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Critical Thinking: A Key Competency in the Twenty-First Century to Deal with Uncertainty and Complexity

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Background

The essence of critical thinking is suspended judgment; and the essence of this suspense is inquiry to determine the nature of the problem before proceeding to attempts at its solution. (Dewey, 1910, p. 225)

According to many observers, today's world is more complex and uncertain than ever before. Much of the increased complexity is self-made, through technology and bureaucracies. As a result, solving complex problems has become one of the key skills of the twenty-first century. But what does that mean? Complex problems have different characteristics, each of which requires special skills: reducing complexity, living with intransparency, dealing with conflicting goals, and understanding the dynamics of a complex system. Critical thinking is a key factor when it comes to dealing with uncertainty and complexity. Problems today are no

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longer merely about finding information but also about evaluating the information found. In addition, value systems are important decision-making aids in dealing with conflicting goals. An important goal of educational institutions is to anchor critical thinking in their curricula.

What Are the Key Competencies in the Twenty-First Century?

In Europe, in the middle of the nineteenth century, during the Enlightenment, compulsory schooling of young citizens began, which institutionally taught the basic skills of reading, writing, and arithmetic. The pedagogical concepts of the nineteenth century still have an impact today. In the twentieth century, this mode of teaching was refined, and memorization was one of the requirements of school education. In the twenty-first century, we need other (additional?) skills. In the age of search engines, it is no longer merely the acquisition and possession of information that is important, but the evaluation of the information found. Some colleagues see a weakness in the metacognitive monitoring and control function that regulates our thinking as an obstacle on our way to rationality (they name it "metacognitive myopia," see Fiedler et al., 2023).

There are several initiatives dealing with the key skills of the twentyfirst century. For example, the "Assessment and Teaching of 21st Century Skills" (ATC21S) initiative was founded by large commercial companies (including Cisco, Intel, and Microsoft) from six countries (see Griffin et al., 2012). However, the OECD's (= Organisation for Economic Cooperation and Development, Paris) DeSeCo report (Rychen & Salganik, 2001) at the beginning of the twenty-first century also describes the new demands on the education system. These demands were reflected, for example, in the OECD's global PISA (= Programme for International Student Assessment) studies and have led to the inclusion of the area of "problem-solving" into their global data collection in the wave of 2012 (see, for more background, Csapó & Funke, 2017). The OECD wants to provide policymakers with important indicators for economic growth by collecting data every three years, since 2000, from 15-year-old pupils (the next generation, the "coming workforce") all over the world under standardized conditions (more than 100 countries and economies participating). The international survey addresses not only basic curricular competencies like reading, mathematics, and science but also extracurricular competencies like problem-solving or collaboration skills that are by-products in school.

The OECD (2020) sees the necessity for a "21st Century Curriculum" to prepare students for a world of challenges and opportunities (p. 7); and even more: "Among skills, attitudes and values for 2030, cognitive skills are the most highly emphasised, e.g. critical thinking (66%) and problem-solving (59%), both in almost all subject areas; this suggests that these cognitive skills are considered highly transferable across any learning areas. The meta-cognitive skills, learning–to-learn, also included in all areas but to a lesser extent (36%). Attitudes and values are also included in curriculum but to a lesser extent, e.g. respect (31%) in areas such as national language, humanities; trust (15%)." (p. 9).

Solving Complex Problems

Research on dealing with complex problems (Dörner & Funke, 2017; Frensch & Funke, 1995) has not provided solutions for the wicked problems of the twenty-first century but has at least been able to describe their characteristics. The five characteristics of a complex problem include:

1. *Complexity*. The complexity of an issue here initially means, quite pragmatically, that we are dealing with a subject area that consists of different variables, which in their multitude and interactions exceed the processing capacity of a human problem solver and therefore require measures to reduce complexity, such as abstraction or simplification. The choice of the appropriate level of resolution is important for complex issues, as the choice of further procedures depends on this decision. This choice depends on the goals of the problem solver: for the butcher, the brain of a cow is not a particularly important body part—it is not considered in a differentiated way, but disposed of; for

the neuroanatomist, on the other hand, a highly complex world opens up because they do not want to dispose of brains, but rather to understand their complicated functioning.

- 2. *Interconnectedness*. Interconnectedness can only exist where several variables are involved. It refers to the fact that in complex situations, not only are several variables involved, but these variables are also interdependent. Therefore, modeling is required on the part of the person acting.
- 3. *Dynamics*. The characteristic of dynamics poses a particular challenge to the person solving the problem: While static problems (e.g., a single chess position) allow for intensive thinking without the situation changing, dynamic problems also have a special form of momentum, that is, the system develops on its own without the intervention of the person acting. Dynamic processes therefore require the ability to assess developments over time. Dynamic chess could mean, for example, that a piece is moved by an invisible hand every few minutes—not a pleasant idea.
- 4. Lack of transparency. This property of a situation appears in two forms: Either you cannot gather all the important information that would be necessary to make a decision due to a lack of time (*temporal* intransparency), or you have plenty of time but cannot get the information you need for reasons of principle (*structural* intransparency). Lack of transparency requires the person solving the problem to decide which information is still to be obtained or how the available information can be evaluated.
- 5. Polytelia (from the Greek word $\pi o \lambda \upsilon \tau \epsilon \lambda o \sigma$ polytelos, many goals). A polytelic, that is, multi-objective problem brings the problem-solving person into value conflicts: How can I achieve one goal without giving up another (Blech & Funke, 2010)? Typical polytelic situations, for example, force you comparatively to weight the economic and the ecological, one's family and one's work. What is required in these situations is a balance between the conflicting goals and a compromise between the various interests. One example of a complex problem is climate change, as it is influenced by a large number of variable factors that are strongly interlinked and that can lead to intransparent and unmanageable effects.

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Complex problem-solving needs critical thinking because it helps in dealing with uncertainty and in evaluating different paths for solution. There are at least four phenomena in the context of complex problems: (1) an "emergency reaction of the intellectual system" (see Dörner, 1980) that demonstrates the interaction of cognition, emotion, and motivation; (2) the important role of background knowledge, in contrast to knowledge-poor problems; (3) specific failures: the potential for failures (Dörner, 1996) rises with the complexity of the problem; (4) a strong context dependency, which impairs training and transfer. Concerning phenomena, there are similarities between complex problems—real-life oriented computer-simulations (Brehmer & Dörner, 1993)—and the approach of "naturalistic decision making" (Klein, 2008).

For an overview on research on complex problems, see Sternberg and Frensch (1991) as well as Frensch and Funke (1995) or Funke (2019).

On Stupidity

While much research has been done on the topic of "intelligence" (see, e.g., Sternberg, 2020), the topic of "stupidity" (technical term: morology, from the Greek words $\mu\omega\rho i\alpha$ moria "foolishness" and $\lambda \delta \gamma o \zeta$ logos "word, speech, teaching") has been researched far less (for an exception, see Sternberg, 2002).

Dietrich Bonhoeffer (born in 1906; executed in Flossenbürg concentration camp, Germany, on April 9, 1945), who, after the Nazis came to power, stood up for the persecuted and tried to change the minds of followers, wrote about stupidity: "Stupidity is a more dangerous enemy of goodness than malice." And elsewhere: "We are defenseless against stupidity."

You can laugh at some stupidity: about the stupidest burglars, for example, who go to great lengths to tear a vending machine out of the wall, only to realize later that it was a bank statement printer.

Intelligence research has not produced a universally valid definition of stupidity. For Immanuel Kant, the great philosopher from Königsberg (today's name of the city is Kaliningrad, Russia), stupidity was a "Gebrechen des Kopfes" (infirmity of the mind) that could not be remedied. Kant saw stupidity as the antithesis of the mind, which is shaped by diligence and principles, not by emotions. Austrian psychiatrist Heidi Kastner (2021) defined stupidity not as a personality trait, but as "situationally misguided behavior" and "the tendency to ignore facts." The Austrian writer Robert Musil (1937) spoke of a "certain lower middle class of the mind," by which he meant that in every society there exists a certain amount of stupid people. At the same time, he warned that any conversation about stupidity is not free of arrogance. The American anthropologist David Graeber (2015) speaks of "structural stupidity," referring to bureaucratic structures that are devoid of meaning. The Italian historian Carlo Cipolla (2021) names 5 "laws" of stupidity:

"Law #1: Always and inevitably everyone underestimates the number of stupid individuals in circulation.

Law #2: The probability that a certain person is stupid is independent of any other characteristic of that person.

Law #3: A stupid person is a person who causes losses to another person or a group of persons while himself deriving no gain and even possibly incurring losses.

Law #4: Non-stupid people always underestimate the damaging power of stupid individuals. In particular, non-stupid people constantly forget that at all times and places and under any circumstances to deal and/or associate with stupid people infallibly turns out to be a costly mistake.

Law #5: A stupid person is the most dangerous type of person. A stupid person is more dangerous than a bandit."

And we should remember the famous saying by Nobel Prize winner Albert Einstein (which has been probably falsely attributed to him): "Two things are infinite, the universe and human stupidity, but I'm not quite sure about the universe yet." Even if Einstein never uttered this saying, it is certainly a good one.

What Helps Against Stupidity?

Dietrich Bonhoeffer once again: "The power of some needs the stupidity of others." In totalitarian regimes, it can make sense to play dumb under certain circumstances. Playing dumb can be a "smart" thing for individuals to survive, but at the group level, it would empower the existence of stupidity. Of course, this strategy does not help against stupidity, but it does help against totalitarianism.

What might help against stupidity is fact-checking as many sources as possible. This is where critical thinking comes into play. Access to knowledge is restricted by fanatical religious leaders, as in Afghanistan, or in totalitarian countries like North Korea or the Soviet Union. There are many ways for people to share in the world's knowledge: the good old encyclopedia, traditional information media, public libraries, educational institutions, Wikipedia. Of course, there are also dubious social media sources on YouTube, TikTok clips, or Telegram forums that we should be wary of.

Why Critical Thinking Is Essential?

Critical thinking (see the fundamental work by Halpern, 1989, 2013; Sternberg & Halpern, 2020) is a crucial skill in the twenty-first century, especially when dealing with uncertainty and complexity. The VUCA concept (volatility, uncertainty, complexity, and ambiguity; e.g., Mack et al., 2016) has become increasingly important in describing the modern economic and social environment. This concept highlights the need for individuals and organizations to navigate unpredictable and complicated situations and emphasizes the importance of critical thinking in such contexts. Grint (2022), in his essay, 'Wicked problems in the Age of Uncertainty', discusses the unprecedented times we live in with a prevalence of 'complex problems' and 'wicked problems', emphasizing the need for effective problem-solving and decision-making skills that are central to critical thinking. And the tolerance for uncertainty does influence decision-making in complex problem-solving situations (see Epishin & Bogacheva, 2020). Furthermore, the development of the VUCA framework emphasizes the recognition of the need for critical thinking in addressing the challenges. According to Facione (1990), critical thinking involves purposeful, self-regulating judgment that leads to interpretation, analysis, evaluation, and conclusions, serving as a liberating force in education and a powerful resource in personal and social life. The ideal critical thinker is characterized by a willingness to make intelligent decisions and work persistently to solve difficult problems.

To summarize, critical thinking in the twenty-first century is undeniably a key skill that is essential for coping with the uncertainties and complexity of the modern world. Its importance is underlined by the VUCA concept and the realization that we are dealing with "wicked problems" (Peters, 2017). This highlights the need for individuals to develop and apply critical thinking skills to effectively manage the challenges of today's environment. Tolerance is needed! Not only uncertainty tolerance (see for the importance of uncertainty tolerance in health care: Hillen et al., 2017) but also tolerance as a necessary basis for compromises (see Morgan & Skitka, 2021).

What Are the Effects of Complexity and Uncertainty?

Increasing complexity leads many people to fear the future because of the inherent uncertainty of future developments. Complexity and uncertainty of future developments are mighty drivers for reductionism, that is, the need for a simple understanding of the experiential world, and the need to make a complex and uncertain world reasonably simple. The connection between NFC (*need for cognition* in the sense of Cacioppo & Petty, 1982) and complex problem-solving has been demonstrated by Rudolph et al. (2018).

To encompass the various aspects of problem-solving competency that have been suggested (see, e.g., Fischer, Greiff, et al., 2015), Funke et al. (2018) proposed the concept of "systems competency" as a comprehensive umbrella term. Systems competency in their sense encompasses (a) understanding and managing both static and dynamic systems; (b) constructing models of these systems; (c) formulating and testing hypotheses about concepts and their interrelations; (d) considering temporal aspects; and (e) evaluating system functionality. It involves developing strategies for identifying and controlling systems and includes the ability to monitor and regulate the process of understanding and controlling systems as part of self-regulatory activities. Systems competency integrates both analytical and creative abilities and is considered to result from implicit and explicit knowledge about oneself and other systems.

The advantage of such a broad concept is threefold. First, it allows for a systemic perspective on a systemic activity. Second, integrating different facets necessitates the development of a comprehensive approach to assessment. Third, many activities integral to the problem-solving process can be easily encompassed within this concept. For instance, understanding climate change processes—one of the most pressing global issues can be viewed as part of this broadly understood systems competency (Fischer, Degen, & Funke, 2015).

The concept of focusing on systems competency as a crucial element in problem-solving within dynamic systems is not new (see, e.g., Kriz, 2003, 2008). However, in the context of assessment, there have been not many proposals for assessing systems competency (but see Care et al., 2018; Griffin & Care, 2015).

The Important Role of Education and Values

Better education might be the key to critical thinking. As Immanuel Kant said for more than 250 years: "Dare to use your own mind" (that was one of the starting points for the "Enlightenment movement")—he was thinking of *educated* minds. But how is education possible? According to the "2023 UNESCO Global Education Monitoring Report," since 2015, the percentage of children completing primary education has increased by less than 3 percentage points to 87% of the world population of children, the percentage of youth completing secondary education has increased by less than 5 percentage points to 58%, and the global number of out-of-school children has risen by six million. Imagine

countries like Afghanistan, where girls and young women have been banned from schools and universities since 2021.

Audrey Azoulay, UNESCO Director-General,¹ says: "Education is in a state of emergency. While considerable efforts were made over the past decades to ensure quality education for all, UNESCO data demonstrates that the number of children out of school is now rising. States must urgently remobilize if they do not want to sell out the future of millions of children." All United Nations members created and adopted in 2015 a comprehensive list of 17 world "Sustainable Development Goals" (SDGs). Goal 4, "Quality education," is seen as a force for sustainable development, nation-building, and peace. But keep in mind: Education is not just about imparting expertise in math, science, reading, and writing (these are the four core measurement areas for the PISA studies mentioned earlier), but above all, about conveying fundamental cultural values. Education is more than knowledge acquisition: it is character formation.

According to Funke (2022b), character formation is a complex process that is not easily quantifiable through psychological measurement. However, one aspect is clear: "Moral reasoning is developmental" (Killen & Mulvey, 2018, p. 112). Furthermore, humans have an intrinsic drive to find meaning (Frankl, 1959/2006) (in German: "Sinn") in everything—even in nonsensical written words, we strive to uncover a message. We perceive things that aren't present (visual illusions), hear things that aren't spoken (phonological gaps), feel things that aren't there (rubber hand illusion), and remember stories that weren't told (Frederic Bartlett's schema theory).

Unlike robots, which require flawless programming and perfect input, humans construct their understanding of the world in ways that make sense to them, even if the input is ambiguous. When we don't grasp the deeper meaning of certain rituals, we might develop "cargo cults" (Feynman, 1974). This relentless search for meaning and values distinguishes humans from machines. We constantly evaluate what actions are right and should be encouraged and what actions are wrong and should

¹https://www.unesco.org/en/articles/unesco-global-number-out-school-children-rises-6-million (last visit 2024, August 10).

be minimized. This ongoing quest for values and meaning is fundamental to what it means to be human. Education is the way not only to reading and writing but also to human values, especially tolerance and humanism.

Conclusion

Critical thinking is considered a key competency in the twenty-first century due to its ability to effectively navigate uncertainty and complexity for several reasons. In an era marked by rapid change and unpredictability, critical thinking enables individuals to approach problems systematically, analyze various factors, and generate innovative solutions. It encourages adaptability and resilience in the face of uncertainty. The twenty-first century presents individuals with myriad choices and challenges, often with incomplete information. Critical thinking empowers individuals to evaluate alternatives, consider potential consequences, and make informed decisions amidst ambiguity. As the volume and complexity of information continue to grow exponentially, the ability to sift through vast amounts of data, discern patterns, and extract relevant insights becomes paramount. Critical thinking equips individuals with the analytical skills necessary to distill information and draw well-founded conclusions. The interconnected nature of modern issues requires a nuanced understanding of multifaceted problems.

Critical thinking enables individuals to deconstruct complex issues into manageable components, identify underlying relationships, and comprehend diverse perspectives, thereby facilitating effective problemsolving and decision-making. Embracing uncertainty fosters an environment conducive to innovation and creativity. Critical thinking encourages individuals to question assumptions, challenge the status quo, and explore unconventional solutions, driving forward progress and innovation in various fields (Holm-Hadulla et al., 2022). And in a rapidly evolving world, the ability to learn, unlearn, and relearn is essential. Critical thinking cultivates a mindset of intellectual curiosity, openness to new ideas, and willingness to engage in lifelong learning, enabling individuals to adapt and thrive in dynamic environments (see, e.g., Sternberg, 1997). With technological advancements and globalization, ethical dilemmas (see, e.g., Foot, 1967) become increasingly prevalent. Critical thinking facilitates ethical reasoning by encouraging individuals to evaluate the moral implications of their actions, consider diverse perspectives, and make principled decisions in complex ethical situations.

In summary, critical thinking serves as a foundational skill in the twenty-first century (Funke, 2022a), empowering individuals to effectively navigate uncertainty and complexity, make informed and value-based decisions, foster innovation, and address the multifaceted challenges of our rapidly changing world.

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