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Original Article

# Concept and theory of Problem-Solving Skills regard to secondary school students of Chhattisgarh

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***Abstract:***

*A society that has lost touch with its creative side is an imprisoned society, in that generations of people may be closed minded. It broadens our perspectives and can help us overcome prejudices. Creativity can be based on some factors such as learning, experience, motivation, imagination, intelligence, flexibility and personality. Creativity is a function of three components: expertise, creative-thinking skills, and motivation. The purpose of this study is to explore the correlation between students' scientific creativity and selected variables including creativity, problem finding, formulating hypotheses, science achievement, the nature of science, and attitudes toward science. In fact, good science relies on creativity. We need creativity in our science to generate alternative hypotheses (good science tests multiple hypotheses for an observation at once, rather than running through them in series), and synthesize new models to further our understanding of how the world works. Scientific creativity assists to develop creative thinking; So far not much research has focused on scientific creative thinking skills. Scientific creative thinking is a way of thinking that is emphasized in scientific or scientific activities. Scientific creative thinking has its own characteristics besides referring to the characteristics of creative thinking in general, namely Torrance (fluency, flexibility, and originality).*

***Key words:*** *Problem solving skills, commission and recommendation of problem is solving skills, role of NEP-2020in problem solving skills, heuristic theory of problem solving skills.*

## Introduction:

Education is the process of facilitating learning or the acquisition of knowledge, skills, values, morals, beliefs, habits and personal development. Education frequently takes place under the guidance of educators; however, learners can also educate themselves. Education can take place in formal or informal settings, and any experience that has a formative effect on the way one thinks, feels, or acts may be considered educational. The methodology of teaching is called pedagogy. Formal education is commonly divided formally into stages such as preschool or kindergarten, primary school, secondary school and then college, university, or apprenticeship. In most regions, education is compulsory up to a certain age. There are movements for education reforms, such as for improving quality and efficiency of education towards relevance in students' lives and efficient problem solving in modern or future society at large, or for evidence-based education methodologies. Science is one of the most important subjects in school due to its relevance to students' lives and the universally applicable problem-solving and critical thinking skills it uses and develops. These are lifelong skills that allow students to generate ideas, weigh decisions intelligently and even understand the evidence behind public policymaking. Teaching technological literacy, critical thinking and problem-solving through science Education gives students the skills and knowledge they need to succeed in school and beyond.



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According to the aims proposed by a Ministry of Education and Culture committee for 2020, Finland was to be ranked as a top country in science education. In this respect, science museums and science centres have strong traditions, but universities have also noted the importance of science education.

**Conceptualization of Problem-Solving Skills**

In problem-solving, understanding the structure of a problem is essential. According to Wickelgren (1973), every problem comprises givens (initial information), operations (processes that transform this information), and goals (desired outcomes). Effective problem- solving involves recognizing these components and strategically applying operations to bridge the gap between givens and goals. Even when subgoals arise, the overarching task remains focused on achieving a single terminal goal. This framework highlights that whether dealing with practical or abstract problems, the process of problem-solving relies on mental representations of these elements. Thus, the key to successful problem-solving lies in how well individuals structure, interpret, and manipulate the given information to reach the desired outcomes, reinforcing the idea that both real-world and theoretical problems can be approached similarly (Wickelgren, 1973). Every day, students face problems that need to be solved; regardless of social, occupational, or financial status, everyone must ultimately decide on a course of action for a problem and manage the ensuing decisions and their consequences. Additionally, our lives are often affected by huge global challenges (climate change, war, pandemics, financial instability) that are out of our reach. The solutions and decisions for these challenges are usually taken by superior entities (such as the Government and specific authorities), and their consequences might directly and indirectly impact millions of people's daily lives. Problem-solving is the ability to understand the environment, identify complex problems, and review related information to develop, evaluate strategies and implement solutions to build the desired outcome. Mathematics boosts problem-solving skills and, in secondary education (Fissore et al.,2021). One of the 21st-century skills tested in this study is problem-solving skills. The definition of problem-solving itself varies. By definition, problem- solving is the ability to understand the environment, identify complex problems, analyze information, evaluate strategies and find solutions (Fissore et al.,2021). Problem-solving can also be defined as a thought process. According to Gürsan and Yazgan, problem-solving is a part of the thinking process to solve complex problems using higher-order thinking skills

Bransford and Stein defined “a problem exists when there is a discrepancy between an initial state and a goal state, and there is no ready-made solution for the problem solver”. Problem- solving is used to identify and describe a problem and find solutions to solve it. For this reason, new inventions are constantly being developed, enabling the evolution of social and cultural dimensions, and supporting market-based economies. Problem-solving skills are essential for success in various fields, encompassing both analytical and creative thinking (Choudhar et al., 2022). Effective problem-solving training incorporates constructivist didactics, self-organized learning, and collaborative settings to advance students' cognitive and metacognitive processes (Drigas & Karyotaki, 2016) These skills involve systematic observation and critical thinking to find appropriate solutions to challenges (Rahman, 2019). While some argue that problem- solving skills are generic and applicable across disciplines, others contend that they are context-specific (Baird, 1983). The problem-solving process includes identifying underlying causes, not just symptoms and employs strategies such as conceptualising, logical reasoning, and decision-making (Rahman, 2019; Choudhar et al., 2022). Although similar skills may be used across different fields, their implementation often depends on mastery of specific domains (Baird, 1983). Developing problem-solving abilities is crucial for both educational and professional settings, as they enable individuals to overcome obstacles and make informed decisions (Choudhar et al., 2022). Assessing these skills may be most effective when conducted within specific fields due to their context-dependent nature (Baird, 1983).

The educational community is being called upon to train the next generation of researchers with 21st-century skills and capabilities (Chauhan & Kumar 2021). Active engagement, collaborative problem- solving, and a shift from passive learning to developing lifelong critical thinking skills are essential for students' success and highly valued across disciplines and professions (McCormick et al., 2015). These competencies align with the core 21st-century skills outlined in various frameworks, which emphasize problem-solving, critical reasoning, creativity, innovation, cooperation, and communication as crucial talents for thriving in today's rapidly evolving world (Karla et al., 2022). The study by Manohari & Sreeya (2019) concludes that problem-solving skills are essential for everyone to lead a peaceful and pleasant life. The findings indicate that effective problem-solving enables individuals to view situations from multiple perspectives and develop various responses, thereby expanding opportunities for success. Furthermore, organizations that foster problem-solving abilities among their employees experience increased collaboration, productivity, and a reduction in conflict. Ultimately, the study emphasizes that problem-solving skills are crucial for success in daily life.

**Theory of Problem-solving Skills**

The theory of problem-solving skills has evolved significantly since its inception. Early work by Newell et al. (1958) established the foundation, emphasizing the need to predict performance, explain processes, and account for learning in

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problem-solving. Subsequent research expanded on this framework, with Tallman et al. (1993) defining problem-solving as a non-routine activity aimed at changing undesirable situations, distinguishing it from coping behaviours. Langley et al. (2005) extended the theory to include the physical context of problem-solving, highlighting the interplay between abstract reasoning and concrete actions. Frederiksen (1983) reviewed cognitive theories and creativity research, emphasizing the importance of practice and distinguishing between well-structured and ill-structured problems in instruction. These developments collectively underscore the complexity of problem-solving, involving cognitive processes, physical interactions, and learning mechanisms, while also highlighting the need for tailored instructional approaches to foster problem-solving skills effectively.

**Heuristic Problem-Solving Theory**

Heuristic problem-solving refers to the use of practical strategies or "rules of thumb" that simplify and expedite the resolution of complex problems. These mental shortcuts allow individuals to make quick decisions based on experience rather than exhaustive analysis, making the process more efficient and flexible. Common heuristic techniques include trial and error, breaking down problems into manageable parts, working backwards from desired outcomes, pattern recognition, and using analogies. This approach is widely applicable across various domains, such as education, business, healthcare, and everyday decision-making. However, heuristic problem-solving has its limitations, including the potential for cognitive biases and errors, a tendency to prioritize satisfactory solutions over optimal ones, and varying effectiveness depending on context. Despite these drawbacks, heuristic strategies enhance decision-making efficiency, and combining them with analytical methods can lead to better outcomes in problem resolution. Heuristic problem-solving involves using the intrinsic properties of a problem to guide the search for solutions, rather than exhaustively exploring the entire problem space (Pizlo et al., 1994). This approach has been applied in various domains, including artificial intelligence and accounts receivable management (Lévy, 1966). Pohl (1973) introduced dynamic weighting of heuristic information in search algorithms, which narrows the depth-first search while maintaining catastrophe protection. Human problem-solving efficiency in metric spaces, such as Euclidean Traveling Salesman Problems, suggests that humans build a single path rather than performing constrained searches (Pizlo et al., 1994). Abel (2003) proposed a problem-solving model incorporating general heuristics adaptable to specific applications across disciplines. These studies highlight the importance of heuristics in problem-solving, demonstrating their effectiveness in reducing search space and improving computational efficiency while maintaining solution quality.

**Cognitive Problem-Solving Theory**

Cognitive problem-solving theory focuses on the mental processes individuals use to identify, analyze, and resolve problems, emphasizing internal thought processes such as perception, memory, reasoning, and decision-making. Cognitive problem-solving theory explores the mental processes involved in finding solutions to challenges. It is considered a fundamental human cognitive process that interacts with other mental functions like abstraction, searching, and decision-making (Wang & Chiew, 2010). Key components include problem representation, which influences how individuals frame and visualize issues; information processing stages such as encoding, storage, retrieval, and application; and various cognitive strategies like algorithms, heuristics, and analogical reasoning. Metacognition, or the awareness and regulation of one's cognitive processes, plays a crucial role in effective problem-solving by enabling planning and monitoring. Cognitive theories suggest that problem-solving skills are acquired through practice and can be taught, with a distinction made between well-structured and ill-structured problems (Frederiksen, 1983) The theory also considers cognitive load, which affects problem-solving efficiency. Its applications span education, psychology, artificial intelligence, and workplace training, enhancing critical thinking and decision-making skills. However, the theory has limitations, including the complexity of real-world problems, an overemphasis on individual cognition while neglecting social interaction, variability in cognitive abilities, and insufficient attention to emotional influences. Overall, cognitive problem-solving theory provides valuable insights into human cognition in problem resolution, though it is essential to consider its broader context and limitations. Various models have been proposed to explain the problem-solving process, including decision-making models and cognitive structures of the brain (Wang & Chiew, 2010; Tallman et al., 1993). Structured training programs based on these theories have been developed and applied in criminal justice and mental health settings, with growing evidence supporting their benefits (McGuire, 2001).

**Constructive Problem-Solving Theory**

Constructivist problem-solving theory emphasizes the importance of authentic problem- solving activities in learning (Prawat, 1993). Research suggests that students of teachers with constructivist beliefs demonstrate higher achievement in problem-solving skills across various mathematical domains (Capraro, 2001). Constructivist problem-solving is a learner-centered approach that emphasizes active engagement in the problem-solving process, where individuals construct their understanding based on prior knowledge, context, and personal experience. This theory promotes active learning, encouraging students to interact with problems directly and relate them to real-life scenarios, fostering deeper comprehension. Key principles include the importance of prior knowledge, experiential learning,

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social interaction through collaboration, and reflection on the problem-solving process. Constructivist approaches, such as problem-based learning (PBL), are widely applied in education, workplace training, healthcare, and technology, enhancing critical thinking and innovation.

Benefits include improved retention, personalized learning, and enhanced communication skills; however, challenges such as time constraints, the need for guidance, assessment difficulties, and variability in learner backgrounds must be addressed. Overall, constructivist problem- solving encourages learners to actively explore, experiment, and reflect on their experiences, equipping them with essential skills for real-world applications. The theory integrates elements from cognitive science and decision support systems, aiming to develop a comprehensive framework for construction problem-solving (Li & Love, 1998). While problem-solving approaches are widely accepted in contemporary learning theories, some critics argue that they may overemphasize obstacles rather than possibilities (Prawat, 1993). An alternative perspective, idea-based social constructivism, focuses on the transformative potential of experiences and the inherent possibilities in learning situations (Prawat, 1993). The integration of creativity with problem-solving and constructivism has also been explored in the early years of education (Siraj-Blatchford & MacLeod Brudenell, 1996), further expanding the application of constructivist principles in learning environments.

**Systems Theory of Problem Solving**

The systems theory of problem-solving is an interdisciplinary approach that views problems as parts of larger, interconnected systems rather than in isolation. This theory integrates systems thinking and design thinking to address complex issues (Korn, 2023) and emphasizes a holistic perspective, recognizing that each component of a system is interdependent and that change to one part can have significant ripple effects throughout the system. It defines systemic problems as those where solutions are interdependent (Mitroff, 1977), and it proposes a taxonomic framework with six design viewpoints to support problem-solvers in conceptualizing and improving problem-solving processes (Ulrich, 1977). Key concepts include the importance of feedback loops, which can enhance or stabilize change, and dynamic complexity, where non-linear relationships and changing conditions necessitate adaptive problem-solving strategies. Systems theory also highlights the phenomenon of emergence, where solutions may lead to new, unanticipated challenges or opportunities. This approach views problem-solving as a cognitive-affective process involving the formation and reorganization of conceptual systems (Ulrich, 1977) and aims to overcome knowledge fragmentation and specialist isolation by promoting an interdisciplinary science with universal application (Skyttner, 2006). It suggests that problem-solving performance should be measured as a multiplicative function of performance across all phases of the process (Mitroff, 1977; Belavkin, 2006). This systemic approach to problem-solving is applicable across various fields, including organizational management, environmental science, healthcare, engineering, and education, where it aids in understanding complex interactions and optimizing decision- making. Benefits include improved comprehensive understanding, enhanced adaptability, and fostering collaboration among stakeholders. However, challenges such as the complexity of analysis, potential resistance to change, resource intensity, and the risk of overgeneralization can arise. Overall, systems theory offers valuable insights into effectively navigating complex problem-solving scenarios by considering the broader context and relationships within systems, applicable from individual to organizational levels and even extending to inanimate systems (Korn, 2023; Skyttner, 2006).

**Creative Problem-Solving Theory (CPS)**

Creative Problem Solving (CPS) is a structured approach that fosters innovative thinking and systematic problem-solving across various fields. Developed by Alex Osborn and refined by Sidney Parnes, CPS emphasizes the importance of alternating between divergent thinking (idea generation) and convergent thinking (idea evaluation) (Brophy, 1998a; Brophy, 1998b). The process, which involves whole-brain, iterative thinking, is most effective when done collaboratively (Lumsdaine & Lumsdaine, 1995). CPS follows a series of stages: clarifying the problem, generating ideas, developing solutions, and implementing them. Individual CPS abilities are influenced by cognitive and personality traits, with different problem-solvers being suited to different problem types (Brophy, 1998b). Tools like brainstorming, SCAMPER, and mind mapping support the exploration and refinement of ideas. The Creative Problem-Solving Profile (CPSP) measures cognitive styles in problem-solving along two dimensions: apprehension and utilization of knowledge (Basadur et al., 2016). While research shows that individuals often outperform groups in CPS tasks due to task design (Brophy, 1998a), CPS training has been explored to enhance problem-solving skills (Brophy, 1998b). CPS encourages creativity through principles like deferring judgment, encouraging unconventional ideas, and combining solutions. The CPSP, with its improved psychometric properties, also has potential applications in collaborative innovation, diversity, and group conflict research (Basadur et al., 2016). Despite challenges like time intensity and potential resistance to unconventional ideas, CPS remains a valuable framework for fostering creativity and addressing complex problems in individual and organizational contexts.

**Factor Affecting Problem-Solving Skills**

Problem-solving skills are influenced by a range of factors that shape how individuals and organizations address challenges. Cognitive factors, such as memory, knowledge base, attention, and mental models, play a crucial

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role in organizing information and generating solutions. Individuals with well-developed schemas and strong metacognitive abilities are often more effective in problem-solving, as they can plan, monitor, and evaluate their thinking processes (Bhadargade et al., 2020). Personality traits like risk-taking, motivation, and emotional regulation also influence problem-solving effectiveness, while social factors such as collaboration, cultural context, and group dynamics further shape outcomes (Yildirim et al., 2019). Expertise and experience allow individuals to draw on prior knowledge and recognize patterns, enhancing their ability to solve problems efficiently (Ali, 2021). Environmental factors like problem complexity, time constraints, and resource availability also affect problem- solving approaches, as do cognitive biases and heuristics, which can lead to shortcuts or errors. In computer science graduates, factors such as problem-solving confidence and planning style are also influential (Bhattacherjee & Kukreja, 2023). Technological tools and digital literacy are becoming increasingly important, providing innovative ways to explore solutions. Creativity and innovation foster divergent thinking, while educational background and training in problem-solving techniques equip individuals with the necessary skills. Overall, a combination of cognitive, emotional, social, and environmental factors interacts to determine problem-solving effectiveness, making it a multifaceted process that is crucial for students across various disciplines. Understanding these influences can help educators develop targeted Interventions and training programs to enhance students' problem-solving skills, ultimately improving their academic performance and employability.

**Problem-solving skills in science**

Problem-solving is an enduring issue in science education, ostensibly because science in itself, is basically concerned with problem-solving--exploring the universe and seeking answers to intriguing phenomena in nature. Remarkable strides have been made in psychology about recording the minutiae of problem-solving as a cognitive process. Concept mapping, a meta- learning tool, is appearing on the scene as a potential pathway for promoting the acquisition of problem-solving skills.Problem-solving skills in science are essential for applying scientific methods and reasoning to investigate phenomena, identify issues, and devise solutions, which are crucial in science education for preparing students to face real-world challenges (Riznani & Siahaan, 2020). These skills involve critical thinking, creativity, and the ability to systematically use the scientific method, beginning with hypothesis formation, experimentation, and data collection, followed by analysis and interpretation (Riznani & Siahaan, 2020). Scientists must identify variables, recognize patterns, and apply logical reasoning to conclude.

The process often includes problem representation through models, diagrams, and graphs to understand complex systems and collaboration across disciplines enhances the diversity of perspectives needed for innovative solutions (Mukhopadhyay, 2013). Scientific problem-solving also involves applying knowledge across domains such as biology, chemistry, and mathematics, integrating these fields to tackle complex challenges (Okebukola, 1992). Creativity is a key component, enabling scientists to design novel experiments and propose alternative solutions when existing approaches are insufficient (Mukhopadhyay, 2013). Additionally, the use of experimental and analytical tools, such as statistical software and lab equipment, supports sophisticated analysis and precise experimentation. However, research indicates that teaching problem-solving strategies alone is insufficient for developing true scientific expertise, as metacognitive skills should also be explicitly taught to build structured knowledge and guide cognitive development (Gok, 2010). Ethical considerations are also critical in scientific problem-solving, ensuring that solutions are pursued with integrity and respect for ethical guidelines. Ultimately, problem- solving skills in science drive the advancement of knowledge, innovation, and the ability to address global challenges such as climate change and pandemics, but studies show that students' problem-solving abilities in science are often low, highlighting the need for targeted interventions and improved teaching methods (Riznani & Siahaan, 2020). These problem- solving skills are essential to students in this 21st-century education (Munawaroh, 2020) and therefore it is necessary to highlight them and consider ways that they can be applied in the science classroom.

**Problem-solving skills in science of secondary school students**

Research on problem-solving skills and scientific attitudes among secondary school students reveals mixed findings. While some studies found a negative correlation between problem- solving skills and scientific attitudes (Ocak et al., 2021), others reported a positive relationship (Ahuja, 2020). Gender differences were observed, with girls demonstrating higher problem- solving abilities and better scientific attitudes than boys (Ahuja, 2020). Problem-based learning (PBL) was found to promote valuable problem-solving skills, particularly collaborative learning (Magaji, 2021). However, students often struggle with non-routine problems, suggesting a need for more diverse problem-solving experiences in curricula (Belgin et al., 2016). Factors such as teachers' pedagogical knowledge and time constraints can limit the effectiveness of PBL implementation (Magaji, 2021). Problem-based learning (PBL) is sparingly implemented by secondary school teachers (Merritt et al., 2017) especially in science as the focus has been on academic attainment rather than those problem-solving skills that led to the attainment. Probable reasons for not adopting PBL could include a lack of good management, teachers' pedagogical knowledge, the means to carry it out, and time involved in planning a PBL. Also, it can be confusing for some students to understand the process (Ghufron & Ermawati, 2018). This contrasts with Ertmer & Simons (2006) who suggest challenges ranging from creating a culture

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of collaboration and interdependence to scaffolding students' learning. Therefore, poorly planned PBL problems may affect the content coverage and activities required to promote the problem-solving skills mentioned earlier. These findings highlight the complex nature of problem-solving skills development in science education and suggest the need for further research to inform effective teaching strategies and curriculum design for secondary school students.

**Committees & Commission Recommendation on Problem-Solving Skills**

Several committees and commissions, both national and international, have highlighted the importance of problem-solving skills in education. These recommendations are primarily aimed at developing critical thinking, creativity, and practical skills among students to prepare them for real-world challenges. Problem-solving skills are crucial for success in the modern world, encompassing abilities like observation, critical thinking, and analytical reasoning (Rahman, 2019). Despite their importance, these skills are often not adequately emphasized in college curricula, as they are more challenging to teach than technical knowledge (Jozwiak, 2004). To address this issue, educators should incorporate problem-solving instruction into their courses, starting with simple assessment techniques and progressing to more sophisticated methods in upper-level classes (Jarvis et al., 2005).

Below is a summary of key recommendations from various committees and commissions:

**Kothari Commission (1964-66)**

The Kothari Commission emphasized a holistic approach to education and the importance of equipping students with problem-solving skills. It recommended:

- **Inquiry-based learning:** Encouraging curiosity and investigative methods in teaching.
- **Learning by doing**: Hands-on learning to foster practical problem-solving.
- **Reforms in examination**: Shift focus from rote memorization to testing understanding, critical thinking, and analytical skills.

**National Policy on Education (NPE) 1986 & 1992**

The NPE highlighted the importance of developing skills that would enable students to meet the challenges of modern society. Key recommendations included:

- **Integration of life skills education to** promote creative thinking and problem-solving.
- **Vocational training as part of the curriculum to** develop practical problem-solving abilities.
- **Improvement in pedagogical methods** that focus on problem-solving, communication, and teamwork (Jarvis et al., 2005).

**National Curriculum Framework (NCF) 2005**

The NCF stressed creating a curriculum that develops problem-solving skills among students. Recommendations included:

- **Constructivist approaches to learning:** Students should actively construct knowledge through engagement with problems.
- **Activity-based learning:** Practical activities that require students to apply concepts to solve problems.
- **Collaborative learning:** Group work that encourages cooperative problem-solving.

**Yashpal Committee (1993)**

The Yashpal Committee highlighted the need to reduce the burden of non-essential information and emphasized meaningful learning through problem-solving approaches:

- **Critical pedagogy:** Teaching methods that foster critical thinking and active problem- solving.
- **Focus on understanding over memorization:** Moving away from rote learning and promoting comprehension and application (Rahman, 2019).

**National Education Policy (NEP) 2020**

The most recent NEP focuses extensively on 21st-century skills, which include problem- solving, critical thinking, and creativity. It recommended:

- **Multidisciplinary education:** Breaking down silos between subjects to encourage lateral thinking and problem-solving.
- **Skill-based assessments:** Continuous assessments that measure problem-solving and critical thinking instead of only factual recall.
- **Technology integration:** Leveraging digital tools to teach problem-solving skills through simulations, projects, and case studies.

**World Economic Forum (WEF)**

Global educational reforms have also echoed the importance of problem-solving as a critical skill for the future workforce:

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- **21st-century skills framework**: Emphasizes critical thinking, creativity, collaboration, and problem-solving as essential skills for the future of work.

**UNESCO and OECD**

These organizations stress problem-solving in education:

- **Competency-based education:** Learning outcomes that focus on the ability to solve complex, real-world problems (Jozwiak, 2004).
- **Global Citizenship Education (GCED):** Integrating problem-solving skills into education to foster global thinking and responsibility.

These recommendations are aimed at developing students' capacity to face modern challenges, adapt to a dynamic environment, and approach problems creatively and systematically.

**Studies Conducted in the Field of Problem-Solving Align with their Findings and Importance:**

The field of problem-solving has been extensively studied across various domains, including business, education, cognitive science, and organizational management. The findings from these studies provide a comprehensive understanding of the different approaches, strategies, and cognitive processes involved in problem-solving.

Wickelgren (1973) conducted a foundational review of problem-solving frameworks, breaking problems into givens, operations, and goals, but it lacks modern perspectives on cognitive flexibility and emotional factors. Fissore et al. (2021) reviewed the impact of mathematics on problem-solving in secondary education, though they did not provide specific methodologies. Gürsan and Yazgan highlighted the thinking process in complex problem-solving but offered limited empirical evidence. Bransford and Stein defined a problem as a discrepancy between an initial and goal state, a widely accepted model that could benefit from recent insights into neuroscience. Choudhar et al. (2022) explored problem-solving across fields, emphasizing the need for context-specific applications. Drigas and Karyotaki (2016) combined constructivist and collaborative settings in problem-solving education, with a call for more recent practical examples. Rahman (2019) examined systematic problem observation, though further explanation of qualitative methods is needed. Baird (1983) discussed the context-specific nature of problem-solving, while Chauhan and Kumar (2021) critiqued education systems for not fully engaging with 21st-century skills. McCormick et al. (2015) emphasized active learning and collaboration in problem-solving, but longitudinal studies are needed to confirm effectiveness. Karla et al. (2022) focused on soft skills in problem-solving, lacking practical application examples. Manohari and Sreeya (2019) reviewed the broad application of problem- solving for peaceful living, though evidence remains generalized. Newell et al. (1958) proposed a dated yet influential problem-solving framework, while Tallman et al. (1993) distinguished problem-solving from coping but lacked exploration of their intersection. Langley et al. (2005) integrated physical context into problem-solving theories, adding depth to cognitive approaches. Frederiksen (1983) reviewed cognitive theories but omitted emotional and social influences, while Pizlo et al. (1994) analyzed heuristic problem-solving, though newer research could extend these insights. Abel (2003) presented a heuristic model that would benefit from comparisons with other frameworks. Prawat (1993) emphasized constructivist engagement in problem-solving, needing updates for modern digital environments. Skyttner (2006) applied systems theory to problem-solving, though a focus on specific systems would add value. Basadur et al. (2016) offered a creative problem-solving framework, requiring cross-cultural validation, and Ali (2021) examined the role of expertise, calling for a broader professional application.

Fernandes et al. (2023) conducted a bibliometric analysis to examine strategic problem-solving, identifying five key clusters: product development and open innovation, firm-customer relationships, creativity and resilience, learning and work environment, and partnership negotiation with supply chain and quality management. These clusters, though distinct, were found to be complementary and reflect the evolving nature of problem-solving research. Similarly, Taconis et al. (2001) conducted a review of experimental research on teaching strategies for science problem-solving. They identified effective approaches emphasizing structured knowledge bases, clear guidelines, and immediate feedback. Their findings suggest that group work is only effective when combined with these elements, underscoring the importance of structured knowledge and feedback in science education. Yingxu Wang et al. (2010) contributed a cognitive and mathematical model of the problem-solving process, highlighting its interaction with abstraction, learning, and decision-making. Using real-time process algebra (RTPA) and concept algebra, they explained the cognitive structures and mechanisms involved in problem-solving, advancing cognitive computing methodologies. Delahunty et al. (2020) also explored problem-solving by focusing on the early stages, particularly in STEM education. They found that memory and visuospatial processes are crucial in conceptualizing convergent tasks, highlighting the importance of these initial stages for reasoning success. In the context of organizational design, Nickerson et al. (2012) emphasized the problem-finding and problem-solving approach, suggesting that identifying problems, opportunities, and challenges is vital for effective management. They integrated capabilities, dynamic capabilities, and governance perspectives to offer a coherent framework For organizational design. On a theoretical level, Tallman et al. (1993) developed a formal theory of problem-solving behavior, based on operant behavior, social exchange theories, and cognitive psychology. Their model focused on decision-making in the latter stages of problem- solving. Earlier, Newell et al. (1958) outlined a theory of human problem-solving that aimed to predict performance, explain processes, and understand mechanisms like "insight" and the learning of problem-solving skills. Their comprehensive framework remains significant in understanding human problem-solving. Finally, Johnsen et al. (2021) highlighted the importance of problem-finding and solving for gifted students, stressing strategies like defining problems, identifying related issues, and formulating hypotheses. Their study focused on real- world problem-solving and the promotion of personal and social responsibility.

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