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## Be Prepared for the Complexities of the Twenty-First Century!

Joachim Funke

### Introduction

What key skills do young people need in the twenty-first century? Classical school education, which has emphasized the teaching of basic knowledge, is reaching its limits: As important as the teaching of basic content and skills from the areas of reading, writing and arithmetic are, these competencies are not sufficient in the face of a global and networked world. The half-life of knowledge is becoming shorter and shorter, especially in the natural sciences. Students who leave university after several years of study with a degree sometimes have to forget the content that was painstakingly acquired in the initial semesters. When the acquisition of certain content becomes less important, other skills come into play all the more, for example, the ability to learn throughout life.

A central competence concerns dealing with uncertainties and intransparency in complex and dynamic contexts. Simple explanations no longer exist; they are usually wrong because they are not appropriate to the complexity. Systemic thinking is necessary, which refrains from one-dimensional evaluations and which classifies complex situations appropriately in multiple contexts. Solving complex problems is a skill that is indispensable in the twenty-first century.

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In a recent Special Issue of the “Journal of Intelligence,” the editors (Robert Sternberg, Andrew Conway and Diane Halpern) have asked their contributors to respond to the (provoking?) statement: “How intelligence can be a solution to consequential world problems”. I found that question not easy to answer (Funke, 2021), because two questions arise: First, what exactly are consequential world problems? Second, why should intelligence (intelligent behavior) be a candidate for their solutions? What other skills would help in solving world problems?

It is not easy to scale and prioritize the challenges to mankind because there are many different perspectives. Lomborg (2007), for example, tried to define “the world’s biggest problems” in terms of costs and benefits. From my point of view, this approach suffers from giving a monetary value to human life. I cannot follow the idea that you can compensate a human life for money. By constitution: “all lifes are equal”.

Then, how to define world problems? As “grand societal challenges” one might define those problems that affect a large number of people, perhaps even the entire planet: Climate change, distributive justice, world peace, world nutrition, clean air, and clean water, access to education, and much more. The next section will elaborate on these problems.

The world around us presents a lot of challenges to mankind: Not only the human-made climate change but also the demand for food and water supply for a world population that soon might reach 8 billion people on this planet. Clean air and clean water are not available in large parts of the world, migration from failed states to more promising ones happens.

The United Nations have compiled 17 “Sustainable Development Goals” that represent a suitable collection of such world problems (see <https://sdgs.un.org>). These goals are concerned with the survival of the planet earth and its inhabitants. They are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including poverty, inequality, climate change, environmental degradation, peace, and justice.

What is psychology’s answer to these grand societal challenges? Let me take a look at research on problem-solving which is my favorite perspective on these challenges that have to be addressed by gifted children. Problem-solving research has produced different approaches for dealing with non-routine situations. We can hopefully learn from their concepts and from their insights. But what is “transformational giftedness”?

In analogy to transformational (not transactional) leadership, transformational giftedness is defined by Sternberg (Sternberg, 2020b, p. 231) as follows: “I will define *transformational giftedness* as giftedness that is transformative—that by its nature seeks positively to change the world at some level—to make

the world a better place”. A definition of giftedness that clearly relates to problem-solving, since problem-solving is defined as transforming an initial state into the desired target state. Because the desired state is unclear, we see an ill-defined problem here. For the analysis of the current state, one needs analytical intelligence; for the vision of the target state (“a better world”), one needs values that give meaning to life (wisdom); and for the transformation steps, motivation and creative ideas for solutions are important.

In addition, in a world in which more and more people have to live together, it is also a matter of shaping this coexistence in a humane way. It is also about “the better place”: humanity, about humanistic values, about an understanding of democratic politics that makes it possible for people with very different ideas to live together without conflict. This is a question of ethical education and the teaching of human values – Tirri and Nokelainen (2007) talk about “ethical sensitivity” that is needed. But let’s start with the competence to solve complex problems. Here we need to understand what the characteristics of such problems are and what these characteristics mean for the problem solver.

## Features of Complex Problems

Complex problems (alternative names: “ill-defined problems”, “wicked problems”, “clumsy problems”; Hartmann, 2012; Simon, 1973; Verweij et al., 2006) are characterized by five features: Complexity, interconnectedness, dynamism, lack of transparency (“opacity”), and multiple objectives (“polytelism”). These features are described in more detail below. As an illustrative example, consider the Corona pandemic, which has all the characteristics of a complex problem situation.

1. *Complexity*: The complexity of what is happening is high – very many construction sites have to be kept in view at the same time. In addition to health, which is threatened worldwide, we see a threatened global economy. But behind these major global problems are thousands of detailed problems. This overwhelms our limited human processing capacity. What is the consequence? Simplification! Especially conspiracy myths, which are booming in these times, offer wonderful simplifications: Sometimes Bill Gates is the culprit, sometimes the Chinese state government Staatsregierung (for dealing with conspiracy myths the “debunking handbook” is highly recommended: Lewandowsky & Cook, 2020). The “bounded rationality” postulated by Nobel laureate Herbert Simon (see, e.g., Gigerenzer & Selten, 2001) also leads to the fact that we cannot keep many complex

problems in mind at the same time, which was pointed out by “Fridays for Future” with their action #FightEveryCrisis on 24.4.2020. Dörner and Schaub (1995) also describe this state of affairs as “overvaluing the current motive.”

2. *Interconnectedness*: In the past, people lightly said “What do I care if a sack of rice falls over in China?” – today, we know that this could be of concern to us. The legendary flap of a butterfly’s wings that sets off a tornado, or the grain of sand that sets off an earthquake (so the title of Buchanan, 2001, which is well worth reading), shows the significance of seemingly distant events for our immediate daily lives. The interconnectedness of our global world shows side effects in places where we did not expect them. A good example of interconnectedness is provided by the Corona infection source in the South Tyrolean ski resort of Ischgl, from where the virus was presumably spread by ski vacationers to various places in the FRG, but also appeared in Iceland.
3. *Dynamics*: “We are dealing with a dynamic outbreak,” said Chancellor Merkel at a press conference on March 12, 2020 – meaning that the situation (and thus the situation assessment) can change rapidly. Constant readjustments are being made. In the background, a non-linear process of virus spreading is taking place that is beyond our imagination. The famous grain of rice, which is supposed to be doubled from square to square on the 64 squares of a chessboard: it starts quite harmlessly with 1-2-4-8-16, but already at 64-128-256-512-1024 we notice that the numbers grow rapidly. So if we have 12,000 infected people on day X, in X plus four more days (12-24-48-96) there are already 96,000 and after another four days 1.5 million (192-384-768-1536). What a dynamic! Of course, this exponential growth has an upper limit and is over at some point...<sup>1</sup>

The “flattening the curve” program resulting from such considerations (see Fig. 9.1) attempts to dampen growth, which at a certain point becomes explosive, and thus makes the massive burdens on the healthcare system manageable. In countries such as Italy, Spain, or even the USA, this has failed and the collapse of the healthcare system has cost additional lives.

4. *Lack of transparency*: Novel situations such as the Corona pandemic are extremely opaque and raise many questions (When is exponential growth over? What are the important indicators?). This opacity creates a need for information whose limit is unclear: When do I have enough information to act? What information is important and reliable, and what is misleading

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<sup>1</sup> A logistic function (more precisely: a sigmoid function) describes this process more adequately, since it includes saturation processes (how many people can still be infected at all?).

## Flattening the curve

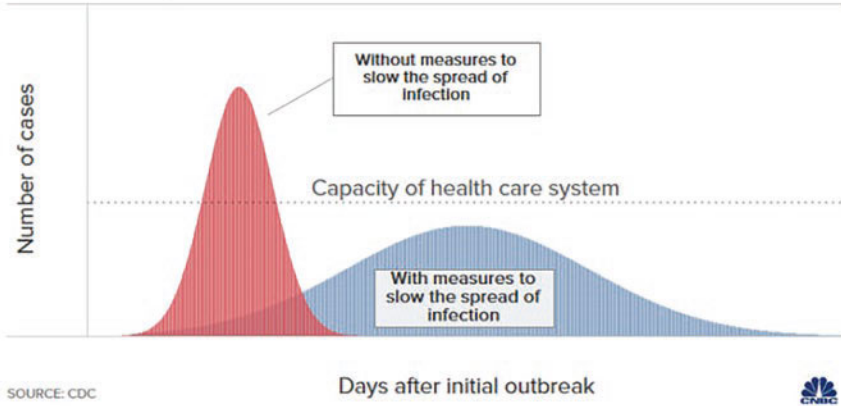


Fig. 9.1 “Flattening the curve”. (Source: CDC; <https://www.cnbc.com/2020/03/22/these-charts-show-how-fast-coronavirus-cases-are-spreading.html>)

or superfluous? On the one hand, it is a great moment for the sciences, which are now in demand (and provide answers, e.g., here: Leopoldina, 2020), but of course do not know the answers to all questions (serious information can be found for Germany at the Robert Koch Institute, Berlin, or worldwide at Johns Hopkins University, Baltimore, ML). On the other hand, it is also a time of half-truths and fake reports (Nocun & Lamberty, 2020). Not knowing anything for sure causes fear – and fear is a bad advisor for problem-solving. Whereas politicians initially said that it was possible to “ease up” if the reproduction figure was below one, later the number of new infections was also used. This number, in turn, depends on the number of tests performed. The number of beds in intensive care units should also be known. The diffuse mixed situation creates uncertainty through lack of clarity – but transparency and clarity are unfortunately not easy to achieve in a complex problem.

5. *Multi-objective* (“polytelism”): Even if there is a reasonably clear overall objective (to prevent the spread of the virus and keep the health care system functioning so that people stay healthy or, if infected, do not die), there are many secondary objectives: to keep the economy running, at least in basic areas; to maintain social contacts; to uphold basic civil rights; etc. These conflicts between different goals are what politicians try to resolve with their decisions (radical curfews versus moderate curfew restrictions). Compromises are inevitable; fundamental rights can sometimes clash irresolvably. Clear value orientations are very helpful in polytelic problem

situations because they help to set priorities. In addition, the multi-objective nature of the pandemic is overlaid by the secondary goals of German politicians, who hope, for example, to have better chances of running for chancellor if they can present themselves as sovereign crisis managers (similarly in the U.S. because of presidential elections).

So much for the five characteristics of a complex problem. More about this can be found e.g. in Dörner (1980, 1996) or also in Funke (2003, 2012). The “Logic of Failure” by Dietrich Dörner (1989) is a good readable introduction to this topic even for laymen. – A potentially important sixth feature (time delays) that is often overlooked comes up in the next section.

***Time Delays*** One of the unpleasant properties of dynamic processes are time delays in their various varieties in the information about the state of the system (e.g., as the dead time between the intervention in a system and the subsequent reaction: One clicks on an app, but has to be patient during the loading process; e.g., as delayed feedback when system states are displayed: The temperature indicator on a car reports the actual temperature with a delay). Such delay elements in complex systems complicate the controllability of a system. Time delays as characteristics of complex systems are listed here as a keyword separately beside the five characteristics of complex problems described above because they occur at different places in the problem space. Time delays exist, for example, in the spread of the virus (incubation period): someone who is infected today will not become ill for 10–14 days. There are time delays in the reporting of case numbers (after weekends, the number of cases in the FRG rose exceptionally strongly several times, because the reports of the weekend case numbers arrived only with delay). The case numbers of today show the situation of 14 days before. Policy decisions (e.g., on the development of a Corona tracing app) were made early but implemented late. Vaccine development was eagerly anticipated but took time. Much research has been done on the adverse effects of delayed feedback by the group led by Swedish psychologist Berndt Brehmer (e.g., Brehmer, 1992, 1995; Brehmer & Allard, 1991); in addition, John Sterman’s idea of the “misperception of feedback” (Sterman, 1989) is certainly worth mentioning.

## The Ethical Dimension

Our current concept of intelligence (as a measure of giftedness) is missing an ethical dimension. During the education process of individuals, we do not solely teach facts and knowledge but we also teach values. The education process, in general, is a process of character formation (Funke, 2020). One of the long-term results of character formation can be seen in the development of wisdom which I see as an important ingredient to transformational giftedness. As Tuchman (1984, p. 21) defined wisdom: “the exercise of judgment acting on experience, common sense and available information.” Is wisdom the result of successful character formation? Is wisdom one of the components of transformational giftedness?

In her recent review, Glück (2019, Table 16.1, p. 310) presents twelve definitions of wisdom. Only one of them mentions “values” explicitly, namely the “balance theory of wisdom” from Sternberg (1998). According to that theory, wise people know – besides other competencies – that different people can have different values. This idea of “value relativism” in wise persons is also one of the five criteria for wisdom within the Berlin Wisdom Paradigm (see, e.g., Baltes & Staudinger, 2000). However, to know that there are different perspectives on dilemmata does not imply that one has clear moral values – it is a kind of meta-knowledge, free of any special content. Values allow for “Sinn” (German, “meaning”) in life.

Similarly, Fischer (2015) argues for a context-free view of wisdom and sees it as “independent of one’s values and context.” On the other hand: Fischer has collected 12 propositions that were commonly known to wise men from four different cultures (Socrates, Jesus, Confucius, Buddha). Those four wise persons show huge parallels concerning certain wise content (e.g., Proposition 10: “Good people (and children) make a good company”). Once again, there is no idea about the acquisition of these pieces of wisdom. We all know that reading alone those “wise” propositions will not make us a wise person instantaneously. To become a wise person is a process that normally takes some time and needs life experience.

## Conclusion

What skills do young people need in the twenty-first century? The term “literacy” describes the ability to absorb, understand and reflectively apply knowledge. However, we must not stop with this general recommendation but must specify which form of “literacy” is meant: It is about “complex systems

literacy”, i.e. the ability to absorb knowledge about complex systems, to understand complex systems appropriately in their structures and processes, and to use this knowledge thoughtfully to manage and control complex systems. The action-guiding goals behind this knowledge should be value-soaked, i.e., serving the good of society as well as the good of individuals, not seeking selfish advantage, but maximizing benefit for the good of the majority.

In the study of complex problems, controversial discussions about the epistemic value of computer-simulated scenarios have taken place in recent years (for an overview, see Dörner & Funke, 2017). As part of the international school performance study PISA, the 2012 survey assessed the problem-solving performance of 15-year-old students using computer-simulated scenarios – Germany and America were in the middle of the pack, and Asian countries were at the top (Csapó & Funke, 2017; Dossey & Funke, 2016).

What can we learn from previous research on solving complex problems? Quite a lot, in my opinion! Here are a few “highlights”: (1) There are (unfortunately!?) no patent remedies. (2) Nobody knows what the best solution to the problem is. (3) One should stay calm and not lose the overview despite uncertainty and insecurity. (4) Mistakes will be made – it is important not to cover them up, but to try to learn from them. (5) Time delays make it difficult to create an adequate picture of the situation.

What helps, in any case, is the competence to “think critically” (one of the best books on this topic: Halpern, 2013) and to think in systems (see also Funke et al., 2018). Understanding global events is very difficult, but reductionist thinking, i.e., tracing complex chains of events back to individual causes, does not help and leads astray. Together with “ethical sensitivity”, this mixture can give rise to “transformational giftedness”, which we so urgently need.

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