JDDM
Journal of Dynamic Decision Making

Open Access

Opinion

Complex problem solving in search for complexity

Joachim Funke[1]

[1]Department of Psychology, Heidelberg University, Germany.

Research on complex problem solving (CPS) has reached a stage where certain standards have been achieved, whereas the future development is quite ambiguous. In this situation, the editors of the *Journal of Dynamic Decision Making* asked me to share my point of view with respect to seven questions about the relevance of (complex) problem solving as a research area, about the contribution of laboratory-based CPS research to solving real life problems, about the roles of knowledge, strategies, and intuition in CPS, and about the existence of expertise in CPS.

Why should there continue to be problem solving research (in addition to research on memory, decision-making, motivation etc.)?

Problem solving research is more than a combination of research on memory, decision making, or motivation because it integrates all basic functions of the human brain (and the human body) in the service of proper acting. Therefore, a theory of action is needed that brings together the different partial cognitive functions with emotion regulation and with motivational issues. Effective problem solving in complex situations requires the integration of cognition, motivation, and emotion.

What are the connections between current CPS research practice and real problems? Where do you see potential for development towards stronger relations?

Recent research on problem solving is still working with simple problems (e.g., puzzle problems, see Sanders et al., 2019) – the problems in daily life or with regard to life on the planet earth are quite different to either moving "Towers of Hanoi" or finding puzzle pieces – different in terms of complexity, dynamics, intransparency, and incompatibility (or even contradictoriness) of multiple goals. Even what is subsumed under the heading of CPS in modern research has lost the original complexities of real-life problems (for validity issues, see Dörner & Funke, 2017). That state of affairs needs to be changed.

Given the artificiality of the laboratory situation, do participants really adopt the presented problems? What insights can be gained despite this artificiality and which cannot?

Laboratory experiments are fine for testing hypotheses – but from my point of view, we are far away from comprehensive theories that would allow for the derivation of specific hypotheses. We are still in need of good field studies (see Brehmer & Dörner, 1993).

What evidence exists for the influence of other kinds of knowledge besides structural knowledge on the results of CPS? Which of these kinds of knowledge should be examined in future research?

Structural knowledge is only one of the ingredients for successful problem solving. Additionally, there is knowledge necessary for interventions into complex systems and knowledge for the identification of unknown systems. The use of semantically "poor" systems (with variable labels like "A", "B", or "C") tries to keep knowledge outside the problem solving process. If we allow problems to be semantically "rich", a broad universe of knowledge becomes immediately important. In future research, domain knowledge should be acknowledged as an significant ingredient of any kind of problem solving. The more we allow domain specificity, the more influential becomes domain knowledge.

What evidence is available for the impact of strategies (except VOTAT) on the results of CPS? Which of these strategies should be examined more closely?

VOTAT is an excellent strategy for simple systems but we need strategy analyses for more complex and realistic problems. Think, for example, of the "Thirty-Six Stratagems" within the Chinese culture based on Sun Tzu's *Art of War* – quite different to the simple strategies discussed in recent research papers (Stadler, Fischer, & Greiff, 2019). The identification of simple systems can be approached by simple strategies but once real-life complexities enter the stage, a strategy like VOTAT is no longer helpful.

Corresponding author: Joachim Funke, Department of Psychology, Heidelberg University, Hauptstr. 47, 69117 Heidelberg, Germany. E-mail: joachim.funke@pychologie.uni-heidelberg.de

Is there intuitive CPS?

As Kahneman and Klein (2009) explain, there is good reason for the assumption of intuitive skills. If that is true, it should be valid also for the domain of complex problem solving. It might be related to wisdom (see, e.g., Fischer, 2015).

What distinguishes experts in CPS from laypersons?

Experts in solving complex problems have a good understanding of systems. Funke, Fischer, and Holt (2018, p. 47) argue for a "systems competency" that consists of the ability to construct mental models of systems, to form and test hypotheses, and to develop strategies for system identification and control. Experts in solving complex problems should be particularly skilled on these dimensions.

Declaration of conflicting interests: The author declares he has no conflict of interests.

Author contributions: The author is completely responsible for the content of this manuscript. The abstract was added by the editors and modified by the author.

Handling editor: Andreas Fischer and Wolfgang Schoppek

Citation: Funke, J. (2019). Complex problem solving in search for complexity. *Journal of Dynamic Decision Making, 5*, 10. doi: 10.11588/jddm.2019.1.69299

Published: 31 Dec 2019

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