

Complex problem solving: A gem to study expertise, strategic flexibility, culture, and so much more; and especially to advance psychological theory

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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 a number of representative authors to share their 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.)?

One book title of Sir Karl Popper's books is: "All life is problem solving" (Popper, 1994). The most intense and crucial situations in life involve dealing with complex problems. Thus, the topic complex problem solving is highly relevant both from a theoretical and applied perspective.

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

It is unclear what current CPS practice is, since there are many different research studies on complex problem solving. Many studies in the field of CPS, however, use microworlds or computer-simulated complex problems to study CPS. Even the best simulations are simulations. Thus, studying complex problems in the real world would be an interesting area for future research. Especially case studies could help with further development of CPS theory, i.e., the interaction of motivation, emotion, and cognition. Such further development of CPS theory would be highly desirable.

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?

Brehmer and Dörner (1993) showed exactly the strength of computer-simulated problems as a research methodology. This methodology allows the study of CPS in the laboratory and gives some control representing at the same time problems that are dynamic, complex, and non-transparent – characteristics shared with complex problems in the real world. Yes, some simulations are quite simple and artificial, but others that simulate hundreds of variables and take several hours are challenging. Participants often are fully emerged emotionally, motivationally, and cognitively into these situations. Although external validity is still an open question, studies with experts and novices show interesting differences in CPS.

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?

Research has shown and analyzed different CPS strategies, for example VOTAT (Vary-one-thing-at-a-time, Molnár & Csapó, 2018; Wüstenberg, Stadler, Hautamäki, & Greiff, 2014), PULSE ("setting all input variables to zero after an intervention and waiting a certain time", Schoppek & Fischer, 2017), cautious versus proactive strategies, flexible versus rigid strategies (e.g., Güss, Tuason, & Orduña, 2015). Research has also shown errors occurring during CPS. Application of various strategies over time and strategic adaptation would be interesting topics for future research.

Is there intuitive CPS?

At first, one is tempted to say no, there is no intuitive CPS, because per definition CPS involves actions that go beyond

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routine actions (Dörner & Funke, 2017, p. 6; Funke, 2012) and involve higher-order cognitive processes. I would argue, however, that there is evidence for intuitive CPS. Any experience is stored in explicit and/or implicit memory. Successful problem-solving behaviors are stored in memory as well and if a new situation is similar to situations encountered in the past, one might search for and execute such a stored CPS behavior pattern or a slightly modified similar version of this CPS behavior pattern. Even if the situation is slightly different, people still execute stored CPS behavior patterns, which sometimes leads to failure (e.g., “methodism”, Dörner, 1996). The impact of intuitive CPS can be seen in cross-cultural studies on CPS (e.g., Güss, 2011). People from different cultures approach CPS situations differently; confronted with a novel, complex, and dynamic situation, people rely first on their previous knowledge and skills. Cultural differences show that some are more cautious and seek information, others are more pragmatic and jump to making decisions; others first react emotionally and show these emotions. These seem to be culturally learned and adequate/acceptable patterns to react to novel and complex problems in different cultures.

What distinguishes experts in CPS from laypersons?

The trivial first answer to this question is knowledge. Experts have accumulated more knowledge than novices. Most experts have engaged in “deliberate practice” for over 10 years or 10,000 hours. Deliberate practice can be defined as “. . . engaging in practice activities assigned by a teacher with a clear, specific goal of improvement and where the practice activities provide immediate feedback and opportunities for repetitions to attain gradual improvements” (Ericsson, 2014, p. 509). But knowledge alone does not make someone smart. In fact, expert knowledge can lead to foolish decisions, if someone simply applies a successful CPS behavior “program” in a new situation, not realizing that the conditions have changed and that exactly in the new situation such “old” actions will lead to failure (e.g., methodism). Regarding knowledge, research has shown a more web-like structure of stored knowledge of experts compared to a more cause-effect-like structure of knowledge of novices (Reither, 1981). One study compared business experts and novices, namely business owners, business students, and psychology students (Güss, Devore Edelstein, Badibanga, & Bartow, 2017) in the simulation ChocoFine (Dörner & Gerdes, 2003), where participants take the role of managers of a chocolate producing company. Results showed that business owners explored the situation in more detail and adjusted their tactics better to the changes in situations compared to novices. They were more sensitive to “read” the new situations, to see the key changes, and to adapt their behaviors flexibly to these changes. In another study the effects of a CPS training and self-reflection on CPS performance was investigated (Donovan, & Güss, & Naslund, 2015). Participants learned about the steps of CPS and filled out a survey on self-reflection. Both training and self-reflection predicted performance. High self-reflection was related to more consistency in planning and decision making. Thus experiences, self-reflection, and adaptive flexibility seem to be key characteristics of expertise.

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