

Problem Solving and Higher-Order Thinking: Mapping Conceptual Overlaps and Distinctions

Mr. Thienkholal Guite¹, Ms. L.Lucy Lhinghoikim Kom²

¹Research Scholar, Teacher Education, Nagaland University

²Research Scholar, Education, Tezpur University

Abstract

Higher-order thinking and problem solving are commonly considered crucial educational outcomes, but the conceptual connection between them is not well elaborated in the educational research. Based on the synthesis of classical and up-to-date literature in the area of educational psychology, this conceptual paper analyzes the theoretical ties and differences between problem solving and higher-order thinking. Based on the existing cognitive models, the paper conceptualises problem solving as a practical, goal-focused expression of higher-order thinking that involves the planning, integration of critical thinking, reasoning, creativity and metacognitive regulation. Using a conceptual analytic methodology, the study identifies the areas of convergence, draws significant differences, and offers an integrative framework of the position of problem solving as a central construct in the framework of advanced cognitive processing. The paper also explains consequences of the curriculum design, instructional practice, assessment and teacher education. This study will help build more coherent theory by providing a conceptual clarity and to design education practices that will enable deep, transferable learning.

Keywords: Problem solving, Higher-order thinking, Critical thinking, Metacognition, Educational theory

1. Introduction

Problem solving has traditionally been identified as an educational goal that has been consistent with the general goal of training learners to react effectively to the complex academic, work and life issues. Problem solving is no more considered as a domain-specific skill in the current discourse of education but rather viewed as a transferable cognitive ability that is required in life-long learning and flexibility in a world that is quickly changing (OECD, 2019). With the growing importance of analytical judgement, flexibility, and innovation in knowledge societies, the world has rediscovered that the ability to work with unfamiliar and poorly structured issues is one of the key aspects of education, hence the importance of university students developing these attributes.

Just in line with this change is the increased appropriateness of higher-order thinking (HOT) as a learning outcome. The higher-order thinking which is normally attributed to the analysis, evaluation, and creation takes place at the top of the cognitive taxonomies and according to the thinkers it forms the basis of deep understanding and meaningful learning (Anderson & Krathwohl, 2001). Problem solving continues to be an output and mode of acquiring more complex thinking processes in curriculum frameworks and policy documents (UNESCO, 2015).

Nonetheless, despite this general focus, there has always been conceptual unclarity on the connection between problem solving and other related terms like critical thinking, reasoning and creativity. The two

terms are commonly synonymously used in education research and practice, resulting in the lack of theoretical articulation and pedagogical disparity (Dwyer et al., 2014). This ambiguity makes it difficult to design the curriculum, plan the instruction, and evaluate the cognitive attainment.

It is against this context that the paper at hand attempts to make clear the conceptual boundaries and overlaps existing between problem solving and high order thinking. The paper will build on a consistent conceptual insight of the constructs through the synthesis of known theories and the current academic literature to understand the concepts from different perspectives. In particular, it is focused on the following guiding questions: How problem solving is theoretically placed in the sphere of higher-order thinking interactions? How does it intersect with, and how it does not intersect with critical thinking, reasoning, and creativity? These questions will help the paper to contribute to a clear conceptual understanding and allow further informed educational theory and practice.

2. Conceptual Foundations of Problem Solving

Problem solving is a typical concept in educational psychology whereby a goal-oriented thought process is classified as problem solving whereby individuals strive to solve problems whose solutions are not clearly visible. In comparison to the implementation of the routine tasks, problem solving presupposes moving through the uncertainty, choosing the adequate strategies to follow, and controlling the achievement of the desired result (Mayer, 2014). It is thus considered to be one of the main processes in which the learners transfer their previous knowledge to new situations and thus a pillar of effective learning.

The classical theoretical views give the background knowledge of problem solving. Among the most popular and the first of them is the model of problem solving proposed by Polya and conceptualizing a systematic approach to problem solving as including the perception of the problem, the generation of a plan, execution of the plan and reflection upon the solution (Polya, 1957). The model emphasizes the reflective and critical approach to problem solving, but not its procedural implementation. In a similar perspective Gestalt psychology focuses on insight and restructuring where it is suggested that problem solving is characterized by people reclassifying their cognition of a problem situation so as to realize unexpected cognition or experiences of “aha” (Kohler, 1947). Conversely, the literature on information-processing approaches treats problem solving as a series of mental processes that consists of encoding, strategy choice and evaluation processes, which place special emphasis on the working memory and cognitive resources (Newell & Simon 1972).

Modern views expand the views to these possibilities by defining problem solving as a metacognitive and cognitive process. The use of cognitive processes involves reasoning, representation, and applying of strategy, whereas, the metacognitive processes involve planning, monitoring and evaluating one thinking in the engagement across the problem (Flavell, 1979). Studies have always demonstrated that effective problem solvers proactively control their thinking processes whereby they manipulate thinking styles based on the behaviour of feedback and task requirements (Schraw et al., 2006).

Literature about education also differentiates between various forms of problems. Routine or structured problems are normally defined by goals and solution directions and the non-routine or ill-structured problems are typified with the lack of clarity of solutions with various options and complexity of situation (Jonassen, 2011). The latter are especially important in promoting higher-level thinking and applicability to a real-life scenario.

Academic importance of problem-solving competence is that it is highly correlated with conceptual knowledge, transfer knowledge as well as learning independence. The problem-solving process helps teachers facilitate serious learning, resilience, and application of the knowledge beyond classroom contexts thereby ratifying the core of modern education objectives and goals (Hattie, 2012).

3. Understanding Higher-Order Thinking in Education

The notion of higher-order thinking (HOT) is rooted in the intellectual work of Bloom whose taxonomy of the educational goals attempted to categorize the mental operations based on the growing complexity of the process. The initial taxonomy identified by Bloom et al. (1956) allowed making a distinction between lower and higher-level processes: knowledge recall and comprehension, analysis, synthesis, and evaluation. This became the top-bottom perspective and emphasized meaningful learning that goes beyond memorization to focus on the active manipulation and transformation of knowledge. This framework was further narrowed in the revised taxonomy offered by Anderson & Krathwohl (2001) which conceptualizes cognitive categories as processes, which involve remembering, understanding, applying, analyzing, evaluating, and creating, and thus provides strong support to the central role of higher-order cognition in modern education.

The higher-order thinking is mostly defined in terms of cognitive complexity, non-algorithmic cognition, and reflective judgement. Students who participate in HOT are called upon to process information and find relations, make judgments, and create new solutions instead of regurgitating learned material (King et al., 2015). Deep learning is strongly linked to this kind of thinking since it encompasses the combination of new information with knowledge acquired previously and its practical application in various situations in an adaptable way. Notably, metacognitive awareness is usually required in higher-order thinking because it helps the learners to plan, monitor, and assess their thinking processes (Schraw & Dennison, 1994).

One of the characteristics of higher-order thinking is that it focuses on the depth of understanding. Instead of correct spelling, HOT teaches students to explore the principles behind it, test the assumptions and build the meaning by thinking and reflecting (Biggs & Tang, 2011). This richness is also to be specifically observed where the learners are dealing with poorly formulated problems, with competing views, or with their own original responses, which require long-lasting mental attentiveness.

Higher-order thinking is also prevalent in the programmes and learning outcomes across the globe. HOT is always a notable educational outcome outlined in international policy documents and national curricula in different countries needed to equip learners to handle complicated demands to meet societal and workplace challenges (OECD, 2019). As a result, learning strategies like inquiry-based learning, problem-based learning, and reflective assessment practices are becoming more and more encouraged in order to promote the engagement of higher-order thinking.

Clearly defined distinction between the higher order and the lower order thought processes is necessary. Though the basic application and recall constitute a basic ground upon which the bottom-up processes lie, it cannot serve alone in mitigating real-world challenges that are intricate. These initial skills are then extended by higher-order thinking, which consists of flexible and transferable skills which become the basis of problem solving and lifelong learning.

4. Conceptual Overlaps Between Problem Solving and Higher-Order Thinking

The concepts of problem solving and higher-order thinking are closely related, which have a significant

conceptual basis in the education theory. To the core, both stress on highly cognitive processes that cannot be reduced to routine application of knowledge. The key point in this overlap is the existence of common cognitive exercises like analysis, synthesis, and evaluation, which is always cited to be characteristic of higher-order cognition (Anderson & Krathwohl, 2001). In problem solving, the learners have to interpret problem situations, synthesize information about the problem, and assess the possible solution strategies, which prompts them to apply the same cognitive processes that occur with problem solving at the higher-order levels of thinking.

Another aspect of overlap becomes the element of metacognition. Both problem solving and higher-order thinking expect the learner to think out how to accomplish something, tracking the progress and reflecting on what has been achieved. Mental control helps people to choose the necessary strategies, eliminate mistakes, and change their thinking according to the feedback (Flavell, 1979). Literature sources and theoretical research indicate that great solvers of problems show the enhanced metacognitive awareness which correlates well with the higher-order thinker who takes a key role in regulating their mental proceedings (Schraw et al., 2006). Therefore, the metacognition serves as an integrative process between the two constructs.

Theoretically speaking, it is possible to think of problem solving as applied application of higher-order thinking. Although the concept of higher-order thinking is a generalization of the more specialist concept of advanced cognitive processes, problem solving offers a tangible scenario within which the said processes are realized. Researchers believe that problem solving operationalizes high-level cognition by locating analysis, appraisal, and invention to goal-based activities that require solving of ambiguity (Mayer, 2014). In this respect, problem solving is not something that occurs outside of the context of higher-order thinking but is one of the main forms in which it is aptly manifested in school.

The other important overlap is with regard to the transfer of learning and application to real-life. The two constructs are appreciated to influence learners in the capacity of flexibly applying the knowledge in different contexts. Higher-order thinking helps in abstraction and generalization, whereas problem solving presupposes that learners need to apply previous knowledge to new and frequently ill-structured cases (Jonassen, 2011). This congruence on transfer highlights their applicability to real learning and life-long competence outside of school.

Together these two common features give a good theoretical basis on conceptual convergence. Instead of considering problem solving and higher-order thinking to be independent or opposing constructs, newer educational scholarship is conceptualizing them into mutually supporting forms. Elucidation of this overlap will aid more coherent curriculum design and instructional activities in a bid to help develop deep and transferable learning outcomes.

5. Conceptual Distinctions Among Related Constructs

Even though problem solving has significant similarities with higher-order thinking, it bears no conceptual similarities with a variety of closely related thinking constructs, in particular, critical thinking, reasoning, and creativity. These differences need to be explained with the purpose of theoretical accuracy and efficiency in education.

Problem solving and critical thinking are often blamed but the two are not the same in objectives and circumstances. The main purpose of critical thinking is the evaluation of the information, arguments, and evidence based on the logical and reflective judgement (Facione, 2015). It focuses on doubt, questioning, and making logical conclusions. On the contrary, problem solving is goal oriented, which means its

orientation is on the goal of finding a particular solution or result where the procedure to finding it is not always clear (Mayer, 2014). Though critical thinking is part of problem solving especially when analysing and assessing a problem, it does not always have a definite solution. In this way, critical thinking may be considered as the supporting process that enlightens problem-solving activity instead of a substitute of this activity.

Another difference related to that appears when comparing problem solving and reasoning. Reasoning can be described as the mental activities by which individuals make inferences and define interactions between notions and can be divided into deductive, inductive, and analogical types of reasoning (Halpern, 2014). Deductive reasoning is used when general rules are applied to particular situations, inductive reasoning when generalizations are made out of particular situations, and analogical reasoning when generalizations are made by means of reference to familiar situations. However, problem solving involves more than reasoning since it also involves strategic planning, making decisions and metacognitive regulation. Problem solving entails reasoning processes although problem solving is a wider and more integrative mental endeavour which encompasses the choice and coordination of various reasoning modalities aimed at a specified object (Jonassen, 2011).

Additional boundaries related to the concept are seen in the nature of the interplay between problem solving and creativity. The creation of novel and suitable ideas or solutions in a specific situation is often considered to be creativity (Runco & Jaeger, 2012). Creative thinking stresses on originality, imagination, and thinking in different ways. Solving problems, however, can or cannot be creative; some problems are those that need to be solved creatively, whereas some may be solved using known measures. Creativity improves problem solving in the ill-structured or open-ended task, but not all tasks that require problem-solving need the output of creativeness. Hence, problem solving is an activity that is driven by creativity and not an internal constituent.

These differences bring out the differences in scope, purpose, and results. Problem solving is solution based, critical thinking is evaluation and judgement based, reasoning is inference and logic based and creativity is based on originality and innovation. The tendency to treat these constructs as synonymous runs many risks, among which are imprecise aims of learning, incoherent medications, and inconsistent practices during instruction (Dwyer et al., 2014). Cognitive clarity is thus such an essential component in progressive research and pedagogical practice in learning.

6. An Integrative Conceptual Framework

In continuation of the above conceptual examination, this paper will come up with an integrative conceptual framework which places problem solving as a central construct as an applied construct in the larger sphere of higher-order thinking. In place of looking at problem solving as an isolated skill, the framework theorizes it as a dynamic cognitive process that entails and integrates a variety of higher-order processes, such as critical thinking, reasoning, and creativity. Such a position corresponds to modern ideas of interrelation and non-linearity of advanced cognitive processes in real-life learning situations (Jonassen, 2011; Mayer, 2014).

In the suggested framework, critical thinking acts as a judgmental basis on working out problems. It helps learners to interpret the conditions of the problem, challenge assumptions, judge the validity of the information, and determine alternative solution directions (Facione, 2015). Reasoning, which refers to the deductive, inductive, and analogical types, is the inferential process with the help of which learners form logical links and draw conclusions that may be required to lead them to a solution (Halpern, 2014).

Creativity, in its turn, helps provide generative ability, which allows learners to generate new representations or strategies especially during work with ill-structured or open-ended issues (Runco & Jaeger, 2012). It is the combination of these processes and coordination that results in problem solving and not in any one cognitive skill.

The primary characteristic of the framework is that it focuses on the context-specific and dynamic nature of problem solving. Critical thinking, reasoning, and creativity make relatively different contributions based on the nature of a task, experience in a domain, and situational pressures (OECD, 2019). Manageable issues can be dependent more on critical thinking and analysis, but intricate and real-world issues can need innovative reorganizing and proactive decision-making. The fact that this flexibility is ranking the significance of the metacognition regulation where learners are able to figure out and modify their cognitive strategies according to the needs of a particular context (Schraw et al., 2006).

The framework has significant implications to the teaching and learning. It implies that the instructional practices need to leave behind the period of individualized skill learning and start to craft some type of learning experiences that intentionally and systematically incorporate assesses, inferential, and generative thinking into tasks based on a problem. Moreover, the evaluation must not be limited to the final answers, but also quality of reasoning, thought, and responsiveness must be evaluated in the process of engaging with the problem.

On the whole, the proposed framework helps to achieve the clarification of the notions by drawing the relationships between major higher-order constructs and by placing problem solving as a unifying, application-focused process. This detail helps build theory more coherently and have a base to develop the future empirical and pedagogical investigations.

7. Educational Implications

The conceptual explanation of problem solving as an applied aspect of higher order thinking has a number of implicative educational implications, especially on the method of curriculum design, instruction, assessment and teacher education.

In curriculum design terms, the framework points at the necessity to leave content-centered syllabi behind the back in favor of curricula that deliberately incorporate problem-solving opportunities in interdisciplinary terms. Higher-order cognitive outcomes in curriculum goals should clearly explain the skills of the learners in analyzing complex situations, applying reasoning, and generating solutions to situations with which they are not familiar. Studies indicate that curriculum programs based on conceptual knowledge, real-world problems, and big ideas are more effective in imparting transferable problem-solving skills as opposed to curricular programs based on procedural knowledge (Biggs & Tang, 2011; OECD, 2019).

Regarding teaching methods, the results reinforce the instructional approaches based on learning centered on the learner, i.e. inquiry-based learning, problem-based learning, and grouping. Such strategies provide the situations under which students are capable of reasoning, reflecting and strategically making decisions, but not passively taking in the information (Hmelo-Silver, 2004). Educators are very important in scaffolding the processes of problem solving by modeling the ways of thinking, occasioning the metacognition and promotion of multiple paths to solutions.

The framework also implies some consequences on evaluating higher-order thinking. It is inadequate to use traditional tests that emphasize memorization and repetitive practice to measure problem-solving competence because of its complexity. Rather, performance-based tests, open-ended assignments and

components of reflection are more appropriate to assess analytical thinking, imagination as well as metacognitive control in students (Brookhart, 2010).

In the last detail, the framework brings to the fore the importance of teacher education and professional growth. Strong conceptual knowledge on higher-order thinking and problem solving are needed by teachers to provide coherent learning experiences and assessment. The focus of professional development programs, in turn, needs to be on pedagogical content knowledge, the design of instruction on how to address complex tasks, and how higher-order cognitive outcomes can be evaluated (Darling-Hammond et al., 2017).

8. Conclusion

By tracing out the theoretical confusions and dissimilarities of problem solving and higher-order thinking in the field of education research, this theoretical paper aimed to explore the connection between the two concepts. Based on the classical and modern literature analysis, it is possible to find out that problem solving should be approached as not a separate ability, but as a purposeful, practical reflection of the cognitive processes of a high order. It absorbs critical thinking and reasoning and creativity and the ability to metacognitively regulate in reaction to complex, and at times, ill-constructed exercises. An explanation of these relationships deals with a conceptual ambiguity in long-standing that restricts coherence in curriculum design, pedagogy and assessment.

The article emphasizes the need of conceptual accuracy in education. To the extent of using higher-order thinking, critical thinking, and creativity interchangeably when defining a problem, instructional objectives become unclear, and assessment is at the risk of being skewed. An explicit theoretical pathway, as suggested in this paper, will allow teachers and scholars to build learning experiences that willingly develop high-level problem solving and transferable knowledge (Anderson & Krathwohl, 2001; Jonassen, 2011).

Theoretically, the integrative framework has a contribution to education where problem solving is placed in a unifying construct to operationalize higher-order thinking in real-life learning settings. This view is in support of an integration of fragmented skill training to coherent and problem-based learning settings. The future directions include expansion of the present research by systematic reviews, design-based researches, or empirical studies addressing the mechanisms of operative role of integrated cognitive processes in disciplines and educational levels. This kind of research would also enhance theoretical and practical background of problem-solving education.

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