# MEASURING STUDENT SUCCESS SKILLS: A REVIEW OF THE LITERATURE ON ANALYTICAL THINKING

May 2024

COMPETENCIES OF THE FUTURE

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1. The Center for Assessment completed this work on behalf of the International Baccalaureate® (IB) in its effort to conceptualize future competencies as a goal for learning and measurement.


2. We acknowledge the support and feedback from Carla Evans at the Center for Assessment whose ideas and suggestions improved this paper. Thanks also to Catherine Gewertz, whose edits improved the clarity of our work.




4. Brandt, W.C., and Lorié, W. (2024). *Measuring student success skills: A review of the literature on analytical thinking.* National Center for the Improvement of Educational Assessment.

# MEASURING STUDENT SUCCESS SKILLS: A REVIEW OF THE LITERATURE ON ANALYTICAL THINKING


## INTRODUCTION

The ability to think analytically is vital in today's world. In an era defined by rapid technological advancements, economic globalization, and societal complexities, analytical thinking skills are paramount to career success. According to the World Economic Forum's "Future of Jobs Report" (2023a), employers rank analytical thinking as the most important skill for workers. Similarly, research conducted by the McKinsey Global Institute (MGI) indicated that analytical skills such as advanced data analysis will be among the fastest growing skills employers need over the next decade (Bughin et al., 2018).

Analytical thinking has been conceptualized and defined in a variety of ways, reflecting its multifaceted nature and the diverse contexts in which it operates. At its core, analytical thinking represents the ability to break down problems, systems, or ideas into component parts, identify patterns or relationships among data, draw conclusions, and articulate how the parts relate to the whole. This perspective underscores the importance of skills like critical thinking, creative thinking, problem-solving and communication in supporting analytical thinking (WEF, 2023b). Perceived this way, analytical thinking is often conceptualized as an umbrella concept that encompasses a broad range of higher-order cognitive skills.

Alternatively, analytical thinking may be characterized narrowly, according to its application within a content domain or context. For instance, in mathematics and science education, analytical thinking may involve the ability to identify patterns and relationships in data, formulate hypotheses, and draw evidence-based conclusions. In business, analytical thinking may encompass strategic decision-making based on financial indicators. In historical literature, analytical thinking may involve understanding how complex relationships among characters, events, and settings contributed to significant historical milestones. In this way, analytical thinking is a concept that underpins, or contributes to, other higher-order skills such as critical and creative thinking, problem-solving, and communication.

This paper examines the contradictory definitions of analytical thinking and attempts to reconcile them. While the varying definitions of analytical thinking are paradoxical, they also reflect its broad applicability and significance across diverse domains and contexts and highlights its role as a fundamental competency for future success.

This literature review (a) provides a working definition of analytical thinking, (b) describes how analytical thinking develops for K-12 students, (c) examines different conceptions of how analytical thinking is taught, (d) discusses specific instructional practices that support the development of analytical thinking strategies, and (e) analyzes how analytical thinking has been assessed. The review concludes with implications for the design and use of analytical thinking assessments in K-12 schools.

# DEFINITIONS

## What is Analytical Thinking?

To develop the working definition presented below, we relied on several information sources:

- Standard dictionary definitions
- Research and resources from the economic and business sectors (e.g., World Economic Forum, O*Net)
- Frameworks for 21st century skills that include analytical thinking
- Academic literature in psychology and education

We propose below a working definition of analytical thinking, which is based on a review and synthesis of several prominent and widely referenced definitions in the sources (see Appendix A for a summary of definitions and descriptions in each of the four sources).

> *Analytical thinking* is a cognitive process that consists of (1) identifying and decomposing a complex concept, problem, system, or process into parts, (2) examining those parts and their distinct characteristics or functions, and (3) communicating or articulating how the parts relate to the whole.

*Analytical thinking* is a cognitive process that consists of (1) identifying and decomposing a complex concept, problem, system, or process into parts, (2) examining those parts and their distinct characteristics or functions, and (3) communicating or articulating how the parts relate to the whole.

The purpose of analytical thinking varies, but it is most often used to deeply understand how something works, whether that thing is a concept, problem, system, or process. For example, analytical thinking may be applied to discover trends in data, identify cause and effect relationships, make connections between factors, identify patterns or themes, and develop heuristics. By doing so, analytical thinking also acts as an essential ingredient in problem-solving, critical thinking, and creative thinking.

## Are Analytical Thinking Skills Generic or Discipline-Specific?

The ability to think analytically involves both domain-general and domain-specific aspects. Many domain-general courses in analytical thinking focus primarily on the *process* of thinking analytically, particularly for high school graduates and adult learners. For example, universities and professional organizations offer courses, certifications, and even degrees in analytical thinking, critical thinking, systems thinking, and data analytics.[1] These courses focus on domain-general processes of analysis, such as how to identify the parts of a concept, identify patterns in data, draw inferences, and support conclusions with valid and credible evidence.

Assessments that include discrete analytical thinking components are also common, particularly after high school. College and post-graduate admissions exams such as the SAT, Graduate Record Examination (GRE), Graduate Aptitude Test in Engineering (GATE), and national college entrance examinations (NCEE) (e.g. the Gaokao) are administered in many countries around the world. These exams include sections that focus on analytical thinking. For example, the GRE includes an analytical writing section in which students must evaluate an issue, consider its complexities, and develop an argument to support a particular viewpoint. The

[1] Examples include Harvard's Big Data for Social Good course, The Open University's short course on Analytical Thinking and Problem Solving, and Purdue Global University's Bachelor of Science in Analytics.

demand for such courses and tests suggests that the ability to think analytically and apply analytic processes is essential among a wide array of employers. This demand also suggests that analytic thinking is an essential skill that transcends disciplines.

While analytical thinking has domain-general aspects, researchers have argued that it can be developed only through domain-specific content (McPeck, 1990). Any thinking, including analytical thinking, is necessarily connected to specific objects of thought (McPeck, 1981). From this perspective, courses that purport to teach domain-general skills of analytical thinking can be developed only by applying the analytical thinking process to *something*. Thus, the utility of analytical thinking is bound to specific disciplines and contexts.

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Moreover, content and context affect which sets of analytic skills are more or less important and how adeptly an individual can apply them. As Barshay (2019) explained:

> *In history, students need to interpret documents in light of their sources, seek corroboration and put them in their historical context. That kind of analysis isn't relevant in science, where the source of a document isn't as important as following the scientific method.*

Because what counts as evidence varies across content domains, general analytical thinking skills—like many higher-order cognitive skills—are necessary but insufficient for enabling analysis within a specific discipline (Lai, 2011; Evans, 2020). The instructional implications of analytical thinking as a domain-general vs. domain-specific skills are explained below (see "What are some instructional approaches to teaching analytical thinking?").

## What Is the Relationship Between Analytical Thinking and Other 21st Century Skills?

Organizing frameworks classify 21st century skills in different ways. For example, the National Research Council (2012) organized them into three competencies: cognitive, intrapersonal, and interpersonal. More recently, the Organisation for Economic Co-operation and Development (OECD) expanded these categories to include metacognition, civics and citizenship, and information & communication technology (see Figure 1; OECD, 2023). Analytical thinking, along with skills like creative thinking, critical thinking, and problem solving, are commonly labeled as *cognitive* competencies.

**Figure 1.** ***Categories of 21st Century Skills***[2]

| | | |
|---|---|---|
| **COGNITIVE** (e.g., *analytical thinking*, critical thinking, creative thinking, decision making, problem solving) | **INTERPERSONAL** (e.g., building relationships, communication, collaboration) | **INTRAPERSONAL** (e.g., self-awareness, persistence, flexibility, adaptability) |
| **METACOGNITIVE** (e.g., self-regulation, metacognition) | **CIVIC AND CITIZENSHIP** (e.g., civic engagement, intercultural communication) | **INFORMATION & COMMUNICATION TECHNOLOGY** (e.g., digital literacy, media literacy) |

[2] The Harvard Easel Lab also includes a helpful taxonomy of many 21st century skills frameworks. More information can be found here: http://exploresel.gse.harvard.edu/

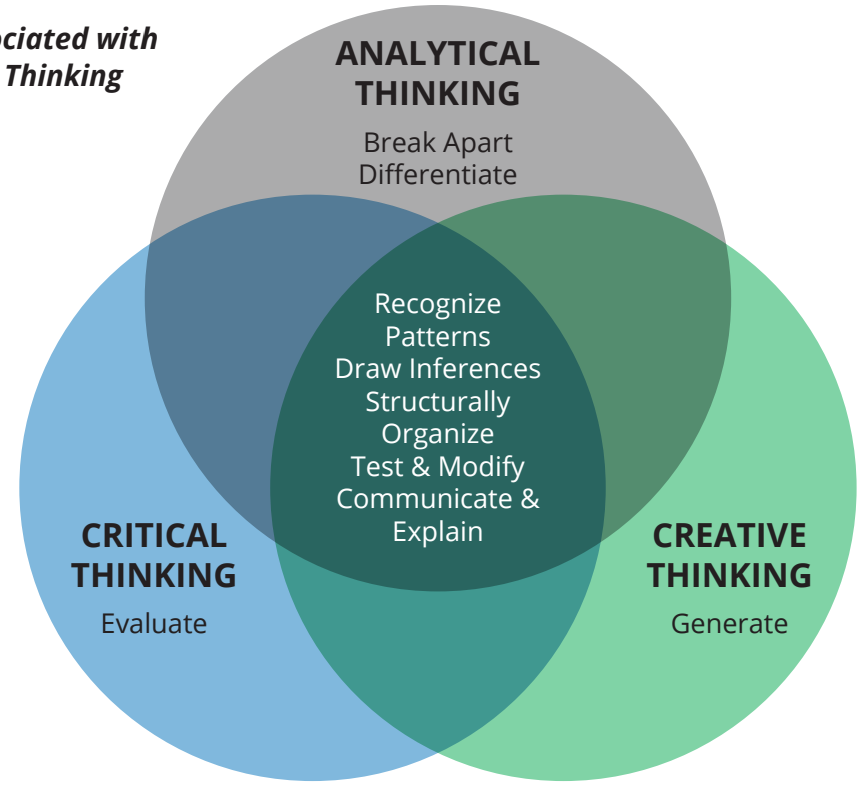
Analytical thinking has been framed as an umbrella term that encompasses many cognitive skills (Kahneman, 2011; WEF, 2023b). Likewise, many cognitive thinking skills include some form of analytical thinking as an essential component. For example, the World Economic Forum's "Defining Education 4.0" taxonomy organizes creativity, critical thinking, digital skills and programming, problem solving and systems analysis under the general label of analytical thinking (WEF, 2023b). Conversely, definitions of critical thinking and creative thinking include aspects of analytical thinking (e.g., examining ideas, refining ideas) as essential sub-skills (Brandt, 2023; Evans, 2020). When viewed in this way, these frameworks may initially appear contradictory. Does analytical thinking subsume critical and creative thinking, or vice versa? A deeper dive into these skills reveals their overlapping nature and how both claims can be true.

A closer analysis of analytical, critical, and creative thinking illustrates the interdependencies across these skills. Formal definitions of critical and creative thinking can be paraphrased as follows:

- *Critical thinking* is done for the purpose of evaluating, making a judgment, or deciding about something. It involves interpreting, *analyzing*, evaluating, and inferencing, as well as explaining the evidence upon which a judgment is based (Ennis, 1989; Facione, 1990).
- *Creative thinking* is done for the purpose of making something (e.g., a product or idea) that is both novel and useful. It involves generating and manipulating ideas, testing and modifying those ideas through *critical analysis* and evaluation, and communicating ideas (Brandt, 2023; Torrance, 1981).

The relationship among these skills—for instance, whether analytical thinking should be thought of as an overarching skill or a subskill of critical and creative thinking—depends on the lens applied to a task or problem. When someone thinks critically about something, analysis is a necessary subskill. When someone wants to create something, analysis is a necessary subskill. And when someone thinks analytically, they might be doing it for the purpose of understanding how something works (analytical thinking), rendering a judgment (critical thinking) or creating something useful (creative thinking). Figure 2 illustrates the overlap in these skills and how the interdependencies of these skills can render different viewpoints about their hierarchical nature.

**Figure 2.** ***Primary Sub-Skills Associated with Analytical, Critical, and Creative Thinking***



The nature of the task determines the hierarchy of thinking skills applied. When an individual thinks *analytically*, they do it for a purpose.

The relationship among these skills—for instance, whether analytical thinking should be thought of as an overarching skill or a subskill of critical and creative thinking—depends on the lens applied to a task or problem.

Analytical thinking is also supported by a host of other skills. Metacognition is a skill that facilitates analytical thinking. Metacognition refers to thinking about one's thinking; it occurs when someone is aware of their own thinking and learning process (Nelson, 1996). Monitoring the quality of one's thoughts makes it more likely that one will engage in higher quality analysis (Lai, 2011) because it guides the selection, evaluation, and correction of cognitive strategies during the analytic thinking process. In other words, analytical thinking is optimized when prior knowledge is consciously selected and applied to a "whole" task or problem, alternative ways of breaking apart the whole are considered and flexibly adjusted, relevant patterns are identified and competently evaluated—all metacognitive processes.

Self-regulation is another skill that influences analytic thinking. Self-regulation is the ability to plan, direct, and control one's emotions, thoughts, and behaviors while engaged in a learning task (Bandura, 1986). Self-regulation acts as a bridge between metacognition and analytical thinking (Lai, 2011). An individual applies self-regulation as they monitor the quality of their thoughts (think metacognitively), and that self-regulation, in turn, supports and strengthens an individual's engagement in analytical thinking (Evans, 2020).

Other inter- and intrapersonal skills are also essential for promoting a suite of cognitive skills that includes analytical thinking. For example, having a growth mindset—believing that intelligence, personality, and abilities are flexible and dynamic—is associated with increased curiosity, persistence, and cognitive performance (Duckworth & Yeager, 2015). Additionally, influential reports from the National Research Council (2012) and the OECD acknowledged that skills such as persistence, curiosity, conscientiousness, collaboration, and communication are overlapping skills that develop in parallel with cognitive skills such as analytic, critical, and creative thinking (Foster and Piacentini, 2023; NRC, 2012).

A strong rationale can be established for using critical thinking as a proxy for analytical thinking, especially when examining promising instructional approaches to develop analytical thinking. This is important because the two terms overlap, and substantially more research has been conducted in educational settings on critical thinking than on analytical thinking. Moreover, prior studies find a strong correlation between analytical and critical thinking skills. For example, using a sample of 433 students from different types of high schools, Demir (2022) reported a correlation of .75 between these students' analytical thinking skills and critical thinking dispositions and found that analytical thinking explained 57% of the variance in critical thinking dispositions (Demir, 2022). Such a strong association between these skills suggests that research focusing on effective instructional approaches to critical thinking may also apply to analytical thinking.

Analogical reasoning is also a suitable proxy for analytical thinking because its definition closely resembles the definition of analytical thinking proposed above. Analogical reasoning is defined as the ability to draw relationships between disparate or dissimilar phenomena, to think relationally, and to make connections between different concepts or ideas (Gentner, 1983; Kao, 2014). When appropriate, research results for critical thinking and analogical thinking are used to support answers to the questions posed in this report about analytical thinking.

# DEVELOPMENT

## How Does Analytical Thinking Develop Over Time?

Three developmentally malleable mechanisms influence children's ability to engage in analytical thinking and other types of complex thinking: executive function, short-term and working memory, and knowledge acquisition.

Three developmentally malleable mechanisms influence children's ability to engage in analytical thinking and other types of complex thinking: executive function, short-term and working memory, and knowledge acquisition. A study by Richland & Burchinal (2013), which included a sample of 1,352 children, found a positive relationship between executive function, inhibitory control, and vocabulary knowledge in early childhood (ages 4-6) and analogical reasoning[3] in high school (age 15). This study's findings suggest that executive functioning, language development, and knowledge development are necessary underpinnings for strong reasoning skills later in life (see also Goswami, 1992). Authors also posited that a focus on these skills in early childhood are essential for students' academic and career success later in life. Notably, several studies have investigated the effects of nurturing these skills on long term academic success; however, the results are mixed (Pascual et al., 2019). Thus, although the research is promising, it remains unclear how these skills are best nurtured in school settings. Additionally, it is unclear whether and how specific types of instructional strategies may affect academic success later in life. Details about executive function, short-term and working memory, and knowledge acquisition are provided below to help explain how analytical thinking develops over time.

### Executive Function

Executive function is an umbrella term that overlaps and is often used interchangeably with self-regulation. Like self-regulation, executive function represents skills required to control one's emotions, focus one's thoughts, and manage one's behaviors while carrying out a learning task. Executive function is more often used in cognitive and developmental psychology and focuses on cognitive actions, while self-regulation is used in social and personality psychology and tends to focus on emotions and behaviors (Sankalaite et al., 2021). Both executive function and self-regulation skills develop rapidly in early childhood and continue to develop throughout childhood (Richland & Burchinal, 2013). Research in behavioral and neurosciences suggests that early and middle childhood (ages 2-12) is when development of executive functioning is especially malleable.

Environmental factors affect the development of executive function. For example, an authoritative and positive parenting style has been found to promote rapid development of executive function (Sadeghi, Ayoubi, & Brand, 2022). Characteristics of an authoritative parenting style include collaborative problem solving, clear rules and expectations, open communication, and natural consequences. Other malleable environmental factors that contribute to executive function include frequent adult-child interactions that emphasize feedback, encouragement, warmth, and closeness. Additionally, cultivating conditions in home, school and community surroundings that promote a child's feelings of safety and security is positively related to executive function ability (Sankalaite et al., 2021).

### Short-Term and Working Memory

Short-term and working memory also influences analytical thinking. More specifically, the ability to reason analytically is limited by working memory capacity (Andrews & Halford, 2002). An individual's capacity to

[3] Analogical reasoning is a close neighbor of analytical thinking. It is associated with applying concepts from one field of knowledge to another (Kao, 2014).

store, retrieve, and hold chunks of information in memory at one time directly relates to their ability to process information analogically and analytically (Kao, 2014). As a child develops, short-term and working memory increases, thereby expanding the child's analytical thinking ability. Empirical studies suggest that working memory—the average number of discrete chunks of information a person can hold and manipulate in their minds to make decisions—increases gradually from birth through adulthood (Miller, 1956; Cowan, 2016).[4] Notably, although analytical thinking may be limited by working memory, analytical thinking and its foundational precursors can develop in students through instruction at all educational levels and across all disciplinary areas (Abrami, 2015).

Knowledge acquisition is another factor influencing analytical thinking. According to the relational-primacy theory (Goswami, 1992), the ability to reason and think analytically is available to children from birth, but limited by their knowledge. Analytic thought requires base knowledge from which a schema is generated, compared against new information, and is then either assimilated into the original schema or modified to accommodate new information. As knowledge expands, children can progress from identifying perceived similarities (e.g., cars and trucks both have wheels) to making relational similarities (e.g., cars: trucks::boats:_____). In problem-solving contexts, relationship similarities are identified by comparing the structure of a problem that has a known solution (the base) to a novel problem with an unknown solution. Thus, within a domain of study, foundational knowledge of a base problem becomes essential in understanding and breaking apart (analyzing) the structure of the novel problem. As knowledge develops, so does the ability to apply analytic thought to decisions and problems. Moreover, the acquisition of relevant (content-based) knowledge frees up working memory, which makes it easier to engage in analytical thinking.

While research is relatively clear about how skills relevant to analytical thinking develop over time, less is known about how analytical thinking skills as a stand-alone construct and its related dispositions develop over time (Lai, 2011). Empirically validated learning progressions for analytical thinking are not well established. Learning progressions exist, but they tend to be embedded in subject-area standards and have not been empirically validated across the K-12 continuum. That said, developmental milestones—represented as broad stages of development—have been developed for critical thinking and include aspects of analytical thinking. For example, the Australian Council for Educational Research (ACER) developed a general critical thinking framework, which adopts the Delphi Commission's definition of critical thinking and identifies "analysis" as one of six sub-domains (Heard et al., 2020). ACER's framework describes three levels of critical thinking skill development (low, medium, high) across three strands: (1) knowledge construction, (2) evaluating reasoning, and (3) decision-making. Additionally, Papp et al. (2014) developed broad developmental milestones of critical thinking for physicians and nurses. Notably, authors caution that these milestones may not apply to all contexts and content areas. Finally, content-specific learning progressions of critical thinking may be under development (e.g., see Nuri et al., 2023), but the empirical basis underlying such progressions is still in its infancy. More research is needed to examine the development of students' analytical

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More research is needed to examine the development of students' analytical thinking skills over time.

[4] Average working memory estimates vary based on the nature of the chunks selected for study. For example, the average 15-year-old can hold about seven chunks of information in working memory when measured using digits. This shrinks to about three or four chunks when measured using words.

thinking skills over time. Practitioners interested in supporting the development of students' analytical thinking could focus on supporting the subskills described in detail above (executive function, short-term and working memory, knowledge acquisition) along with general analysis skills such as breaking ideas or concepts into parts, examining the relative strengths of each, and then communicating how the parts relate to the whole.

## What Might Be Distinct About Analytical Thinking Across Contexts and Cultures?

Research has examined how culture influences critical thinking (Wang, 2017) and creative thinking (Shao et al., 2019); not analytical thinking distinctly. However, the overlapping relationships among critical, creative, and analytical thinking makes this literature relevant to analytical thinking.

Findings from research suggest that students from cultures that value collectivism—prioritizing the group over individuals within it—may be less inclined to engage in thinking that is, by definition, critical, evaluative, and judgmental (Lun et al., 2010). This may be especially true when students are asked to debate and challenge an authority figure's actions or ideas. Notably, information processing research suggests that Asian students tend to think more holistically, whereas Western students tend to think analytically (Nisbett et al., 2001). According to deOliveira & Nisbett (2017), holistic thinking:

- involves greater attention to context and relationships (e.g. all of life and nature are related),
- embraces the idea that reality is dynamic and constantly changing, and
- accepts contradictions (e.g., opposing propositions may exist in the same object or event).

Conversely, analytical thinking, which dominates Western culture:

- involves greater attention to the attributes of individual objects, and assumes that objects can be understood independent of their contexts,
- embraces the idea that change is linear and predictable, and
- applies rules to reasoning, which influences rejection of proposed contradictions.

Like studies of critical thinking, the research on creative thinking has found that definitions and attributes of creative thinking vary across cultures and contexts. For example, Shao et al.'s (2019) review of creative thinking found that:

- People from different cultures have distinct conceptions of creativity.
- People from different cultures (particularly Eastern vs. Western cultures) show different preferences in terms of valuing specific components of the creative process and output. For example, when evaluating creative output, usefulness tends to be perceived as more important than novelty in Eastern cultures.
- Assessments of creativity tend to incorporate content that is culturally bound. As a result, cross-cultural differences may be attributed to cultural biases inherent in the assessment.

Educators should consider how students' cultural backgrounds might influence how they approach an analytic task.

Findings from these cross-cultural studies have important implications for those who teach and assess analytical thinking. First, educators should consider how students' cultural backgrounds might influence how they approach an analytic task. For example, a student with holistic thinking tendencies may be more inclined to accept a contradictory proposition (e.g., an environmentalist may not recycle his trash), and a student with analytical thinking tendencies may be more inclined to provide critical feedback. Because of this, classroom teachers should provide clear guidelines and expectations for activities and performance tasks that involve analytical thinking. Second, teachers should create a classroom learning environment that supports all students to

expand out of their comfort zones. Third, teachers should engage in regular communication and feedback with students. Doing so will help ensure that students share a common understanding of the learning goals and success criteria related to the activity or task, especially in relation to the analytical thinking process.

Educators should be sensitive to the cultural biases and subjectivities they bring to the creative process and how that might affect students' task or activity engagement and performance.

Finally, educators should be sensitive to the cultural biases and subjectivities they bring to the creative process and how that might affect students' task or activity engagement and performance. For example, educators should guard against stereotyping students as having a holistic or analytic thinking preference solely based on background characteristics (e.g., whether they are from an Eastern or Western country). Although holistic and analytical thinking styles tend to play dominant roles in Eastern and Western countries, respectively, between- and within-country variation in thinking styles is common (e.g., Miyamoto et al., 2013). Subcultures that exist within countries may subscribe to different thinking styles. Moreover, situational factors can override cultural differences. Thus, in any given situation, inferring that someone from an Eastern country will tend to think less analytically than someone from a Western country is unfounded (Wong et al., 2021).

# INSTRUCTION

## What Are the Strengths and Limitations of Domain-General and Domain-Specific Instructional Approaches Based on Research Evidence?

For decades, researchers have debated about how analytical skills as well as cognitive competencies like critical and creative thinking—should be taught (Brandt, 2023; Evans, 2020). Should analytical thinking be taught as a domain-general process? Or is analytical thinking better taught and learned through domain-specific instruction? Though not definitive, recent research suggests that both approaches can be effective.

### The Case for Teaching Analytical Thinking as a Domain-General Process

Research suggests that students are better prepared to demonstrate learning objectives for analytical thinking within specific domains when they:

- understand what it means to think analytically,
- learn general processes involved in thinking analytically, and
- regularly practice applying these processes (Elder & Paul, 2007).

Examples of domain-general and interdisciplinary analytical thinking skills include questioning concepts, breaking apart concepts into discrete pieces, examining how the pieces relate to one another and to the whole, identifying patterns and trends, and using stepwise logic to explain a phenomenon. Learning to apply logic-based principles generally (e.g., transitive property of equality; text-dependent analysis in reading) can develop thinking habits that apply to phenomena and problems across domains (Dwyer, 2017; Thompson, 2018).

These skills are both teachable and essential for understanding phenomena, checking assumptions, and solving real-world problems that emerge across domains. Content knowledge is a necessary but insufficient prerequisite for good analytical thinking (Dwyer, 2017). For example, there are times when being a non-expert is advantageous in understanding a new phenomenon (Epstein, 2019). This is because non-experts are less likely to allow their content-specific biases to influence their decisions. Moreover, content expertise

in specific situations has been observed as unrelated to judgment accuracy and even *negatively* correlated with accuracy (Hammond, 1996; Kahneman, 2011). For example, Kahneman (2011) illustrated how heuristics used by experts may lead them to draw erroneous conclusions based on little evidence. Other research suggests that students who are adept at thinking analytically in one subject may not transfer these skills to other subjects (Dwyer, 2017; Willingham, 2020). Training on general analytical thinking processes is therefore useful for checking assumptions, questioning traditional logic, and validating solutions.

**The Case for Teaching Analytical Thinking Through Specific Domains**

As described above, analytical thought also requires base knowledge from which a schema can be generated, compared against new information, and then either assimilated into the original schema or modified to accommodate new information. To think analytically, one must first have something to think about. Additionally, the acquisition of relevant (content-based) knowledge frees up working memory, which makes it easier to engage in analytical thinking. Those who are trained in a specific domain are better equipped to differentiate relevant from irrelevant information, identify patterns, and draw logical conclusions (Sweller, 2010). For example, Dwyer, Boswell & Elliott (2015) found that those with business expertise (five or more years of practical business experience) scored significantly higher on business-related critical thinking than novices (those with less than five years of experience) and those without business experience. Additionally, experts in teaching science recommend that scientific reasoning be taught in the context of rich subject-matter knowledge. According to the National Research Council (2007), "Teaching content alone is not likely to lead to proficiency in science, nor is engaging in inquiry experiences devoid of meaningful science content (p. 38)."

Ennis (1989) developed a framework of critical thinking instructional methodologies that is applicable to the study of analytical thinking for two reasons. First, critical, and analytical thinking[5] share overlapping definitions and sub-skills. Second, both skills share a similar debate regarding whether to teach them via domain-generic processes or domain-specific content. Table 1 presents Ennis' framework, which clarifies four approaches for teaching critical thinking: general, infusion, and immersion, and mixed.

- ***General:*** general critical thinking skills and dispositions are explicitly taught, but independently of specific subject-matter content.
- ***Infusion:*** critical-thinking skills learning objectives are explicitly taught and practiced through specific subject-matter content.
- ***Immersion:*** critical-thinking learning objectives are practiced through specific subject-matter content; however, critical-thinking objectives are not made explicit.
- ***Mixed:*** critical-thinking skills and dispositions are taught independently, and these skills are also taught via a subject-specific content, through either infusion or immersion.

A meta-analysis revealed that critical-thinking skills and dispositions can develop in students using all four instructional methodologies (Abrami et al., 2015). Specifically, all four of the methods in Table 1 produced significantly positive average effect sizes, with the mixed approach showing the largest effects (ES=.39) Notably though, across-category effect size comparisons were non-significant. This means that differences observed between the four groups may have been due to chance. Abrami et al's (2015) meta-analysis strengthened the evidence regarding the efficacy of various methods for teaching critical/analytical thinking; however, the corpus of research falls short of providing conclusive evidence about the effectiveness of any single approach.

[5] In this context, we refer to an umbrella conceptualization of analytical thinking, which includes skills that are commonly associated with other higher-order thinking skills such as critical thinking and creative thinking.

**Table 1: Effect Sizes of Four Approaches to Critical Thinking (CT)**[6]

| APPROACH | GENERAL CRITICAL THINKING SKILLS (EXPLICITLY OR IMPLICITLY TAUGHT) | SUBJECT MATTER INSTRUCTION | EFFECT ON CT PERFORMANCE[7] |
|---|---|---|---|
| General | Explicit | Low | .26 |
| Infusion | Explicit | High | .29 |
| Immersion | Implicit | High | .23 |
| Mixed (General + Infusion or General + Immersion) | Explicit | High | .38 |

In summary, a growing body of research suggests that analytical thinking is both domain-general and domain-specific. Furthermore, just as nature and nurture influence child development, it appears that both domain-general and domain-specific instructional methodologies influence analytical thinking. There may not be an either/or solution to the domain-general vs. domain-specific debate. Rather, both domain-general and domain-specific instructional approaches appear to demonstrate promise for addressing content-based phenomena and solving real-world problems. That said, content knowledge mediates the processes required for analytical thinking. The type of content a person engages with can significantly influence the development and exercise of analytical thinking skills.

Just as nature and nurture influence child development, it appears that both domain-general and domain-specific instructional methodologies influence analytical thinking.

Content knowledge mediates the processes required for analytical thinking.

Despite a growing research base, questions persist about the efficacy of domain-specific and domain-general approaches to teaching analytical thinking. For example, instructional research overwhelmingly focuses on critical and creative thinking, not analytical thinking specifically. Moreover, analytical thinking emphasizes different sub-skills when applied across distinct domains. As described above, analysis in history is not the same as analysis in mathematics. More research needs to focus specifically on the nature of analytical thinking within domains. Some examples include:

- Which domain-general aspects of analytical thinking are most relevant to instruction within specific domains and/or content?
- To what extent do distinct domain-general instructional principles influence students' ability to transfer their analytical thinking abilities from one domain to another (e.g., instruction on clarifying questions, gathering information, clarifying concepts, disentangling variables, identifying patterns and relationships)?
- Which domain-specific aspects of analytical thinking (e.g., systems analysis, mathematical analysis) tend to be more/less transferable to solving problem in other domains?

[6] Table adapted from Evans, C. (2020). Measuring Student Success Skills: A Review of the Literature on Critical Thinking. Dover, NH: National Center for the Improvement of Educational Assessment, Inc.

[7] Effect size estimates were extracted from Abrami et al., (2015).

- To what extent can domain-general instruction of analytical thinking displace content-based instruction and learning?

## What Do We Know About the Effects of Instructional Approaches on the Development of Analytical Thinking and Related Skills?

In this section, we shift from examining domain-general vs. domain-specific methodologies to examining classroom instructional approaches and strategies. What evidence exists about which instructional approaches and strategies are most effective in improving students' analytical thinking skills? And how confident can we be in the results of existing research?

Research examining the effects of instruction on analytical thinking as a distinct construct is sparse.

Research examining the effects of instruction on analytical thinking as a distinct construct is sparse. We found no large-scale studies that examined effects of instructional approaches or structured interventions on analytical thinking or derivative terms (e.g., analysis, logical/analytical reasoning). Several research studies have, however, examined instructional approaches and strategies that support critical thinking. Moreover, studies have examined the effects of various instructional approaches on executive functioning, which is an important mediator of analytical thinking skills. These studies are summarized below.

### Approaches that Support Critical Thinking Skills

A recent systematic review from Loyens et al. (2023) examined effects of critical thinking, critical-analytic thinking, and higher-order thinking in problem- and project-based learning environments. Of the 28 studies that met review criteria in the Loyens et al. (2023) study:

- No studies focused on critical-analytical thinking,
- Two studies focused on higher-order thinking, defined as "skills that enhance the construction of deeper, conceptually, driven understanding" (p. 5), and
- 27 studies focused on critical thinking specifically.[8]

Loyens et al. (2023) found positive effects of project-based and problem-based learning on both higher-order thinking and critical thinking skills; however, authors noted a lack of clarity and consistency in how researchers conceptualized and measured these thinking skills. Additionally, the study found a variety of design issues in the effectiveness studies included in their meta-analysis (e.g., lack of control groups), suggesting that further studies are needed.

Two meta-analyses (see Abrami et al., 2015; 2008) found that there are effective strategies for teaching critical thinking skills and dispositions both via domain-general and domain-specific instructional approaches. Moreover, these studies identified several effective strategies associated with the development of critical thinking skills and achievement. These included: (1) opportunity for dialogue, (2) exposure of students to authentic or situated problems and example, and (3) mentoring, tutoring, coaching and apprenticeship opportunities that include one-on-one interaction between an expert (the teacher) and a novice (the student).

Willingham (2020) considered the implications of cognitive science research for teaching critical thinking across subject-area domains. Research points to four general principles, which apply to analytical thinking and other deeper learning skills.

[8] One study focused on both critical thinking and higher-order thinking skills using two distinct outcome measures.

- ***Define and clearly communicate the analytical thinking skills required within a specific domain of study.*** This step involves being specific about the tasks that tap into critical thinking skills rather than focusing on the skills themselves. Educators should determine the specific critical thinking skills that students should be able to demonstrate in different subjects, such as mathematics, history, and science. These skills should be explicitly taught and practiced.
- ***Identify the domain content that students must know. It is important to recognize that domain knowledge is a crucial driver of thinking skills.*** Educators should determine the essential knowledge that students need to possess in order to engage in analytical thinking within a specific domain. For example, if students are expected to analyze historical documents, they need to have background knowledge about the relevant historical context.

It is important to recognize that domain knowledge is a crucial driver of thinking skills.

- ***Select the best sequence for students to learn the skills.*** Skills and knowledge build on each other, so educators should determine the most effective sequence for students to learn critical thinking skills. Just like in mathematics and history, where concepts are taught in a specific order, critical thinking skills should also be taught in a logical sequence that allows students to build upon their existing knowledge.
- ***Decide which skills should be revisited across years.*** Studies have shown that students tend to forget about half of the content they have learned within three years. Therefore, it is important to plan for long-term retention of critical thinking skills by revisiting and reinforcing these skills over multiple years. This ensures that students have ample practice and opportunities to apply critical thinking skills in various contexts.

**Approaches that Support Executive Functioning Skills**

Studies have shown a strong relationship between executive function and analytical reasoning (Richland & Burchinal, 2013). The Center on the Developing Child at Harvard University (2014) developed a guide that synthesizes numerous activities for enhancing and practicing executive function skills from infancy through adolescence. Effective strategies for school-aged children include structured activities to encourage goal-setting, planning, and self-monitoring (see also Yarbro & Ventura, 2018). These strategies work best when the focal activity is meaningful to the student, and when scaffolding, positive teacher-student interactions (Sankalaite et al., 2021), and formative feedback (Black & Wiliam, 1998) are provided for students who may struggle to independently implement these strategies. Additionally, interventions such as Positive Behavioral Interventions and Supports (PBIS) and related multi-tiered systems of support, when implemented with fidelity, have been found to impact students social-emotional functioning, particularly for the most disruptive students (Bradshaw et al., 2012; Nitz et al., 2023).

In summary, research that examines the effects of specific instructional approaches on analytical thinking is sparse. As a result, even empirically based recommendations regarding best practices for teaching analytical thinking skills should be interpreted with caution. Several limitations in the existing corpus of research on analytical thinking and related skills preclude us from making definitive conclusions about the efficacy of various instructional approaches. A few salient limitations are listed below.

- Definitions of analytical thinking cited in research vary widely.
- Some research designs leave open the possibility that factors other than the focal instructional approach/strategy under investigation were responsible for the outcomes found.

- We found no studies that examine the efficacy of interventions or instructional approaches on K-12 students' analytical thinking skills specifically.

## MEASUREMENT/ASSESSMENT

### How Is Analytical Thinking Typically Measured or Assessed?

Analytical thinking is typically measured through standardized tests and performance-based assessment tasks. A summary of common measures and scoring rubrics used is provided below.

Analytical thinking is typically measured through standardized tests and performance-based assessment tasks.

**Standardized Tests**

Standardized tests and admissions exams such as the SAT, GMAT, LSAT, and GRE include sections devoted to measuring students' analytical thinking and reasoning skills. Table 2 provides a list of several prominent standardized tests that measure and report scores specifically for analytical thinking and related higher-order thinking skills.

Internationally, high-stakes proficiency tests often measure analytical thinking skills, but most do so indirectly. For example, the Programme for International Student Assessments (PISA), GATE (India), Gaokao (China), Korean SAT, and Hong Kong Diploma of Secondary Education (HKDSE) test for content-based understanding. These tests embed items that require students to apply analytical thinking. Although an analytical thinking score is not separately reported on test score reports, their inclusion underscores that analytical thinking is a valued competency globally.

**Table 2.** ***Prominent Standardized Measures That Include Analytical Thinking Components***

| MEASURE | DESCRIPTION | AGE OR GRADE-LEVEL(S) | ANALYTICAL THINKING SCORE REPORTED? |
|---|---|---|---|
| Graduate Management Admission Test (GMAT) | The GMAT includes Quantitative Reasoning and Verbal Reasoning sections that focus on critical reasoning, data literacy, problem-solving, critical thinking, and reading comprehension skills. The Integrated Reasoning section also requires test-takers to analyze data presented in various formats and draw conclusions (GMAC, 2024). | Post-undergraduate | Subscores are reported for induction, deduction, observation, credibility and identification of assumptions. |
| Graduate Record Examination (GRE) | The GRE includes an Analytical Writing section that evaluates students' ability to analyze complex issues, develop coherent arguments, and articulate ideas effectively. These sections require test-takers to analyze an issue and present an argument or analyze an argument presented in a passage (ETS, 2024). | Post-undergraduate | Reports scores for five subdomains including: drawing inferences, recognizing assumptions, deducing, interpreting, and evaluating arguments. |

| | | | |
|---|---|---|---|
| Law School Admission Test (LSAT) | The LSAT consists of sections that assess various skills, including analytical reasoning, logical reasoning, and reading comprehension. The Analytical Reasoning section, also known as Logic Games, requires test-takers to analyze relationships and solve complex problems using logical deductions (LSAC, 2024). | Post-undergraduate | Reports seven subscore dispositions: truth-seeking, open-mindedness, anticipating consequences, proceeding in a systematic way, being confident in the powers of reasoning, and being inquisitive (or resistant) in learning |
| SAT | The SAT includes a Critical Reading section that assesses students' ability to analyze and interpret written passages, draw logical conclusions, and evaluate arguments. Additionally, the SAT Essay section requires students to analyze and critique an argument presented in a passage (College Board, 2024). | A pre-SAT version is available for grades 8-10. The SAT is typically administered in grades 11-12. | Reports eight subscores: analysis, interpretation, inference, evaluation, explanation, induction, deduction, and numeracy |
| Cornell Critical Thinking Test (CCTT) | The CCTT is a series of assessments designed to measure various cognitive skills, including analytical thinking. It includes tasks that require students to analyze data, make predictions based on evidence, and identify patterns or relationships (The Critical Thinking Company, 2023). | Grades 5-12 | Subscores are reported for induction, deduction, observation, credibility and identification of assumptions. |
| Watson-Glaser | The Watson-Glaser assesses various aspects of critical thinking, including analytical thinking. It evaluates skills such as recognizing assumptions, drawing inferences, and interpreting information, which are central to analytical reasoning (Pearson, 2023). | Age 16 and above | Reports scores for five subdomains including: drawing inferences, recognizing assumptions, deducing, interpreting, and evaluating arguments. |
| California Critical Thinking Skills Test (CCTST) | CCTST assesses critical thinking skills across different dimensions, including analysis, interpretation, inference, and evaluation. Analytical thinking is integral to these dimensions, as it involves breaking down information, identifying patterns, and drawing logical conclusions (Facione, 1991). | Age 15 and above | Reports seven subscore dispositions: truth-seeking, open-mindedness, anticipating consequences, proceeding in a systematic way, being confident in the powers of reasoning, and being inquisitive (or resistant) in learning |

| | | | |
|---|---|---|---|
| EDUCATE INSIGHT Reasoning Skills | INSIGHT offers a Numerical Reasoning Test and an Assessment Suite – Analytical Reasoning Test, among others. These assessments measure specific cognitive skills, including analytical thinking, by presenting test-takers with tasks that require logical reasoning, problem-solving, and decision-making (Insight Assessment, 2024). | Grades K-12 | Reports eight subscores: analysis, interpretation, inference, evaluation, explanation, induction, deduction, and numeracy |

Standardized tests have several strengths. They undergo rigorous development and validation processes, and they are designed to be objective measures of what a student knows and can do. They tend to be efficient tools for assessing large numbers of individuals in a relatively short time. This makes them practical for high-stakes purposes such as school accountability, college admissions, program services (gifted, special education), and policy evaluation.

Standardized tests also have limitations. One limitation is the potential for cultural bias. Standardized tests that intend to measure higher-order thinking are generally normed based on the knowledge and values of majority groups, which can create bias against minority groups, including gender, race, community status, language background, socioeconomic status, and culture (Kim & Zabelina, 2015). To guard against cultural bias, assessment items and tasks should be carefully reviewed by a diverse group of experts for cultural relevance and other potential sources of implicit bias (e.g., students with disabilities). Additionally, performance differences among students with different background characteristics should be examined via differential item functioning (DIF) analyses for potential bias before test items and/or tasks are widely administered in large-scale assessment contexts. Finally, caution is needed when interpreting scores of standardized tests of analytical thinking, particularly when these tests are administered to students from diverse geographies, cultures, and backgrounds.

It is important to gather information from multiple sources and measures when making inferences about a student's analytical thinking skills and abilities.

In standardized tests of analytic thinking, another limitation is the disparate ways in which analytical thinking is defined and measured. Analytical thinking definitions vary widely, and measures of analytical (and critical) thinking consist of different sub-domains and sub-scales. This means that the scores and interpretations of a student's analytical thinking skills will vary from one test to another. For example, Watson-Glaser Critical Thinking measures a different set of underlying skills than the California Critical Thinking Skills Test. Similarly, skills measured in the SAT's "problem solving and data analysis" subscore are different from the underlying skills measured in EDUCATE INSIGHT's "analysis" subscore. Scores generated from these tests have different meanings and require different interpretations. It could be misleading to conclude that a student is a highly adept analytical thinker (or the opposite) based on scores from one of these tests, since the underlying skills measured are distinct from other measures of analytical thinking. For this reason, it is important to gather information from multiple sources and measures when making inferences about a student's analytical thinking skills and abilities.

**Performance-Based Assessments**

High-quality performance-based assessments require students to apply and/or transfer their knowledge and skills to novel contexts. Performance-based assessments involve students doing, making, or producing

something such as writing a report, solving a complex problem, creating a product, designing an experiment, and presenting a solution. These products are then evaluated against specific criteria from a rubric or scoring guide.

A few organizations and researchers have created rubrics to assess various types of analytical thinking and analysis skills. These rubrics accompany performance-based assessment tasks or project-based learning experiences. Examples include the GRE Analytic Writing Rubric (ETS, 2024), the Inquiry & Analysis VALUE Rubric [American Association of Colleges and Universities (AAC&U), 2024], and the SAT Essay's Analysis rubric (College Board, 2024). These rubrics have undergone extensive expert review and have established acceptable levels of inter-rater reliability (e.g., see Bresciani et al., 2009).

Performance-based assessments are well-suited to gather evidence of students' level of sophistication in applying analytical thinking skills and dispositions (Evans, 2020). This is largely because they allow individuals to demonstrate their skills and knowledge in real-world contexts or tasks that closely resemble the tasks they will encounter in academic, professional, or everyday settings. This authenticity enhances the relevance and validity of the assessment. Moreover, performance assessments are often more engaging for individuals than traditional standardized tests, as they involve active participation and hands-on activities. This increased engagement can lead to deeper learning and a better understanding of the material being assessed. Finally, performance assessments can provide rich, qualitative feedback that goes beyond numerical scores. Observations, comments, and critiques from assessors can help individuals understand their strengths and areas for improvement in a more meaningful way.

Performance-based assessments also have limitations. First, they can be resource-intensive in terms of time, personnel, and materials. Evaluating performance tasks often requires trained assessors and detailed scoring rubrics, which may not be feasible for large-scale assessments. Many performance-based assessments rely on human judgment. When administered across a large population of students, this influences their subjectivity and increases the potential for inconsistent and unreliable scoring. Performance-based assessments also tend to be narrow in scope. The information gleaned from one performance assessment may not provide sufficient information about a student's analytical thinking ability beyond the assessment's explicit objectives. For example, a low score on an analytical writing test may suggest that a student struggles to formulate and write a well-developed examination of an argument about World War II. However, within a different domain—mathematics or science, for example—the student may excel in their ability to apply analytical thinking to solve a complex problem.

Standardized measures and performance-based assessments offer unique strengths that can be leveraged to provide a comprehensive understanding of individuals' abilities, knowledge, and skills. When used together strategically, they can offer a more holistic and nuanced assessment of individuals' competencies.

When used together strategically, standardized and performance-based assessments can offer a more holistic and nuanced assessment of an individual's analytical thinking skills.

## What Are the Measurement/Assessment Issues Related to Analytical Thinking?

### Distinguishing Among Conflated Definitions

One issue that affects the measurement and assessment of analytical thinking is the disparate definitions of analytical thinking. A clear construct definition is the foundation of sound measurement and assessment. Unfortunately, the research literature often conflates analytical thinking with other cognitive skills such as critical thinking and creative thinking. Additionally, definitions of analytical thinking can vary, and this can

make analytical thinking susceptible to construct underrepresentation and misinterpretation. This compromises validity for the announced use. For example, someone might think they are measuring general analytical thinking ability when, in fact, they may be measuring a specific form of analytical thinking such as systems thinking or data analysis.

A clear construct definition is the foundation of sound measurement and assessment.

The propensity to conflate terms is quite common and has been called the jingle-jangle problem. The jingle problem is when the same term is defined differently across research traditions (Duckworth et al., 2019), and the jangle problem is when different terms are used to refer to the same construct. The jingle-jangle problem makes it difficult to tease apart the differences between analytical thinking and other skills. However, doing so is important. This is because valid, reliable, and fair assessment relies on a clear understanding of the skills and abilities to be measured. One objective of this paper is to show that definitions of analytical thinking vary widely in research literature. Therefore, researchers, practitioners, and test developers should be clear about how they define and operationalize analytical thinking in the assessment design and scoring process.

Varying definitions represent the wide range of contexts in which analytical thinking is applied, and the range of skills that encompass analytical thinking. Whichever definition an educator chooses to adopt should align with the claims they want to make about what a student knows and can do. A clear definition makes it easier to (a) clarify the desired inferences that educators expect to make from assessment results, (b) determine what evidence will be collected, and (c) design or select assessment approaches and tools that provide information to elicit the appropriate evidence and support valid inferences (Mislevy & Haertel, 2006).

**Controlling for Mediating Factors**

Another issue affecting analytical thinking measurement and assessment is that mediating factors often are difficult to control, or isolate, when designing assessments and measures of analytical thinking. As described above, analytical thinking skills are mediated by a range of other skills and dispositions. For example, when a student cannot transfer skills from one domain to another, it might be because they need

Analytical thinking skills are mediated by a range of other skills and dispositions.

- more domain-specific instruction,
- more instruction on analytical thinking skills (e.g., practicing breaking a concept into its component parts, differentiating among those parts, or drawing inferences from component relationships),
- more instruction to improve dispositions such as self-efficacy and persistence, or
- an environment or task that addresses unique language or cultural issues that may have affected the student's performance.

Content knowledge and dispositional skills, as well as environmental and cultural considerations, all potentially confound analytical thinking outcomes. Therefore, the design of analytical thinking measures—and especially standardized measures—must account for the potential role of these factors in an individual student's analytical thinking development and performance (Foster & Piacentini, 2023).

**Eliciting Sufficient Evidence to Support Desired Inferences**

A third issue involves eliciting sufficient evidence to support desired inferences of students' analytical thinking skills. Sufficiency and generalizability are two important concepts in educational assessment and measurement. Sufficiency refers to the extent to which the assessment adequately covers the breadth and

depth of the construct being measured within a specific context. It focuses on ensuring that the assessment task or items effectively capture the full range of skills and abilities associated with the targeted construct. Generalizability is the measurement analog to transfer in learning (Marion & Evans, 2018). Generalizability pertains to the extent to which the assessment results can be applied or generalized to broader situations, contexts, and content areas. For any future competency, making valid and reliable inferences about what a student knows and can do requires attention to both sufficiency and generalizability.

Sufficiency and generalizability are two important concepts in educational assessment and measurement.

In determining how much evidence is sufficient, Marion & Evans (2018) offered the following suggestions:

- ***Identify the intended uses of the assessment(s).*** Ensuring sufficiency is important in summative assessment, particularly when the stakes are high. If the focus is on formative feedback, sufficiency is less important.
- ***Develop explicit student claims and include transfer/generalizability claims.*** If you want to claim that student competence extends beyond the performance on the single assessment or set of assessments, then carefully evaluate whether the set of assessments adequately represents the target of your inferences (such as analytic writing) and provides enough information to support your decisions.
- ***Be clear about your tolerance for being wrong.*** The higher the stakes (such as denying a student a chance to progress), the more important it is to have sufficient information to support the decision.
- ***Carefully balance having too little information with the tradeoffs associated with obtaining more.*** This balance is especially important when information comes from assessments that are administered separate from instruction.

For example, below are two claims. The first claim is typically for mathematics educators, and the second claim is typical for language and literature educators:

- ***Mathematics claim:*** students can interpret and draw conclusions from data presented in tables and graphs, identifying trends, patterns, and relationships
- ***Language and literature claim:*** Students can analyze characters, settings, plot events, and themes in historical fiction texts, demonstrating an understanding of how these elements contribute to the overall meaning and impact of the story

Although both claims incorporate essential components of analytical thinking, the content knowledge and skills required to apply analytical thinking across these two claims are quite different. The first claim (math) requires knowledge of numbers, graphs, charts, and a range of ideas/concepts they could represent. The second claim (ELA) might conceivably require an understanding of specific historical events, personal development, human relationships, and how historical context might influence decision-making. Assessment evidence collected to support the mathematics claim would likely be insufficient to support the ELA claim. Moreover, an educator's ability to generalize across content areas or context would likely require administering multiple assessments in both subjects across time and sampling from a variety of situations. Although this example illustrates the concepts of sufficiency and generalizability by comparing standards across two different content areas, these same concepts hold true within the same content area or topic.

## What Are the Implications of Research for Assessment Design and Use?

The findings described above have several implications for assessment design and use. The section below provides general principles for both large-scale and classroom-based use.

**Assessment Design**

***Define the construct.*** Analytical thinking is a complex and multidimensional construct that overlaps with other 21st century skill cognitive competencies (e.g., critical thinking, creative thinking). As a result, definitions of analytical thinking vary widely. Valid, reliable, and fair assessment begins with a clear understanding of the characteristics (i.e., the knowledge, skills, and dispositions) that are represented in analytical thinking. Moreover, relying on any subset of these characteristics underrepresents the construct and can mislead users into thinking they have more information than they really do (Marion & Domaleski, 2024).

***Evaluate the defining characteristics to support intended use.*** Not all analytical thinking assessments reflect comprehensive or research-based definitions of the analytical thinking process. Educators should consider the assessment's construct definition and then ask, "What analytical skills and abilities does this assessment really assess?" For example:

- Do the underlying dimensions of analytical thinking, as described in the assessment's definition of analytical thinking, accurately reflect the predominant research-based frameworks?
- Does the assessment's definition reflect all aspects of the analytical thinking process, or is it designed to assess only a few (e.g., breaking apart, differentiating, inferencing)?
- Is the assessment's definition congruent with the user's intended use of the assessment?

With regard to the second question, robust measures of specific aspects of analytical thinking may be useful for improving particular subskills of analytical thinking, provided they are not mistaken for the comprehensive process of analytical thinking itself. A clear understanding of how analytical thinking was defined and operationalized can support educators to use the results in ways supported by the collected evidence.

***Utilize principles of evidence-centered design.*** The most useful assessments elicit observable evidence and allow students to demonstrate the highest forms of analytical thinking, whether it be within a content area or via general learning contexts. Evidence centered design (ECD) is a process for developing assessments of hard-to-observe constructs like analytical thinking. ECD incorporates validity arguments into the design process, rather than seeking validity evidence after administration. ECD views an assessment as an evidence-based argument, using things that students say, do, or create to make inferences about the extent of their knowledge, skills, and abilities (Mislevy & Haertel, 2006). In this way, ECD is especially relevant when designing items or performance tasks that include analytical thinking as an outcome. Through the ECD process, assessment developers delineate types of evidence—an interrelated set of knowledge, skills, and abilities— known to reflect a construct or competency. This collection of evidence is then structured to reflect the relative importance in demonstrating each competency. Rubrics or scoring guides can be designed to capture the intended evidence (e.g., divergent thinking, experimentation, elaboration), and the weight of that evidence, toward measuring the overall competency. Finally, cycles of iteration typically are needed to refine the rubric.

Evidence centered design (ECD) is a process for developing assessments of hard-to-observe constructs like analytical thinking.

***Account for content and context.*** Content and context affect the types of analytic strategies that students must access and how these strategies are applied. As we described above, a historical analysis of World War II military strategies requires skills that are qualitatively distinct from a financial analysis of tech-based companies.

General analytical thinking skills—like many higher-order cognitive skills—are necessary but insufficient for enabling analysis within a specific discipline (Lai, 2011; Evans, 2020). This does *not* imply that analytic thinking skills should exclusively be taught through content. As indicated above, courses that explicitly teach

analytical thinking skills have been shown to be effective in terms of enabling students to transfer those skills to a variety of problems and contexts. What it *does* imply is that an individual's ability to demonstrate analytical thinking skills will be influenced by their depth of content knowledge, prior experiences, and ability to transfer skills to novel contexts or problems.

From an assessment perspective, claims about a student's analytical thinking skills are limited to the content assessed and the context(s) in which the assessment(s) occurred. Thus, it is important for assessment designers to be clear about the claims they want the assessment(s) to support (Marion & Evans, 2018).

***Review the test materials for face validity.*** In this context, face validity is the extent to which what is measured by a test, task, or item is understood similarly by students who speak different languages or represent different cultural groups. Ideally, the assessment should be reviewed by experts in the measurement of analytical thinking and who are familiar with the cultural groups being tested. This often happens through committee, in which groups of experts independently evaluate the assessment and then convene to compare judgments. This results in a set of judgments about the content validity of the items or tasks and may also involve recommendations for improving the assessment's quality. The content review should focus on evaluating the assessment items and tasks to ensure that:

- the assessment's language is understood similarly across groups,
- the assessment is unlikely to produce construct-irrelevant variance—score variance that is unrelated to analytical thinking ability—by virtue of its language or other design features, and
- the assessment is free of cultural bias.

***Conduct cognitive laboratories.*** Cognitive laboratories ("cognitive labs") provide evidence of student response processes, which is one of the main sources of validity evidence. Cognitive labs involve providing a draft assessment to a student who then engages with the test materials out loud. For example, a teacher might ask the student to "read the directions aloud and then talk through what you are thinking as you engage with the task." Cognitive labs are also known as "think alouds." They are a valuable and efficient way to gather feedback from students about the quality and understandability of the tasks and items created. The information produced can help educators understand whether the directions to the task are clear, students are drawing on the knowledge and skills thought necessary to approach and complete the task, and students are calling on the cognitive processes that we believe the task would require.

***Conduct small-scale pilot studies.*** In such a study, the assessment is given in at least one classroom for validation purposes. An analysis of the results can reveal whether the assessment's items are performing as intended, both in general and for targeted groups of students. Any problematic items are then revised.

***Conduct a field trial.*** A field trial serves to confirm that any problems identified in the pilot study were successfully addressed by giving the assessment to a larger, representative sample of the target population. This process provides the opportunity to conduct a comprehensive review of the assessment prior to administering it to the whole target population. Analysis of student data or annotations of student work can be undertaken to ensure that the assessment is measuring what it is designed to measure and, further, that the results support valid interpretations across racial, ethnic, and other cultural groups.

Applying these procedures is important for ensuring valid interpretations of test results in any case, but particularly where students have different socio-cultural backgrounds.

**Assessment Use**

***Use a range of assessment information to support analytical thinking.*** Earlier in this section, we submitted the idea that a robust assessment design starts with a clear definition of the construct. This idea holds true

for assessment use. Educators who want to assess analytical thinking comprehensively should incorporate a variety of summative tools and formative strategies in their practice. They should consider gathering evidence from numerous sources that include self and peer assessment, teacher observations, as well as teacher and expert feedback on student work products.

Educators who want to assess analytical thinking comprehensively should incorporate a variety of summative tools and formative strategies in their practice.

***Prioritize assessment practices that complement promising instruction.*** The research base linking specific instructional strategies to the development of analytical thinking skills is sparse. Additionally, research on instructional practices to promote higher-order thinking is promising but far from well-established. Although the field is not definitive about which instructional strategies are most effective for promoting specific higher-order skills, there are some well-established and reliable principles of good instruction. Approaches such as project- and problem-based learning are two examples that reflect many of these principles of good instruction. Additionally, strategies for improving executive functioning such as goal-setting, planning, and self-monitoring are associated with stronger analytical thinking skills. These strategies work best when the focal activity is meaningful to the student, and when scaffolding, positive teacher-student interactions, and formative feedback are provided (see Black & Wiliam, 1998; Sankalaite et al., 2021; & Yarbro & Ventura, 2018).

***Practice formative assessment.*** Research underscores the importance of ongoing formative assessment practices to support the development of analytical thinking skills over time. Formative assessments provide timely feedback to students, allowing them to reflect on their thinking processes, identify areas for improvement, and refine their analytical approaches. Educators can use formative assessment strategies, such as peer feedback, self-assessment, and structured reflection activities, to scaffold students' development of analytical thinking skills and promote continuous growth and learning.

Research underscores the importance of ongoing formative assessment practices to support the development of analytical thinking skills over time.

***Use assessment to improve environmental conditions for analytical thinking.*** The environment in which one learns to think analytically is an important lever for integrating analytical thinking into students' and teachers' everyday behaviors. Schools that attend to the conditions supporting analytical thinking and associated skills (e.g., ensuring school safety, providing social-emotional support) tend also to promote analytical thinking and performance. Additionally, students learn through interactions with their environment. Parents, adults, and community members who regularly model analytical thinking will influence children to engage in analytical thinking. Collectively, by practicing analytical thinking, adults create an environment for students that is conducive to thinking analytically.

## CONCLUSION

Analytical thinking is a vital cognitive skill if students are to thrive in the information age. It involves breaking down complex concepts, problems, systems, or processes into parts, examining those parts, and understanding how they relate to the whole. Analytical thinking is closely related to other 21st-century skills such as critical thinking and creative thinking, and it is influenced by factors such as executive function, short-term and working memory, and knowledge acquisition. Instructional approaches to teaching analytical

thinking can be both domain-general and domain-specific, and both approaches have shown promise in developing students' analytical thinking skills. Standardized tests and performance-based assessments are commonly used to measure and assess analytical thinking, but there are challenges in defining and assessing it due to varying definitions and mediating factors. Further research is needed to explore the specific nature of analytical thinking within different domains and to establish more conclusive evidence on the effectiveness of instructional approaches. By incorporating the findings from this research into their development and assessment practices, assessment experts and educators alike can better support students in developing analytical thinking skills.

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# APPENDIX A

## Definitions and Descriptions of Analytical Thinking

To develop the working definition presented below, we relied on several information sources:

- Standard dictionary definitions
- Research and resources from credible labor organizations (e.g., World Economic Forum, O*Net)
- Frameworks of 21st century skills that include analytical thinking
- Academic literature in psychology and education

The following working definition of analytical thinking is based on a review and synthesis of several prominent and widely referenced definitions found in the sources just noted:

Analytical thinking is a deliberate cognitive intellectual process that consists of (1) identifying and decomposing a complex concept, problem, system, or process into parts, (2) examining those parts and their distinct characteristics or functions, and (3) communicating or articulating how the parts relate to the whole.

The sections below summarize findings across each of the four sources listed above.

### Standard Dictionary Definitions

Table 1A presents definitions of *analysis* from four widely used English-language dictionaries. This sampling of definitions reveals three noteworthy characteristics of analysis. First, all four dictionaries include the notion of *separating something (a "whole") into its parts.* This is consistent with the etymology of the word, whose ancient Greek root literally means "a breaking up, a loosening, a releasing" (Online Etymology Dictionary, n.d.). Second, three of the definitions explicitly refer to understanding a whole by studying its parts and *their relationships and interrelationships.* Third, all definitions indicate that analytic thinking is done for a particular purpose, with two definitions specifying that analysis is done for *the purpose of understanding and explaining the nature and meaning of something.*

**Table 1A.** ***Definitions of Analysis from Four Widely Used English-Language Dictionaries***

| DICTIONARY | DEFINITION |
|---|---|
| American Heritage Dictionary (2022) | a. The separation of an intellectual or material whole into its constituent parts for individual study<br>b. The study of such constituent parts and their interrelationships in making up a whole<br>c. A spoken or written presentation of such study |
| Merriam-Webster Dictionary (2022) | 1a. A detailed examination of anything complex in order to understand its nature or to determine its essential features: a thorough study<br>1b. A statement of such an examination<br>2. Separation of a whole into its component parts |
| Britannica Dictionary (n.d.) | 1a. A careful study of something to learn about its parts, what they do, and how they are related to each other<br>1b. An explanation of the nature and meaning of something |
| Collins English Dictionary (2023) | 1. The division of a physical or abstract whole into its constituent parts to examine or determine their relationship or value<br>2. A statement of the results of this |

Specialized uses of the term analysis often emphasize a particular characteristic of its definition. For example, a common definition of analysis used in chemistry emphasizes the first characteristic: separating a whole into parts (e.g., a *chemical analysis* reveals the components of a compound such as water or soil). Terms such as *systems analysis* in engineering and business, *analysis of variance* in statistics, *analysis* in philosophy, and *psychoanalysis* in psychology represent the second characteristic: a study of relationships and interrelationships between a whole and its parts.

**Research and Resources from Credible Labor Organizations**

Our synthesis of definitions also included a review of credible organizations focused on workforce readiness and economic development; specifically, the World Economic Forum (WEF) and O*NET. The WEF is an independent international organization that engages leaders globally to improve the state of the world. Since 2016, WEF has published a bi-annual Future of Jobs Report. These reports are based on a survey-based data set that covers job trends and labor expectations among the world's largest employers (WEF, 2023a). The Future of Jobs Reports are a robust source of information for understanding and analyzing skill-related needs globally. Additionally, the WEF developed two global skills taxonomies—*Education 4.0 Learning Taxonomy and the Global Skills Taxonomy*—which were developed by leading experts, employers, and practitioners to help businesses, learning providers, and governments with faster adoption of skills-based practices and approaches.

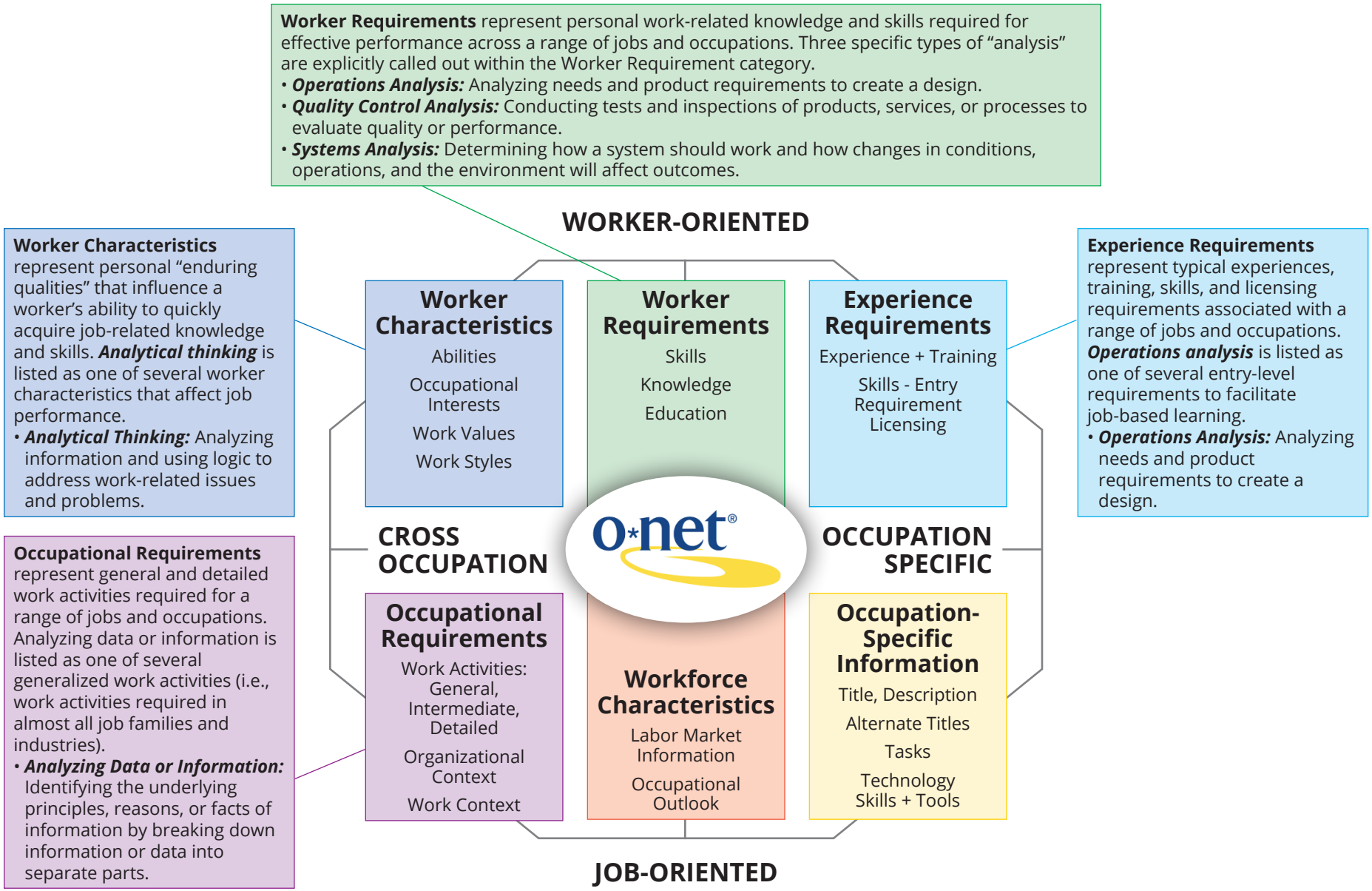
We also incorporate findings from the O*NET database. O*NET is managed under the sponsorship of the U.S. Department of Labor and provides information about occupations and occupational requirements across several dimensions. While the O*NET program is the primary source of occupational information in the United States, the database covers occupations that are not limited to a U.S. context and includes information on skills and occupations that, like WEF, are relevant globally.

In its *Global Skills Taxonomy* (GST), the WEF defines *analytical thinking* as "[the] capacity to break down concepts and complex ideas into basic or fundamental principles. WEF's definition of analytical thinking incorporates critical thinking, whereby judgments are made by analyzing and interpreting facts and information." (WEF, 2023b). The WEF's *Education 4.0 Learning Taxonomy* (E4LT) places five skills (*creativity, critical thinking, digital skills & programming, problem solving, and systems analysis*) in a *cognitive (analytical)* category, described as "skills that emphasize structured thinking and calculation, deductive and inductive reasoning, and development of understanding by functional analogy in various contexts" (WEF, 2023b). A strong conceptual association between *analytical thinking* and *critical thinking* in the broader literature on these skills is evident in the GST's mapping of the first in its framework, to the second, in the E4LT's.[9] We say more about the relationship between analytical, critical, and creative thinking in this report (see "Definitions" section above).

Figure 1 presents O*NET's Content Model, which was developed based on an extensive analysis of the knowledge, skills, and abilities required for specific occupations. The model reflects the character of occupations through two main descriptors: those that are (1) job-oriented and those that are (2) worker-oriented. Each descriptor includes three major domains that specify key attributes and characteristics of workers (three boxes at the top of Figure 1) and occupations (three boxes at the bottom of Figure 1). The O*NET Content Model labels and explicitly defines analytic thinking and several derivative terms within all three of the major worker domains and one of the job-oriented domains.

[9] In the E4LT, *critical thinking* is defined as "deductive reasoning to infer logical conclusions, and inductive reasoning to infer greater generalized understanding, with respect to making sound judgements, including those related to decision-making and comparisons of potential outcomes of hypothetical scenarios; the ability to engage with seemingly contradictory sets of information, for instance, with regard to media literacy." (WEF, 2023b)

**Figure 1.** ***References to Analytical Thinking and Analysis in the O*NET Content Model***



***Worker characteristics*** represent personal work-related knowledge and skills required for effective performance across a range of jobs and occupations. Here, analytical thinking is described as a personal "work style" associated with a broader category of *practical intelligence*. Notably, analytic thinking is *not* defined as a distinct cognitive ability; rather, it is included as a descriptive element associated with a work style.[10] *Analytical thinking* is defined as "analyzing information and using logic to address work-related issues and problems." As will be seen below, more specific "analysis" terms associated with analytical thinking represent aspects of analytical thinking that are content-, context-, and purpose-dependent.

***Worker requirements.*** O*NET organizes worker requirements into distinct skills, knowledge, and education requirements. Three specific types of "analysis" are explicitly grouped as "cross-functional skills" and defined as follows:

- *Operations analysis:* Analyzing needs and product requirements to create a design.
- *Quality control analysis:* Conducting tests and inspections of products, services, or processes to evaluate quality or performance.
- *Systems analysis:* Determining how a system should work and how changes in conditions, operations, and the environment will affect outcomes.

A comparison (or analysis) of each sub-skill definition suggests two things. First, analytical thinking is operationalized differently according to specific context demands. For example, quality control analysis focuses on testing and inspecting something, whereas systems analysis focuses on determining *how* something works. Moreover, different types of analysis are operationalized to meet distinct purposes. For example, operations analysis is done for the purpose of *creating* or designing something; quality control analysis is done for the purpose of *evaluating* something; and systems analysis is done for the purpose of *solving a particular problem.*

***Experience requirements.*** Operations analysis (same definition as above) is again listed as a specific entry-level skill requirement for jobs that require "developed capacities used to design, set up, operate and correct malfunctions involving application of machines and technological systems" (O*NET, 2024). The reference to operations analysis here highlights the context and content-dependencies associated with different types of analytical thinking. In this case, operations analysis refers to analysis of operations conducted specifically on machines and technological systems.

***Occupational requirements.*** O*NET lists occupational requirements to describe content and activities associated with occupations. The O*NET database distinguishes between generalized, intermediate and detailed work activities. Generalized work activities represent activities that are commonly identified across nearly all occupations. Analyzing data or information is listed as one of four generalized mental processes commonly performed in jobs; it is defined as follows:

> Analyzing Data or Information: Identifying the underlying principles, reasons, or facts of information by breaking down information or data into separate parts.

Due to its affiliation with highly generalizable work activities, it is perhaps not a surprise that "analyzing data or information" closely reflects the essence of analytic thinking: to break down and separate into parts. We noted above that this same essence of analytical thinking was revealed in standard dictionary definitions.

**Frameworks of 21st Century Skills That Include Analytical Thinking**

*"21st century skills"* refers to valued cognitive, emotional, or behavioral inter- and intra-personal characteristics developed through educational experiences, and not connected exclusively to a single

[10] See Work Styles, listed under the major category, Worker Characteristics, in Figure 1.

academic content area, grade, or course of study. 21st century skills are also referenced by other names, such as competencies of the future, student success skills, durable skills, soft skills and social-emotional learning (SEL) skills. Analytical thinking, critical thinking, creativity, collaborative problem-solving, and resolving conflicts constructively are some examples of 21st century skills.

Sources of 21st century skills and skill frameworks are numerous. A recent report by ETS and the Carnegie Foundation lists twelve major competency-based frameworks (Liu et al., 2023) and Harvard's Ecological Approaches to Social Emotional Learning (EASEL) maps 40 21st century skills frameworks, including many that are not explicitly SEL-focused (Harvard Graduate School of Education, n.d.). Examples of prominent 21st century skills frameworks include the *Battelle for Kids Partnership for 21st Century Learning's Framework for 21st Century Skills* (Battelle, 2019), the CASEL *Framework for Systemic Social and Emotional Learning* (CASEL, 2022), and the *ACT Holistic Model of Education and Work Success* (ACT, 2022).

Four of the 40 frameworks (10%) in EASEL's database make some reference to "analytical thinking" (e.g., analytic, analyze). However, none of these frameworks names "analytical thinking" or "analytic thinking" as a distinct skill. Connecticut's *Components of Social, Emotional, and Intellectual Habits* framework for kindergarten through grade 3 (CSDE, 2018) calls out "critical and analytical thinking." By contrast, "critical thinking" or some variant (such as "critical thinking skills" or "critical thought") appears in eight (20%) of EASEL's frameworks. In another five frameworks, "critical thinking" appears in combination with another concept, including "analytical thinking" in the aforementioned "critical and analytical thinking," but also "decision-making," "independence" and "problem solving."

It would be premature to conclude that the underlying ideas of analytical thinking are absent from these frameworks. The P21 definition for "critical thinking and problem solving" uses "analyze" or "analysis" four times:

- Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems
- Effectively analyze and evaluate evidence, arguments, claims, and beliefs
- Analyze and evaluate major alternative points of view
- Interpret information and draw conclusions based on the best analysis (Batelle for Kids, 2019, p. 4)

EASEL employs a coding scheme with 18 descriptors under a "Critical Thinking" umbrella. One of these explicitly references "analyze," and at least one other descriptor aligns closely with general dictionary meanings of *analysis*:

> *Employs strategies to analyze information, evidence, and/or arguments (including assessing assumptions, separating fact from opinion, questioning validity, verifying information, and/or listening and observing)*
>
> *Systems thinking; understands the complexity of systems and actors (including how parts interact with the whole) (Harvard Graduate School of Education, n.d.)*

Fifteen of EASEL's frameworks (38%) include skills coded with one or both descriptors.

Both in the P21 definition of "critical thinking and problem solving" and in the number EASEL frameworks with analysis-relevant dimensions, we can conclude that although 21st century skills sources do not foreground analytical thinking in their frameworks, two common dictionary characteristics of analysis are integral to their other skills, especially those with "critical thinking" or "problem solving" in their names. These two characteristics are (a) studying a whole by learning about its parts and their interrelationships, and (b) explaining the nature and meaning of something.

**Academic Literature in Psychology and Education**

In a 2014 special issue of *Educational Psychology Review*, Patricia Alexander recounts how 18 scholars from varied disciplines gathered the previous year for a two-day conference to discuss the question, "What does it mean to thinking critically and analytically and how can critical-analytic thinking be measured and fostered in our children and youth?" (Alexander, 2014, p. 469). Participants came to consensus on several characteristics of critical-analytic thinking (or CAT), including that it is effortful, deliberate, and engages "System 2"[11] processes. In the same issue, Byrnes & Dunbar (2014) address the problem of defining CAT by adopting a categorical approach, which abandons definitions in favor of describing "characteristic features" of CAT. Among those, they include:

> It is *analytic*, because it involves separating out and scrutinizing the elements of evidence gathering and evidence evaluation process (e.g., such as a theory and the evidence to support this theory; the individual steps of a reasoning chain and the permissible inferences between them. (p.481, emphasis in original)

We note here the connection of "separating out … the elements" to the first dictionary sense of *analysis*.

Table 2A includes definitions of analytical thinking and related terms—including critical-analytic thinking, analogical reasoning, analyzing, analysis, analyze, and critical thinking—from twelve academic sources. The definitions corroborate definitions of critical-analytic thinking, as well as the dictionary definitions listed above. Salient characteristics that emerge across these definitions include: a process of breaking something into parts, examining and explaining those parts, identifying relationships, differentiating, organizing, and drawing inferences from what is observed.

[11] See Work Styles, listed under the major category, Worker Characteristics, in Figure 1. "System 2" is often contrasted with "System 1." Both refer to modes of thinking. System 1 is fast, intuitive, and unconscious, while System 2 is slower and more deliberate. As Da Silva (2023) notes, "[System 2] is in charge of conscious thought, reasoning, problem solving, and decision making." (p.1057).

**Table 2A.** ***Prominent Definitions of Analytical Thinking and Related Terms***

| AUTHOR(S) (YEAR) | REFERENCED TERM | DEFINITION | NOTES |
|---|---|---|---|
| Adhiya and Laksono, 2018 | Analytical Thinking | Analytical thinking is the competence in differentiating, organizing and relating an object, theory, problem or event, and can determine the relation of those aspects based on certain reason, principle or function. | |
| Anderson et al., 2001; Krathwohl, 2002 | Analyzing | Breaking materials or concepts into parts, determining how the parts relate to one another or how they interrelate, or how the parts relate to an overall structure or purpose. | Mental actions included in this function are differentiating, organizing, and attributing, as well as being able to distinguish between the components or parts. When one is analyzing, he/she can illustrate this mental function by creating spreadsheets, surveys, charts, or diagrams, or graphic representations. |
| Bloom et al., 1956 | Analysis | The ability to break down or distinguish the parts of material into its components so that its organizational structure may be better understood. | Documented examples of verbs that relate to analysis: (1) analyze, compare, probe, inquire, examine, contrast, categorize (2) differentiate, contrast, investigate, detect, survey, classify, deduce; (3) experiment, scrutinize, discover, inspect, dissect, discriminate, separate. |
| Byrnes & Dunbar, 2014 | Critical-Analytic Thinking | Critical-analytic thinking refers to the processes we use when we question or at least do not simply passively accept the accuracy of claims as givens. | A distinguishing feature [of critical-analytical thinking] compared to critical thinking is its focus on justification and determining whether appropriate and credible evidence supports a claim or proposed response (Murphy et al., 2014)...critical-analytical thinking research literature puts the processes of weighing the evidence at the forefront (p. 39). |
| Facione, 1990 | Critical Thinking | Critical thinking is purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based. | Defines analysis as one of six components of critical thinking. Characteristics of analysis listed in this report include (1) examining ideas, (2) identifying arguments, and (3) analyzing arguments. |
| Foundation for Critical Thinking (FCT), 2019 | Analyze | To break up a whole into its parts, to examine in detail so as to determine the nature of, to look more deeply into an issue or situation. | Noted in the FCT definition of analyze: All learning presupposes some analysis of what we are learning, if only by categorizing or labeling things in one way rather than another. |

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| Gentner, 1983 | Analogical Reasoning | Analogical reasoning is the ability to draw relationships between disparate or dissimilar phenomena. | |
| Halpern, 2003 | Critical Thinking | The use of cognitive skills or strategies that increase the probability of a desirable outcome. It is used to describe thinking that is purposeful, reasoned, and goal directed—the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions, when the thinker is using skills that are thoughtful and effective for the particular context and type of thinking task. | |
| Kahneman, 2011 | System 2 Thinking | System 2 (slow) thinking allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration. | System 2 is contrasted with System 1 (fast) thinking, which is thinking that operates automatically and quickly, with little or no effort and no sense of voluntary control. |
| Kao, 2014 | Analogical Reasoning | Analogical thinking involves mapping two domains or situations and bringing across inferences from the more familiar domain to the less familiar domain. | |
| Sternberg, 2006 | Analytical Thinking | Analytical thinking involves abilities to (1) take apart a problem and understand its parts, (2) explain the functioning of a system, the reasons why something happens, or the procedures of solving a problem, (3) compare and contrast two or more things, or (4) evaluate and critique the characteristics of something. | |
| Thaneeranonon, et al., 2016 | Analytical Thinking | Analytical thinking is about breaking things (situations, practices, problems, statements, ideas, theories, arguments) down into their component parts. | Analytical thinking is blended with critical thinking, especially as a part of the problem-solving process, considered essential for providing the skills required to prepare children for a more complex life and work environment in the 21st Century (p. 124). |
| University of Minnesota (2024) | Analytical & Critical Thinking | Analytical & critical thinking comprehensively explores issues, ideas, knowledge, evidence and values before accepting or formulating an opinion or conclusion. | Core competencies of analytical & critical thinking:<br>- Recognize there may be more than one valid point of view<br>- Evaluate an issue or problem based on multiple perspectives, while accounting for personal biases<br>- Identify when information is missing or if there is a problem, prior to coming to conclusions and making decisions. |

# MEASURING STUDENT SUCCESS SKILLS: A REVIEW OF THE LITERATURE ON ANALYTICAL THINKING


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