative thinking in the classroom.

Cultural norms and expectations

Cultural norms and expectations can **influence the skills that individuals develop, the values that shape personality development, and the differences in performance expectations** within societies. Some studies have investigated how cultural differences affect national measures of creativity and innovation, concluding that differences along the individualism-collectivism spectrum significantly shape how creative work is defined and valued (Rinne, Steel and Fairweather, 2013; Ng, 2003).

Educational approaches

Some educational approaches might actively discourage creative thinking and achievement at school (Wong and Niu, 2013). For example, the **pressures of standardisation and accountability in educational testing systems often reduce opportunities for creative thinking** in schoolwork. Some have even claimed that narrow educational approaches and assessment methods are at the root of a 'creaticide' affecting young people (Berliner, 2011). Schools and school systems therefore need to encourage creative thinking by **implementing policies and practices that increase the opportunities and rewards for producing creative work** and that decrease associated costs. School leaders are also critical in establishing a conducive culture for creative thinking (Lucas et al., 2021).

Classroom climate

Classroom practices can also stifle creative thinking by perpetuating the idea that there is only one way to learn or solve problems, or that originality is a rare quality, by cultivating attitudes of fear of authority, and by discouraging students' curiosity and inquisitiveness (Nickerson, 2010). **Teachers need to value creative work and consider it a fundamental skill that should be developed in the classroom.** Teachers can actively cultivate students' creativity through signature pedagogies (Lucas and Spencer, 2017), encouraging students, for example, to set their own learning goals, take responsibility for creative teamwork, ask questions about different phenomena they observe, and put forth their own ideas to explain them (Bereiter and Scardamalia, 2010).

What does creative thinking look like in the classroom?

Students can produce different kinds of **'everyday' creative work at school,** either as individuals or as part of a group, that are **multi-disciplinary and extend beyond traditional subjects.**

Creative expression

Creative expression refers to both **verbal and non-verbal forms** of creative engagement **where individuals communicate their internal world and imagination to others**. Verbal expression involves the use of language, including both written and oral communication, whereas non-verbal expression includes drawing, painting, designing, modelling, and musical expression, as well as expressive movement and performance like dance and drama.

Knowledge creation

Knowledge creation refers to the **advancement of knowledge and understanding**, with an emphasis on making progress rather than achievement per se (for example, by improving an idea). Knowledge creation refers not only to important discoveries or advancements in society, but also to the **purposeful act of building up and iterating on ideas** that can happen at all levels of society and across all domains of knowledge.

Creative problem solving

Not all problems require creative thinking: creative problem solving is a **distinct class of problem solving characterised by novelty, unconventionality, persistence, and ill-defined problems** (Newell, Shaw and Simon, 1962). Creative thinking is necessary when students are challenged with problems outside of their realm of expertise or where the techniques with which they are familiar do not work (Nickerson, 1999).

The PISA 2022 creative thinking assessment

Chapter 3

What are the main features of the PISA 2022 Creative Thinking assessment?

For the first time, in 2022, PISA will assess creative thinking. The assessment will provide **internationally comparable data on how well students around the world can engage in creative thinking** as well as shed light on how this capacity is shaped by their internal resources and their learning environments.

Who does PISA assess?

PISA assesses **15-year-olds** nearing the end of compulsory schooling. The creative thinking assessment will be administered to students in **over 60 countries worldwide**.

What does the PISA assessment involve?

Students taking PISA sit a **two-hour test** (combining modules on reading, mathematics, science, and creative thinking) as well as answer a **questionnaire module** that collects information about students' background, school activities and attitudes. Teachers and school leaders will also complete a questionnaire module that collects information about their school background, school activities, and attitudes towards creative thinking.

How does the creative thinking test work?

Students who receive a creative thinking module will spend up to 60 minutes on creative thinking items. The items are organised within units that vary in several important ways, including:

- the **facets of the construct that are measured** (students will be asked to generate original ideas or improvements, or generate different ideas);
- the **domain contextualisation** (written expression, visual expression, social problem solving, scientific problem solving); and
- the **duration of the unit** (between 5 to 15 minute guidelines).

Every item in the test is open-ended, meaning there are multiple ways that students can demonstrate creative thinking in their responses. In general, students provide **short written responses** but some tasks requires students to use **interactive tools like a visual design application or a simulation**.

Why are students tested in different domains?

The creative thinking test contextualises tasks in **four domains: written expression, visual expression, social problem solving, and scientific problem solving.** In each domain, students complete everyday tasks that do not require technical knowledge or skills in order to minimise the role of prior experience as a significant driver of performance.

These four domains were chosen for the creative thinking test for several reasons:

- they are **accessible** contexts for students around the world;
- they correspond to the types of **typical activities** in which 15-year-olds engage inside and outside the classroom;
- they reflect the nature of **'little c' creativity**;
- they provide a **sufficiently diverse coverage** of the construct to allow for generalisation.

Including multiple domains in the assessment will also **provide insights on country-level strengths and weaknesses** that might reflect differences in the importance attached to these domains in school.

How are students scored?

All items in the test are open-ended, meaning there are infinite ways to successfully demonstrate creative thinking. Scoring students' answers in the test relies on **human judgement, based upon detailed scoring rubrics and well-defined coding procedures.** These materials have been developed following careful analysis of students' responses in several validation and pilot studies. National coding teams also provided feedback on the materials and attended three rounds of in-depth coder training, where they learnt how to code responses consistently by examining a large set of genuine student responses selected from the various validation and pilot studies.

How has the assessment been validated?

Given the complex nature of measuring creative thinking, the assessment tasks, scoring materials, and coder training practices have undergone extensive validation. This has included several rounds of **review of the assessment materials** by PISA participating countries, **cognitive laboratories** in 2 countries, **small-scale pilot data collections** in 5 countries, and **two large-scale Field Trial data collections**.

When will the results be published?

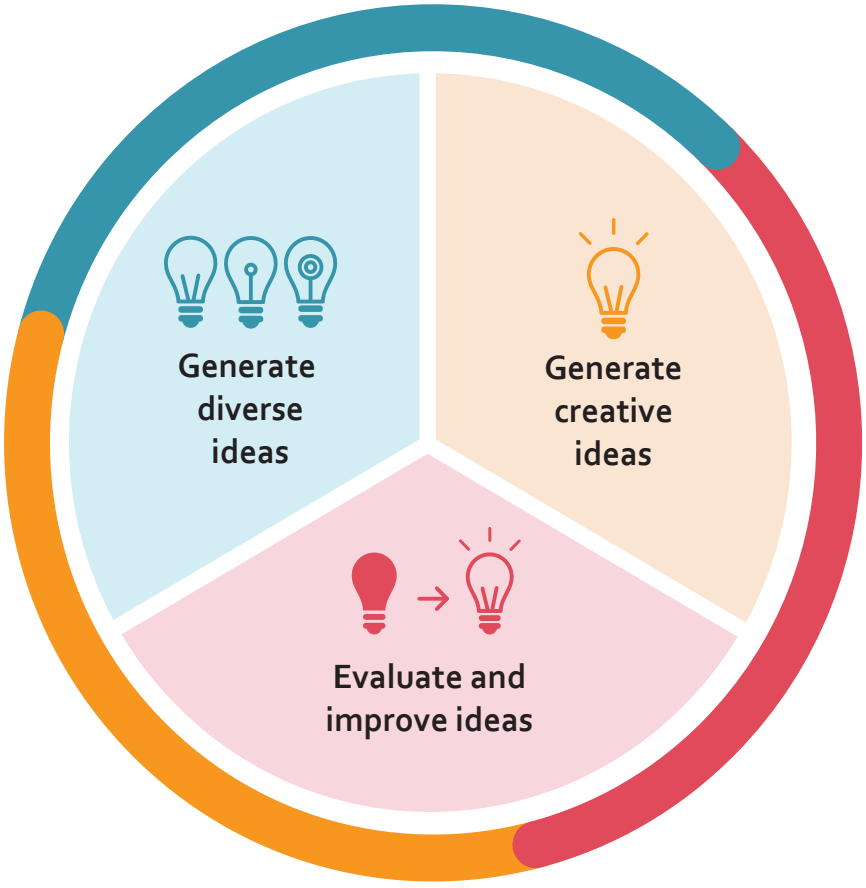
Data collection will continue throughout 2022, and the first PISA report on the creative thinking data is **expected in early 2024.**

How does the PISA test measure creative thinking?

The competency model (Figure 1) describes how the construct of creative thinking has been broken into **three distinct facets** for measurement purposes in the PISA assessment: **'generate diverse ideas', 'generate creative ideas' and 'evaluate and improve ideas'**.

The three facets of the competency model reflect the PISA definition of creative thinking (page 11) and encompass. the cognitive skills required for creative thinking in the classroom. The competency model also incorporates **both divergent cognitive processes** (the ability to generate diverse ideas and the ability to generate creative ideas) and **convergent cognitive processes** (the ability to evaluate other people's ideas and identify improvements to those ideas).

Figure 1 Competency model: facets of creative thinking



Generate diverse ideas

Typically, attempts to measure creative thinking have focused on the number of ideas that individuals are able to generate – often referred to as 'ideational fluency'. Going one step further is 'ideational flexibility', or the capacity to generate ideas that are different to each other. When it comes to measuring the quality of ideas that an individual generates, some researchers have argued that fundamentally different ideas should be weighted more than similar ideas (Guilford, 1956).

The facet 'generate diverse ideas' encompasses these ideas and refers to a student's **capacity to think flexibly by generating multiple distinct ideas.** Test items for this facet will present students with a stimulus and ask them to generate two or three appropriate ideas that are as different as possible from one another.

Generate creative ideas

Creative ideas and outputs are generally defined as being both novel and useful. Clearly, expecting 15-year-olds around the world to generate ideas that are totally unique or novel is neither feasible nor appropriate for this assessment. In this context, 'originality' is a useful concept as a proxy for measuring the novelty of ideas. Defined by Guildford (1950) as "statistical infrequency", originality encompasses the qualities of newness, remoteness, novelty, or unusualness, and generally refers to deviance from patterns that are observed within the population at hand. In the PISA assessment context, originality is therefore a relative measure established with respect to the responses of other students who complete the same task.

The facet 'generate creative ideas' focuses on a student's **capacity to generate appropriate and original ideas.** 'Appropriate' means that ideas must demonstrate a minimum level of usefulness. This dual criterion ensures the measurement of *creative* ideas – ideas that are both original and of use – rather than ideas that make random associations that are not meaningful. Test items for this facet will present students with a stimulus and ask them to develop one original idea.

Evaluate and improve ideas

Evaluative cognitive processes help to identify and remediate deficiencies in initial ideas, as well as ensure ideas or solutions are appropriate, adequate, efficient and effective (Cropley, 2006). Being able to provide feedback on the strengths and weaknesses of others' ideas is also an essential part of any collective knowledge creation effort.

The facet 'evaluate and improve ideas' focuses on a student's **capacity to evaluate limitations in ideas, iterate, and improve their originality**. Test items for this facet will present students with a given scenario and idea and ask them to suggest an original improvement. An 'original improvement' is defined as a change that preserves the essence of the initial idea, but that adds or incorporates original elements.

In which contexts do students think creatively in the test?

Test units are divided among four domain contexts. The **written and visual expression domains involve communicating one's imagination to others**, and creative work in these domains tends to be characterised by originality, aesthetics, imagination, and affective intent and impact. In contrast, **social and scientific problem solving involve investigating open problems.** They draw on a more functional employment of creative thinking that is a means to a better end, and creative work in these domains is characterised by ideas or solutions that are original, innovative, effective, and efficient.

Written expression

Creative writing involves **communicating ideas and imagination through language.** Both fictional and non-fictional writing can be creative, and learning how to express oneself creatively can help students develop effective and impactful communication skills that they will need throughout their lifetimes.

In the PISA test students express their imagination in a variety of written formats. For example, students will caption an image, propose ideas for a short story using a given text or visual as inspiration, or will write a short dialogue between characters for a movie or comic book plot.

Visual expression

Visual expression involves **communicating ideas and imagination through a range of different media.** Creative visual expression has become increasingly important as the ubiquity of desktop publishing, digital imaging, and design software means that nearly everyone will need to design, create, or engage with visual communications at some point in their personal or professional lives.

In the PISA test, students express their imagination by using a digital drawing tool. The drawing tool does not enable free drawing, but students can create visual compositions by dragging and dropping elements from a library of images and shapes. Students are also able to resize, rotate, and change the colour of elements. Students will create visual designs for a variety of purposes, such as creating a clothing design, logo, or poster for an event.

Social problem solving

Young people use creative thinking every day to solve personal, interpersonal, and social problems. These problems can range from the small-scale and personal level (e.g. resolving a scheduling conflict) to the wider school, community, or even global levels (e.g. finding ways to improve sustainable living). Creative thinking in this domain **involves understanding different perspectives, addressing the needs of others, and finding innovative and functional solutions** for the parties involved.

In the PISA test, students solve open problems that have a social focus. These problems focus on issues that affect particular groups within society (e.g. young people) or on issues that affect society at large (e.g. the use of global resources or the production of waste materials). Students are asked to propose ideas or solutions in response to a given scenario, or to suggest original ways to improve others' solutions.

Scientific problem solving

Scientific problem solving involves **generating new ideas and understanding, designing experiments to probe hypotheses, and developing new methods or inventions.** Students demonstrate creative thinking as they engage in a process of scientific inquiry by exploring and experimenting with different ideas to make discoveries and advance their knowledge and understanding.

Although creative thinking in science is related to scientific inquiry, the tasks in this domain differ fundamentally from the PISA scientific literacy tasks. In this test, students are asked to generate multiple distinct ideas or solutions, or an original idea or solution, for an open problem for which there is no pre-defined correct response. In other words, the tasks measure students' capacity to produce diverse and original ideas, not their ability to reproduce scientific knowledge or understanding. For example, in a task asking students to formulate different hypotheses to explain a phenomenon, they would be rewarded for proposing multiple plausible hypotheses regardless of whether one of those hypotheses constituted the right explanation for the phenomenon.

How does PISA score student responses?

Tasks in this assessment are open-ended, meaning there are essentially infinite ways of demonstrating creative thinking. Scoring therefore relies on **human judgement following detailed scoring rubrics and well-defined coding procedures.**

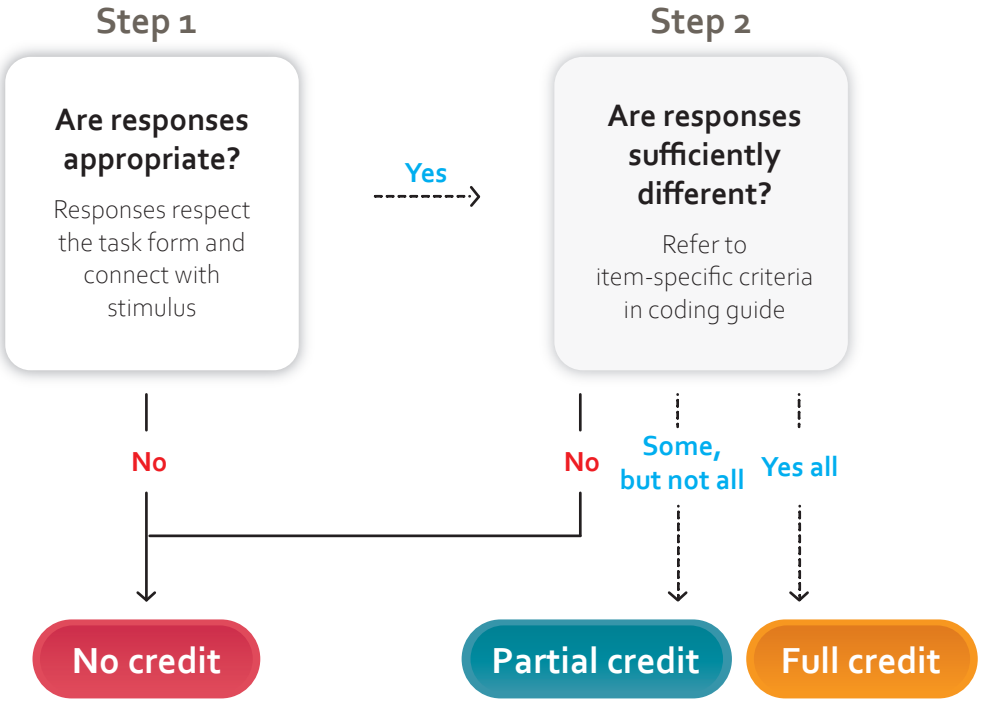
All items corresponding to the same facet of the competency model apply the same general coding process, but the item-specific criteria for evaluating responses varies by task and domain. The **detailed coding materials describe the item-specific criteria and provide example responses** to help human coders score consistently.

Scoring methods for 'generate diverse ideas' items

All 'generate diverse ideas' items require students to provide two or three responses. **The general coding procedure for these items involves two steps** (Figure 2). First, coders determine whether responses are **appropriate**. Second, coders determine whether **responses are sufficiently different** from one another, based on item-specific criteria described in the coding guide.

The item-specific criteria are as objective and inclusive as possible of the range of different potential responses. For example, for a written expression item, sufficiently different ideas must use words that convey a different meaning (i.e. are not synonyms). For items in the problem solving domains, the coding guides list pre-defined 'categories' of responses to help coders distinguish between similar and different ideas. The **coding guides provide detailed example responses and explanations** for how to code each example.

Figure 2 General coding process for generate diverse ideas items



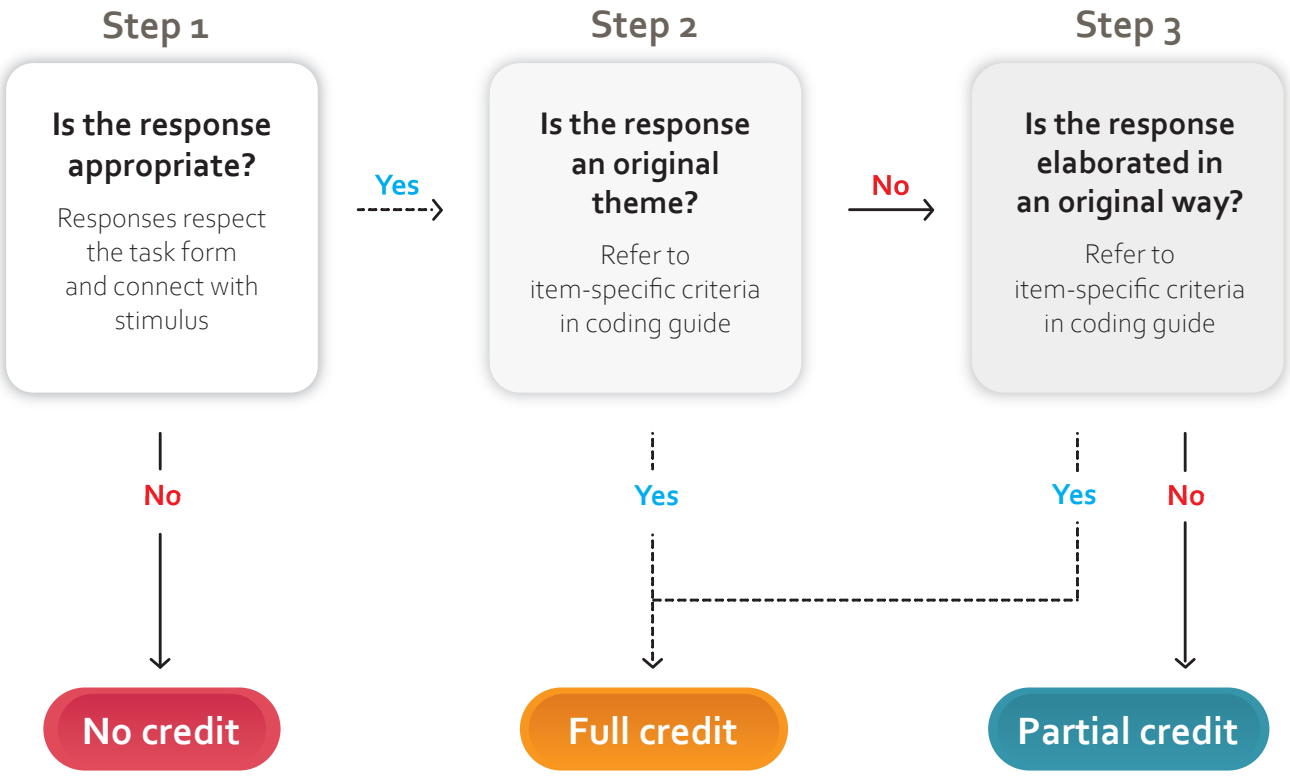
Scoring methods for 'generate creative ideas' items

All 'generate creative ideas' items require a single response. **The general coding procedure for these items involves two or three steps** (Figure 3). First, coders determine whether the response is **appropriate**. Then, coders determine whether the response is original by considering two criteria.

An original idea is defined as relatively uncommon with respect to the entire pool of responses. The coding guide identifies conventional themes for each item, according to the patterns of genuine student responses revealed in multiple validation studies. **If a response does not correspond to a conventional theme, it is directly coded as original.**

If the response corresponds to a conventional theme, coders determine whether it is **elaborated in an original way**. For example, a student might add a twist to a conventional story idea. This twofold originality criterion ensures the scoring takes into account both the general theme and the details of a response.

Figure 3 General coding process for generate creative ideas items



Scoring methods for 'evaluate and improve ideas' items

All 'evaluate and improve ideas' items require a single response, and generally ask students to adapt a given idea in an original way rather than coming up with an idea from scratch. **The general coding procedure for these items involves the same steps as above** (Figure 3). However, an **appropriate response must be both relevant and an original improvement.** The coding guide provides item-specific criteria, examples, and explanations to help orient coders. For appropriate responses, coders establish **originality** by considering the same two criteria as for 'generate creative ideas' items.

How have the test and scoring approach been validated?

In an international assessment like PISA, cultural, socio-demographic, and linguistic **validity issues need to be taken into account throughout the entire test design and development process.** This includes considerations about (a) how creative thinking is defined and its relevance across cultures and population groups; (b) students' familiarity with task and item formats; and (c) accessibility of item content, in terms of domain readiness required and the clarity and appropriateness of task instructions and stimuli. To investigate these issues and ensure the validity, reliability, and comparability of the PISA creative thinking test, **several validation activities were undertaken** throughout the test development process.

Validation activities

1
Face validity reviews

Experts in the measurement of creative thinking and participating countries in PISA have engaged in **several cycles of review of the assessment framework, test material, and coding guides** to validate the construct definition, task contexts, item stimuli, and scoring criteria. These review exercises have helped to identify and eliminate possible sources of cultural, gender, and linguistic bias.

2
Cognitive laboratories

Experienced test development professionals conducted **cognitive laboratories with students in three countries** participating in PISA in three continents. Students simulated completing the test units and responded to a series of questions in a 'think aloud' protocol while working through the test material, explaining their thought processes and pointing out misunderstandings in the instructions or task stimuli.

3
Small-scale validation exercises

Genuine **student data were collected and scored in a series of small-scale pilot studies.** The analysis of the data was used to identify items that did not perform as intended, informing evidence-based improvements to the test material, coding guide, and scoring procedures.

4

Translatability reviews

Experienced test development and translation professionals conducted translatability reviews to **ensure that all assessment materials (items, stimuli, and coding guides) could be sufficiently and appropriately translated** into the many languages of the PISA main study. This included ensuring a balanced adaptation of the linguistic and cultural references associated with each language group in PISA.

5

Field Trials

The Field Trial provides an opportunity for a **full construct and measurement validation exercise** prior to the Main Study, **undertaken in all participating countries**. Analysis of the Field Trial data is used to exclude test items that demonstrate insufficient validity and score reliability, within and across countries, in addition to differential item functioning. Due to the global disruption to schooling caused by the COVID-19 pandemic, the PISA 2021 study was postponed to 2022. A partial Field Trial was conducted in 2020, followed by a full Field Trial in 2021.

Investigating inter-rater reliability

Ensuring the reliability and comparability of scores is a fundamental principle in all PISA assessments. In the creative thinking assessment, the success of the scoring approach clearly depends on the quality of the scoring rubrics and clear coding processes. The **scoring rubrics and coding guides underwent a rigorous process of verification** throughout the test development cycle, with input from coders in countries participating in PISA on the content and language used in the coding materials.

Inter-rater reliability (i.e. the extent to which two or more coders agree on the code assigned to a response) **was also investigated in all of the validation activities involving the collecting and scoring of student responses**, in line with established PISA practices, in order to understand and address issues of consistency by improving the item design or the coding guidance.

What is in the PISA questionnaires?

In addition to the tests, **PISA gathers self-reported information from students, teachers, and school principals** through the use of questionnaire instruments. In the PISA 2022 cycle, the questionnaire collects **information about various enablers and drivers of creative thinking** that are not directly assessed in the test.

Individual factors

Curiosity and exploration

Items will measure students' **curiosity, openness to new experiences, and disposition for exploration.** Scales on openness were informed by the extensive literature on the relationship between personality and creativity, as well as the existing inventory of self-report personality measures that have been used in previous empirical studies focusing on the 'creative person'.

Beliefs about creativity

One scale explores various **beliefs students have about creativity in general**. The items ask students whether they believe creativity can be trained or it is an innate characteristic, whether creativity is only possible in the arts, whether being creative is inherently positive, and whether they hold other beliefs that might influence their motivation to learn to be creative.

Creative self-efficacy

Students will complete items measuring **the extent to which they believe in their own creative abilities,** focusing on their general confidence in thinking creatively as well as their beliefs about how well they are able to think creatively in different domains.

Environmental factors

School environment

The **student, teacher and school principal questionnaires** collect information about students' school environments. Items focus on **student-teacher interactions** (e.g. whether students believe that free expression in the classroom is encouraged) as well as the **wider school ethos.** These items can provide further information on the role of extrinsic motivation on student creative performance (e.g. students' perception of discipline, time pressures, or assessment).

Creative activities in school

The student questionnaire asks students about the **activities in which they participate, both inside and outside of school**, which might contribute to their domain readiness and attitudes towards different creative domains. The **school and teacher questionnaire** will also gather information about **creative activities in the curriculum and extracurricular time.**

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For a more detailed description of the PISA 2022 creative thinking assessment and its theoretical underpinnings, you can consult the full draft assessment framework at:
www.oecd.org/pisa/publications/pisa-2021-creative-thinking-framework.pdf.

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