Problem solving skills

Definition

Problem solving skills refer to an individual's capacity to engage in cognitive processing to understand and resolve situations where a method or solution is not immediately obvious (OECD, 2016[1]). Problem solving takes time and includes several stages that presume different subskills (Rausch, Schley and Warwas, 2015[2]) and can include a variety of forms starting from individual problem solving to different forms of collaborative problem solving.

Relevance for 2030

Links to the framework

- Creating new value

People need competencies that will enable them to be comfortable with uncertainty, complexity, and ambiguity demands when solving problems to create new value(citation). Skills in solving ill-defined and knowledge rich problems opens a way to be successful in the future in increasingly volatile, uncertain, complex and ambiguous world and have critical implications for well-being and the larger society (Jiang, Lyons and Huebner, 2016[3]).

- Reconciling tensions and dilemmas

Individuals need to possess skills to reconcile tensions and dilemmas across a range of problems, and these skills need to be coupled with the capacity to deal with a variety of problems that are complex, diverse, dynamic, complicated, and interrelated (Fischer, Greiff and Funke, 2012[4]). Thus, skills for solving ill-defined (no clear goals, no best solution) and knowledge-rich in addition to well-defined and knowledge-poor problems are particularly important (Rausch, Schley and Warwas, 2015[2]). In other words – it is important to acquire skills to solve complex problems. It means that individuals should have the capacity to recognise that a problem may require more than just one single good solution and that a problem can be solved in multiple ways.

- Student agency

The capacity to engage in collaborative, knowledge-driven activities aimed at creating shared knowledge objects. Within this framework, students are positioned as active agents in setting forth ideas, formulating questions, and designing solutions to problems, thus driving the collective advancement of knowledge. By engaging in joint planning, sharing responsibility for idea production, and contributing to collective knowledge advancement, students cultivate epistemic agency, empowering them to actively shape their learning experiences. However, the realization of student agency in classrooms necessitates a redistribution of authority from teachers to students, allowing students to take center stage in directing and monitoring knowledge-building processes. Implementing student agency in the classroom presents

challenges, such as adapting curriculum materials to students' ideas and navigating tensions between achieving learning objectives and fostering student agency within accountability frameworks. (Akgun and Sharma, 2023[5])

Impact

Academic Outcomes

- Problem solving skills as assessed in early mathematics play a role not only in school success but also in economic success in adult life (Ritchie and Bates, 2013[6]).

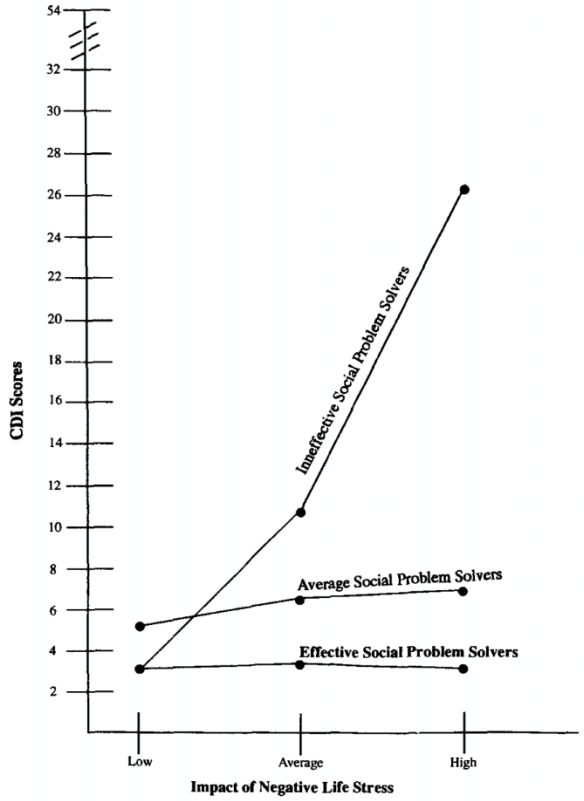
Emotional well-being

- Several studies have shown that social problem solving skills can moderate the impact of life stress on well-being and social adjustment (Dubow et al., 1991[7]; D'Zurilla and Sheedy, 1991[8]; Goodman, Gravitt and Kaslow, 1995[9]). For example, Goodman et al. (1995[9]) found that social problem solving skills provided a safeguard against depression during negative life events (see Figure 1).

Economic outcomes

- A survey with 3,000 graduates of the University of Washington showed that 5–10 years after graduation, the importance of defining and solving problems, locating information needed to help make decisions or solve problems were rated among the most important skills for their jobs (Gilmore, 1998[10]).

Figure 1. The impact of negative life event on problem solving



Note: The impact of a negative life event on depression scores at different levels of stress, for effective social problem solvers, average social problem solvers, and ineffective social problem solvers.
Source: Figure adapted from Goodman et al. (1995[9])

Interrelatedness

Problem solving skills are closely related to:

- **Creativity:** Creative thinking is related to thinking outside of the box and generating several solutions and is particularly important for solving complex (ill-defined and knowledge-rich) problems (Sternberg, 2006[11]).
- **Critical thinking:** Critical evaluation allows the selection of the most suitable solutions (Zimmerman, 1998[12]).
- **Growth mind-set:** Growth mind-set is related to motivation to act, it encourages students to start solving a problem, but – most importantly – helps them deal with difficulties and provide more effort into solving the problem after failures (Burnette et al., 2013[13]; Yeager and Dweck, 2012[14]).
- **Goal orientation and completion (e.g. grit, persistence)**: Mastery-oriented people tend to be more persistent even after failure while avoidance-oriented people tend to leave problems unfinished (Eccles and Wigfield, 2002[15]).
- **Self-efficacy:** In order to start to solve a problem either individually or in a group, students must believe in their ability to have enough competence and succeed in this process. Self-efficacy is also important in problem solving as it helps a person not to leave the task unfinished (Marsh et al., 2005[16]; Meißner et al., 2016[17]) and learn from failure.

Problem solving skills are also related to:

- **Empathy:** When solving problems, students should keep in mind the feelings and perspectives of others and should be able to identify the implications and impact of their solutions on others (Lemerise and Arsenio, 2000[18]).
- **Reflective thinking:** Reflective thinking is needed to evaluate the solution and process of solving the problem (National Research Council, 2000[19]).
- **Self-control/ regulation:** Solving problems successfully requires that an individual does not act impulsively and does not rush to a decision (Blair, Calkin and Kopp, 2010[20]; Zimmerman, 1998[12]).

Malleability

Similar to other cognitive skills, the development of problem solving skills follows a developmental trajectory in which individuals move from a concrete or surface level understanding for defining a problem and identifying solutions to a more complex and sophisticated understanding of the many different facets of problems and their solutions. This developmental shift in problem solving is partly due to increased competence in children's capacity for detecting and understanding the complex nature of problems due to advances in cognition. However, practicing solving problems in different areas is necessary. Problem solving skills are domain specific, meaning that expertise develops due to practice (National Research Council, 2000[19]; Tynjala et al., 1997[21]).

Children start solving problems from an early age. At school, the first problems students encounter (e.g., in mathematics or science) tend to be well-defined and knowledge poor. In early school years children are not capable of solving complex problems on their own but they can do it with adult guidance. It is important to give young children problems with different solutions, and explicitly teach and discuss the processes involved in creative problem solving that will be needed later in life (Sternberg, 2006[11]; van de Kamp et al., 2014[22]). Schools can also support the development of problem solving skills via long-term projects and by providing possibilities for collaborative problem solving. Studies have indicated that it is not enough to provide children with variety of problems, but explicit discussions on problems solving skills and individual differences are additionally needed (van de Kamp et al., 2014[22]).

Research on brain development refers to adolescence as a period at which dealing with complex, multi-solution problems becomes available (Blakemore and Mills, 2014[23]; Casey, Getz and Galvan, 2008[24]). One of the recent discoveries in neuroscience shows that some areas appear to develop more rapidly during adolescence in contrast to later developmental periods (Paus, Trends in Cognitive Science[25]). Rapid changes that occur during adolescence are seen predominantly in the prefrontal cortex - the area of the brain responsible for reasoning, planning, and decision-making, the regulation of emotions, and abstract and hypothetical thought. Note that although adolescents' problem solving skills are more sophisticated than those of children, there is also tremendous variability in adolescents' problem solving competencies. It is partly due to a brain that is still maturing (the prefrontal cortex of the brain is not fully developed until around 25 years of age) but also due to variability of learning experiences that either support or inhibit the development of problem solving skills. Adolescents, similarly to younger children, learn from solving multiple problems together with explicit teaching about problems solving stages and discussions about necessary skills, more and less efficient solution, and individual differences (van de Kamp et al., 2014[22]).

Measurability

In this section, we include measures that are established and have demonstrated good psychometric properties, such as reliability and validity. When possible, we have tried to go beyond self-report measures

to include direct evidence of measurability at the classroom level. But we cannot be exhaustive and are only able to highlight a few measures below. More research is needed on the measures and there is a need to move beyond self-reports to other forms of assessments such as teacher-report measures.

There are many ways of assessing problem solving abilities in children and adolescents across a range of dimensions that are domain specific (e.g., mathematics, science, social problems), as outlined in Table 1.

Table 1. List of instruments that measure problem solving

Instrument	Type	What does it measure?	What age/grade?	Context	References
PISA	Subject-related problems	Mathematics, science problem solving skills	15 years old	International	http://www.oecd.org/pisa/
PIAAC	Problems from different areas	Abilities to solve problems for personal, work, and civic purposes	Adults	International	http://www.oecd.org/skills/piaac/
Life Skills Development Scale for Adolescents, problem solving subscale	Self-report	Problems from different areas	13 to 20 years old	International *English*	(Darden, Ginter and Gazda, 1996[26])
Social Problem solving Inventory (SPSI) and its revised form	Self-report	Positive Problem Orientation (PPO), Negative Problem Orientation; Rational Problem Solving; Avoidance Style; Impulsiveness/ Carelessness Style	From Grade 4	School *English*	(Maydeu-Olivares and D'Zurilla, 1995[27])

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