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Behavioral and organizational characteristics of individual problem-solving

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Abstract

Our research aims at exploring the behavioral (task habit) and organizational (deliberate learning mechanisms) antecedents of problem solving of individuals in the working life. Drawing on the behavioral and cognitive psychology literature, we argue that individuals who perform a repeated task, i.e. task habit, free up mental resources to be used in problem solving. Drawing on the literature on deliberate learning mechanisms, we theorize that knowledge articulation and knowledge codification at the organizational level assist individuals in motivating, reasoning and attributing meaning throughout the problem solving process. Hierarchical linear modeling on data collected from 142 workers in 13 plants is conducted to test our hypothesis. Our findings corroborate the role of task habit and deliberate learning mechanisms in individual problem solving. Overall, this research contributes to the microfoundations literature and to the development of an integrated theory of learning, habit and problem solving literature.

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Keywords: problem solving, learning mechanisms, habit, microfoundations.

INTRODUCTION

Problems are ubiquitous in any organization. The problem-solving process (March and Simon, 1958; Simon, 1978b) encompasses steps of (1) problem identification, (2) problem scrutiny, (3) generation of alternatives, (4) solution selection and implementation, (5) solution testing and (6) standardization of solution and routinization. Different managerial and operational approaches are available for supporting problem solving, from lean management aiming at continuously improving the organization by overcoming small problems at a time to useful tools such as Deming (1986)'s PDCA cycle or DMAIC cycle (Schroeder et al., 2008). Similarly, for many organizations, creating new capabilities is a central path by which they deal with problems to compete in complex and unstable environments (Teece et al., 2007). These higher-order capabilities work for modifying zero-order organizational practices that are no more effective (Winter, 2003), thus suggesting that ad hoc problem solving is enacted. This demonstrates that current managerial and operational approaches have assumed problem solving processes being simply a sequence of actions that are a tautological consequence of some organizational premise.

Yet, problem solving processes are enacted by individuals. By taking account that individuals are rationally bounded, Simon (1978b) rejects the economic notion of maximization by contending that processes of individual problem solving "are always rough approximations to the reality, and we must hope that the approximation will not be too inexact to be useful" (p.11). In other words, problem solving is always the result of the selection of satisfactory alternatives, rather than optimal alternatives. The fact that solutions space is infinite and can be depicted by peaks in Kauffman (1993)'s rugged fitness landscape that derives from the number and intersection of search choices provides evidence of the complexity involved in the discovery of problems and selection of solutions (Levinthal, 1997). Understanding that carrying out problem solving cannot be limited to a pattern of actions and that individuals have their own perceptions of problems and problem solving rules, which introduce variations in the actions they perform (Narduzzo et al., 2000; Feldman and Pentland, 2003) opens up new avenues for research on problem solving.

This position is especially relevant given the recent organizational trends towards the need for taking into consideration cognitive and behavioral characteristics of individuals.

Recent research has called for a greater attention on the microfoundations of organizational and managerial phenomena (Gavetti, 2005; Abell et al., 2008; Barney and Felin, 2013). This means that by focusing on the micro-level of analysis, i.e. individual, is possible to better understand the macro-level characteristics of an organization. The unit level of analysis should therefore be the individual, in whom resides heterogeneity in dealing with problems.

Our research intends to investigate the antecedents of individual problem solving in the working setting. Our core argument is that both organizational and individual attributes affect the way individuals deal with problems at work. On the one hand, the organizational context can either foster or inhibit the capacity to correctly define a problem, its solution and the embeddedness into routines (MacDuffie, 1997). This has been set forth by Zollo and Winter (2002) forwarding the idea that the evolution of routines – which result from cycles of problem solving processes – depend on the learning mechanisms of experience accumulation, knowledge articulation and knowledge codification. The ability that an organization has in creating knowledge and making it easily available affects beliefs, behaviors and actions of individuals (March, 1991; Kogut and Zander, 1992; Nickerson and Zenger, 2004). Thus, organizational learning mechanisms guide individuals in generating alternatives and sustain them throughout problem solving.

On the other hand, individual problem solving depends on the individual behavior, in particular his or her habits. Specifically, "work and daily life [of individuals] are mostly action, and (as Simon would agree) [individuals] capacity for careful reflection and choice is extremely slow and very limited in scope and depth" (Cohen, 2007:777). Actions that individuals engage in the work setting reflect standard operating procedures, heuristics or organizational practices that individuals store as work habits in their procedural memory (Cohen and Bacdayan, 1994) and that are triggered by contextual cues. Whenever a job problem is presented, the habitual pattern of actions performed by individuals is compromised and deliberation-driven problem solving starts playing a dominant role (Dewey, 1922; Winter, 2013).

The main objective of the present research is thus to contribute to the literature on problem solving. Though Newell and Simon introduced the theory of human problem solving (Newell et al., 1958; Newell and Simon, 1972), research on social sciences has scarcely investigated problem solving at the individual level. Our focus on the link between habit and problem solving contributes to "understand the organization in terms of one of its central "inputs," individuals, rather than postulate macro causes for individual behavior" (Barney and Felin, 2013:141) and, on the other hand, our focus on the role of learning mechanisms in problem solving allows "to study and understand the role of structure in shaping individual-level outcomes, macro to micro causation" (p.144). Therefore, the research topic has important implications from both a theoretical and practical viewpoint as it investigates job problems in terms of the way individuals can become more effective in solving them.

RESEARCH CONSTRUCTS

In this section, we draw on concepts from psychology and organizational behavior to explain the three building blocks of the present study: individual problem solving, task habit and deliberate learning mechanisms. These insights help us framing the research question and give a hint at the underlying reasons prompting the hypothesis development.

Individual problem solving

In the last few years, problem solving has been investigated from different organizational perspectives. Nickerson et al. (2012) adopt a problem-finding and a problem-solving approach to reconcile research on capabilities, dynamic capabilities and governance perspectives. In addition, literature on innovation management has investigated creative problem solving in the process by which existing knowledge and new inputs lead to innovative outcomes (Scott and Bruce, 1994; Felin and Zenger, 2014). From a knowledge-based perspective, Nickerson and Zenger (2006) submit that the development of new knowledge depends on the alignment of governance forms with problem solving.

Moreover, problem solving plays an important role in operations management (MacDuffie, 1997; de Mast and Lokkerbol, 2012; Choo, 2014). Investigating the root causes of problems in the shopfloor of three automobile companies, MacDuffie (1997) shows that the process of problem-solving in cases of water leaks, paint defects, and electrical defects share similar approaches. He notices that several structures were in use to avoid poor performance of problems identification, incorrect diagnoses, and scarce solutions. Scarce solutions may in fact lead to new problems that need again to be scrutinized in order to create a new solution, which raise the "cost of failure". Likewise, Choo (2014) finds that the time spent in defining problems helps to uncover all possible information and knowledge that are necessary for shorten project duration.

Despite the literature on innovation and NPD, problem solving is mostly exemplified in a series of steps that winks at a systematic, rather than improvised, problem identification, problem analysis and solution implementation. In particular, individuals respond to problems in job-related tasks by adjusting their knowledge, skills and abilities in an effective way (Jundt et al., 2015). In such an adaptive performance behavior, the problem solving activity in which individuals engage can thus be described drawing on the rational problem solving concept set forth by D'Zurilla and Goldfried (1971), i.e. "a behavioral process, whether overt or cognitive in nature, which (a) makes available a variety of potentially effective response alternatives for dealing with the problematic situation and (b) increases the probability of selecting the most effective response from among these various alternatives" (p.108).

Differences in problem processing thus are not referred to the individuals' cognitive systems of "processing (perceiving, organizing and analyzing) information using cognitive brain-based mechanisms and structures" (Peterson et al., 2009: 520). Though individuals have inbuilt, fairly stable cognitive styles that characterize the personal tendencies in dealing with problems in either a systematic or intuitive fashion (Jabri, 1991; Scott and Bruce, 1994; Rayner and Riding, 1997), the present paper looks at individual problem solving from a behavioral perspective. Following Newell and Simon's (1972) theory of human problem solving, an individual "operates as an information processing system" (p.19) that uses specific methods to work through problems. "The function of a method is to produce behavior rationally related to an end" (p.837) by guiding the steps that an individual makes from the definition of a problem space till the generation of a solution. Problem space is a mental representation of the initial problem situation, the goal to be attained and the possible actions that reach the goal. Individuals choose among alternative actions to (concretely or figuratively) move to the successive state of the problem. Each state of the problem "may be thought of as a possible state of knowledge to which the problem solver may attain. A state of knowledge is simply what the problem solver knows about the problem at a particular moment of time" (Simon and Newell, 1971: 171). Thus, individuals interpret the outcomes derived from the chosen action and move from one knowledge state to another till a solution is identified and implemented.

Thus, problem solving is a multistage process, encompassing different activities that are not necessarily performed at one moment in time. Since problem solving ranges from problem analysis to solution implementation and standardization is, by definition, characterized by discrete, not continuous, activities. The extent to which these activities are performed in a systematic manner is the objective of the present research.

Task Habit

Historically, task habit has been associated with organizational routines, i.e. recursive sequence of actions that are performed by different individuals aiming toward the functioning of the firm (Dewey, 1922; Stene, 1940; Cohen and Bacdayan, 1994, Nelson and Winter, 1982; Feldman and Pentland, 2003). Several studies argue that organizational routines may be explicative of individual habits (Stene, 1940; Nelson and Winter,1982; Winter, 2013; Cohen et al., 2014), thus suggesting that the exploration of organizational routine is a sufficient condition for understanding the habitual behavior of individuals. However, recently, Cohen (2012) points out that "the distinctiveness of the routine mode of action stems from its being grounded in an ensemble of individual psychological processes that may be grouped together with the broad term habit" (p.1383).

Dewey (1922) posits that the underlying constituencies of individual behaviors reside in its habit, impulse and intelligence. In particular, "man is a creature of habit. Not of reason, nor yet of instinct" (p.88), thus suggesting that the "habitual faculty" is able to shape and empower the "cognitive faculty" and the "emotional faculty" of human beings (Cohen, 2007). Wood and Neal (2007) define habits as "learned dispositions to repeat past behaviors" (p. 843). Thus, habits are "patterns of response [that] probably develop in the same way as any skill acquisition. With repetition and practice of a skill in a given setting, the cognitive processing that initiates and controls the response becomes automatic and can be performed quickly in parallel with other activities and with allocation of minimal focal attention" (Oulette and Wood, 1998: 55). They enact in response to contextual cues including locations, actions in a sequence and other people (Neal et al., 2006). This impulse-response link is immediate and not mediated by the pursuit of a goal.

It would be misleading to conclude that habits are mindless, rigid and mundane. Indeed, Dewey describes habitual actions as those of a violin player or an engraver that perfectly master their movements in order to create an outstanding music or artifact, thus suggesting that habit is “infused with thought and feeling” (p.51).

In domains in which habits have not yet been acquired or need to be changed, individuals’ actions are elicited by intentions (Wood and Neal, 2007). Individuals enact a behavior in order to pursue an explicit goal overriding an automatic response primed by contextual cues. People have to guide their behaviors by exerting effortful self-control. Self-control can be considered a finite resource that people deplete as they endeavor to inhibit or override thoughts, emotions, and behaviors in order to pursue their intentions (Muraven and Baumeister, 2000). In this way, deliberate processes are dedicated to create or modify existing habits and they are precluded from being used for other reasons.

The more behavior is repeated the more it becomes automatic (James, 1890). In his analysis of computer procedures, Simon (1978a) postulates that the choice of the most efficient procedure depends on the number of times it has been used. Similarly, habits are the result of winnowing out the most efficient way of performing tasks that have been repeated many times. The advantage of automaticity is that as a task is frequently repeated, individuals tend to internalize the repeated tasks in an unconscious way (Giddens, 1984) and to perceive they can master and predict their actions (Reich and Zautra, 1991). The way tasks are habitually performed is stored in the part of the memory that is called procedural memory (Squire et al., 1993). Procedural memory is characterized by low decay rate (Cohen and Bacdayan, 1994) that allows individuals to steadily remember the “know-hows” of doing things. It differs from declarative memory that individuals use to consciously recollect facts, propositions and events (Cohen and Squire, 1980). Thus, individuals perform a habitual behavior without the mediation of deliberate search for alternative actions and of deliberate decision on which one to perform. This implies that the declarative memory is spared and individuals can process information coming from different processing modules (visual, auditory and olfactory) that are bound together to depict an event or an object (Cohen et al., 1997) without impairing the performance habit. Declarative memory can be eventually used for engaging in deliberate and conscious behaviors elsewhere, allowing individuals to devote attention and energy to other tasks that require them (Bargh and Chartrand 1999, Kahneman 1973, Posner and Snyder 1975).

As an individual has acquired a habitual behavior in performing his job, competencies are developed through repeated actions (Green, 1999). Competencies refer to an individual's knowledge, skills, and abilities in performing a specific job (Shippmann et al., 2000). Task habits can thus help workers to enhance their competencies and, as a consequence, their ability to overcome problems.

Deliberate learning mechanisms

Argote and Miron-Spektor (2011) review previous studies to provide a commonly accepted definition of organizational learning, i.e. "a change in the organization that occurs as the organization acquires experience" (p.152). A change refers to changes in the knowledge that an organization possesses in the form of explicit knowledge and tacit knowledge. In particular, explicit knowledge is more easily accessible and codifiable than tacit knowledge (Polanyi, 1967). The latter is difficult to be classified, it resides in the know-hows of individuals (Nonaka, 1991) and it is high in "causal ambiguity" thus impairing to be transferred among (groups of) individuals (Szulanski 1996). Finally, tacit knowledge can be either "inarticulable" or "articulable" (Cowan et al., 2000).

Zollo and Winter (2002) argued that there are three learning mechanisms that explain how knowledge evolves, is formulated and is made available throughout the organization, i.e. experience accumulation, knowledge articulation and knowledge codification. While experience accumulation is a by-product of deviations occurring in the existing business activities and processes and it is similar to the idea of “learning-by-doing” developed by Pisano (1994), the other two learning mechanisms encompass “deliberate cognitive processes involving the articulation and codification of knowledge derived from reflection upon past experiences” (Zollo and Winter, 2002:340). In this study we focus on the learning mechanisms for which organizations embark in certain tasks and are required to make investments in tangible assets. Experiential learning, on the other hand, might be difficult to isolate whenever it is inarticulable or rather it can be gleaned by means of deliberate cognitive processes.

Knowledge articulation refers to “the process through which implicit knowledge is articulated through collective discussions, debriefing sessions, and performance evaluation processes” (p.341). Knowledge that can be articulated is easier to circulate in the organization and needs shorter time to get it transferred among colleagues. This might be similar to the “double-loop learning” model provided by Argyris and Schon (1974), in which individuals continuously discuss with each other about their assumptions, ideas and information in order to make them flow smoothness in the organization and to create consensus by avoiding misunderstanding and misspecification of knowledge. Knowledge articulation can in fact reduce causal ambiguity thanks to a collective understanding of the links between actions and performance outcomes (Lippman and Rumelt 1982).

Knowledge codification occurs when “individuals codify their understandings of the performance implications of internal routines in written tools, such as manuals, blueprints, spreadsheets, decision support systems, project management software, etc.” (Zollo and Winter, 2002:342). Codification provides a common way for representing knowledge and make it possible to reduce its complexity and make it meaningful to all members of an organization. The codification process is possible only when knowledge has been previously articulated and understood by individuals (Zollo and Winter, 2002). The trade-off with knowledge articulation is that knowledge codification is applicable only to a limited number of activities as it is costly for individuals to detail their understandings in written formats.

Knowledge articulation and knowledge codification are two organizational learning mechanisms that, being collective cognitive processes, do not dwell in the individuals taken separately. However, individuals make use of this collective knowledge through mental schemata. Schemata are pre-structural representations that originate from past knowledge and that enable individuals to make sense of complexity by reducing it to simple patterns (Bartunek, 1984). They “are the bases upon which one relates knowledge, attributes meaning and fashions understanding” (Poole et al., 1989: 272). New knowledge coming from a continuous activity of knowledge articulation and codification leads individuals to fit new information into pre-existing mental schemata. This occurs because mental schemata are at some point activated or retrieved as individuals perceive similarity with situations or problems observed previously that enact analogical reasoning (Clement, 1988). This situation or problem thus triggers individuals to get engaged into reasoning through which mental schemata are continuously modified till all requirements are met and a solution is found (Ericsson and Lehman, 1996).

HYPOTHESES DEVELOPMENT

The relationships between our theoretical constructs, i.e. deliberate learning mechanisms and task habit, and individual problem solving are presented in Figure 1. Our research model investigates the antecedents of problem solving through an analysis of habit and problem solving at individual level, and an analysis of organizational related- knowledge articulation and codification and individual problem solving.

Insert Figure 1 about here

A habitual behavior that performs repeated tasks activates an automatic behavior, which frees up mental resources and reduces the attentional load of the skilled worker. This may lead to affect positively the problem solving process. Specifically, individuals frequently repeating the same tasks are not required to be constantly aware of what they are accomplishing so that mental resources may be used on other cognitive activities and, therefore, to think about other aspects of their work (Ohly et al., 2006) As a result, workers have the capacity to identify problems as soon as they occur and think about possible solutions.

The effect of habitual behavior on the problem solving process can be explained drawing on the study of Winter (2013) exploring the relationship between habit and deliberation through the two systems model of cognitive processes developed by Kahneman (2011). System 1 refers to automatic, effortless and fast reasoning and it is governed by habit and System 2 refers to deliberately activated, effortful and slow reasoning that can not occur in concomitance with another cognitive activity. The two systems are related in terms of "when System 1 runs into difficulty, it calls on System 2 to support more detailed and specific processing that may solve the problem of the moment. System 2 is mobilized when a question arises for which System 1 does not offer an answer" (p. 24). This is indicative of the relationship between habit and problem solving in the working context: whenever workers perceive that there is an error in their habitual behavior (System 1), an effortful reasoning is activated to identify the problem and solve it (System 2).

Task habit can be seen as the experience of prior choices that shape the cognitive representation of job-related tasks (Weick, 1995; Gavetti and Levinthal, 2000). Specifically, a worker mastering a job better than a colleague will have a greater understanding of the tasks required to accomplish the job. Thus, when a problem occurs, task habit provides a broader problem space in which deliberation might wander. On the other hand, deliberation allows a broader examination of the problem space. As a consequence, task habit is more likely associated to a systematic problem solving at individual level.

Therefore,

Hypothesis 1: Task habit is positively associated with individual problem solving.

Both knowledge articulation and accumulation mechanisms are learning efforts that lead to better identify the underlying causes of problems, to explore possible solutions and to implement them. Argyris (1977) argued that “learning is [..] defined as the detection and correction of errors, and error as any feature of knowledge or of knowing that makes action ineffective. Error is a mismatch: a condition of learning, and matching a second condition of learning” (p.365). Learning mechanisms therefore embed lessons learned from past experiences and trial-and-errors processes that were shared, standardized and explicitly available among colleagues for future circumstances. The stock of knowledge coming from learning influences individuals’ abilities to represent the problem space, interpret the information about the problem and see solutions (Yu, 2001). Under these conditions, effective problem solving processes occur to the extent individuals have access to past knowledge and can combine chucks of this knowledge in such a way that the problem is overcome and a feasible solution is adopted.

An organization showing its capacity of developing knowledge articulation, thus fostering communication and interactions among internal actors, “implies knowledge creation—it allows tasks to be accomplished that could not previously be accomplished or not accomplished so well. By definition, articulation leads to an increase in the amount of explicit knowledge available to the community in question [workers]” (Hakanson, 2007: 64). Thus, increasing knowledge articulation makes new knowledge becomes available (Cowan et al., 2000), though it may not be easily accessible and understood by individuals. This can be due to the fact that "knowledge codification is a step beyond knowledge articulation. The latter is required in order to achieve the former, while the opposite is obviously not true" (Zollo and Winter, 2002: 342), thus suggesting that knowledge codification enables articulated knowledge to get organized and encoded in symbols, vocabulary, language and standards that can be commonly understood by individuals (Zander and Kogut, 1995).

Codified knowledge is faster to be transferred, it lowers systematic biases in interpretation and it is easily replicable in different situations. Moreover, the fact that codifiable knowledge can be stored, transferred and retrieved from new technologies makes it easier for individuals to use this knowledge at the time, place and moment they require it (Davenport and Prusak, 1998). This knowledge can be used in substitution or in support of individual knowledge (Ancori et al., 2000). Whenever individuals can not use their existing cognitive schemata to solve a problem, they tend to reflect on the underlying reasons that make them inadequate, thus enabling knowledge codification to come to the rescue. Individuals thus engage in a back and forth process for confronting new knowledge with their existing knowledge, i.e. mental schemata, "that can be retrieved and superimposed on subsequent activities" (Choo, 1996: 334). Thus, the extent to which an organization develops the learning mechanism of knowledge codification shapes the way individuals make use of this knowledge and valorize it in the process of problem solving.

Therefore, knowledge codification plays a mediating role in the relationship between knowledge articulation and individual problem solving by transforming articulated knowledge into codified knowledge. Knowledge codification allows individuals to have access to symbols, vocabulary, language and standards throughout all steps of problem solving, thus extending problem space, spurring the generation of alternatives and supporting the implementation of the best solution.

Therefore,

Hypothesis 2: Knowledge codification mediates the relationship between knowledge articulation and individual problem solving.

Hypothesis 3: Knowledge codification is positively associated with individual problem solving.

METHODS

We tested our hypothesis using data extracted from a large survey that started in September 2014 and is still in progress (it will be concluded by May 2015). This survey collects data from different questionnaires directed to hierarchically related respondents, i.e. plant managers, shopfloor supervisors and workers, which cover several topics including operations management, strategy and performance. Our sample contains manufacturing plants located in the Northern part of Italy, an area that was closed to the authors' affiliated University. This choice made it possible for the authors to personally present the survey to the top management of all participating plants in order to ensure that the study was feasible, its objectives clearly understood and informants appropriately selected. For the purpose of the present research we use only data gathered by questionnaires from workers. Targeted respondents were individuals working in teams, performing stable and repeated tasks in their daily job and holding the same position for at least one year. In this way, we avoid response bias due to poor familiarity with the job and the organization in general. For each plant, workers grouped together in one room and filled in paper questionnaires during paid work hours under the supervision of one of the authors. Managers recommended at least one researcher assisted the administration to workers in order to guarantee them the questionnaire was anonymous and the top management did not have direct access to the information, thus reducing social desirability bias. It also ensures the questionnaire is explained and possible misunderstandings are addressed.

Our sample is composed of 142 workers from 13 different plants. Descriptive statistics about the plants is reported in Table 1. The average number of workers per plant is 11 (SD=2); most of them are man (82%); with regard to the age, 14% were in the range between 18-30 years, 61% in the range 31-45 years, 25% in the range 46-60 years and none was above 60 years; in terms of ethnicity, 100% were Italian; 3 had primary school certificate, 73 had junior high school certificate and 66 had a high school degree.

Insert Table 1 about here

Measures

The questionnaire was developed based on an in-depth review of the literature on behavioral organization and cognitive psychology. As the informants of this study are Italian, the preliminary English version of the questionnaire was translated to Italian and double back-translated into English following the approach of Brislin (1980). Though all constructs have been previously validated in psychological studies and strategic management research, questionnaire items were refined to adapt them to the present study. Questionnaires were initially inspected by a group of four academics and five practitioners to ensure all measures have face validity and content validity. When items did not obtain good psychometrics they were modified or dropped and, eventually, replaced with new ones upon group approval. A pilot test of the questionnaire within three manufacturing plants, followed by interviews with respondents, was administered to confirm consistency and coherence of the measurement scales.

If not specified, all measures were rated on a 7-point Likert scale ranging from "strongly disagree" to "strongly agree". Moreover, measurement validity and reliability is tested for each construct. Next, we report how each construct was obtained.

Individual Problem Solving. As problem solving processes engage people into a systematic and step-by-step analysis of problem identification, generation of possible alternatives to solve the problem, solution selection and implementation, our scale of individual problem solving has to capture the behavioral approach of individuals when they are involved in solving problems. In psychological literature focusing on problems in daily life, Maydeu-Olivares and D'Zurilla (D'Zurilla and Maydeu-Olivares, 1995; Maydeu-Olivares and D'Zurilla 1996) developed the *rational problem solving* (RPS) scale that refers to a cognitive-behavioral pattern that involves a deliberate and systematic application of problem-solving skills, including problem definition and formulation (PDF), generation of alternative solutions (GAS), decision making (DM) and solution implementation and verification (SIV). In the present study, the RPS scale has been adapted to focus on problems that workers face in their daily work in the shopfloor. Our measurement scale has six items. A note in the questionnaire identified the type of problems (e.g. machines breakdowns, tiring physical movements, time wasted to search for tools/parts) workers had to think of in reporting their responses. Example items were "When I am confronted by a problem in my work, one of the first things I do is survey the situation and consider all the relevant pieces of information", "I have a systematic method for comparing alternatives and making decisions" and "When a solution to a problem in my work is successful, I tend to systematically embed the solution in my activities". Cronbach's alpha was .84.

Task Habit. Empirical studies on management sciences have described task habit in terms of a behavioral attitude in performing routinized, automatic and mindedness activities (Cohen and Bacdayan, 1994; Birnholtz et al., 2007; Laureiro-Martinez, 2014). We captured individual habit with Verplanken and Orbell (2003)'s 12-item measure (the Self-Report Habit Index; SRHI). Though this measure entails the dimensions of automaticity, frequency and self-identity (the extent to which an individual identifies himself with the habit), we focus only on the automaticity of the task habit given the characteristics of our research. This measure has been extensively used in several psychological studies (see Verplanken et al., 2005 for a review) and it assesses habitual behavior as a function of "the history of repetition, lack of awareness, difficulty to control and mental efficiency" (Verplanken, 2006: 641). To ensure that the task habit measured a specific behavior in the workshop, a note in the questionnaire asked workers to report the most important task for their job and to refer to this task in responding the SRHI (Ohly et al., 2012). Some examples of the tasks wrote down by individuals were assembly, quality inspection, welding. A sample item is "Behavior X is something . . . I do automatically". Cronbach's alpha was .72.

Deliberate learning mechanisms. A review of the empirical literature on learning mechanisms, measured in terms of knowledge articulation and knowledge codification, showed that this construct has been mainly investigated in research on dynamic capabilities (Emden et al., 2005; Kale and Singh, 2007; Barrales-Molina et al., 2010, 2014; Schilke, 2013) and plant performance (Su and Chen, 2013). As most of the existing scales were measured in strategic and operations management research at the organizational level, we created two measurements that could be adapted for capturing knowledge articulation and codification perceived at the individual level by slightly changed items collected from past research. Four items measure the construct of knowledge articulation, an example is "In general, there is good communication among the members of the plant". Four items measure knowledge codification, an example is “I use a well defined procedure to develop work-related improvements”. EFA results indicated the unidimensionality of each construct with average factors loading of .76 and .83 and explaining 58% and 68% of the total variance, respectively. Cronbach’s alpha was .74 and .83, respectively. CFA results indicate the two-factor model fit the data well (χ^2 = 38 , *df*=17 , RMSEA= .083, CFI=.96, TLI=.94). The fit indexes were better than the one-factor model (χ^2 = 36, *df*=18, RMSEA= .086, CFI=.93, TLI=.91), thus confirming that knowledge articulation and knowledge codification are two distinct constructs.

Control variables. We controlled for gender (0=female, 1=male), individual age (0=from 18 to 30 years old, 1=from 31 to 45 years old, 2=from 46 to 60 years old, 3=above 60 years old) and education (0=primary school certificate, 1= junior high school certificate, 2=diploma or higher) to rule out influences from personal characteristics. Similarly, we controlled for personality traits using the 10 items version of the Big Five Personality Questionnaire (Gosling et al., 2003). As Barrick et al. (2013) argued, personality traits have an important role in explaining behavior at work, thus including problem solving processes. To avoid biased parameter estimates and for parsimony reasons (Becker, 2005), we only controlled for “extraverted/enthusiastic” and “critical/quarrelsome” which resulted to significantly affect problem solving compared to the other personality traits based on a preliminary regression analysis. Finally, we controlled for tenure of workers (number of years) and job complexity (4 items based on Zacher and Frese, 2011; the coefficient alpha was .70) in order to rule out influences from problem characteristics and familiarity with tasks and problems. At the organizational level, we included plant size (logarithm of employees) to control for heterogeneity of the sample.

Analytical Strategy

Given that our sample comprises workers, nested in plants, we used hierarchical linear modeling (HLM) to test our hypothesis. To validate the aggregation of knowledge articulation and knowledge codification at the organizational level, we computed within-group interrater agreement (r_{wg}) and intra-class correlations (ICCs). Average r_{wg} values of .86 and .88 and ICC[1] of .7 and .68, respectively, provide consistent support in favor of aggregation. Next, to justify the use of HLM as the most appropriate statistical approach, we ran a null model with no predictors (Model 1, Table 3). The model shows that the variance attributable to the organizational variables, relative to that from the lower-level variables, is not significant (ICC[1] =.1 , p=.17). This is not surprising due to the limited number of plants in our research-in-progress. From a review of statistics literature, Kreft (1996) concluded that sample size is not a problem for the accuracy of the parameter estimates whereas it tends to provide a smaller estimate of the group-level standard errors when ICC[1] is low. Given the above statistical considerations and the fact that the multilevel model fit better our theoretical model in terms of interpretation of results, we conducted HLM and we comment on the implications of the variance components estimates for knowledge articulation and knowledge codification.

One important final issue to consider in multilevel models is whether and how to use a centering solution to detect individual-level effects and group-level effects on a dependent variable measured at individual level (Raudenbush, 1989; Paccagnella, 2006). Statistics literature is cautious in providing a general rule for making a decision as it depends on the objective of the study. Based on Paccagnella (2006)'s suggestion, as the intent of the present research is to investigate both individual and organizational antecedents of problem solving, thus "to distinguish group-level effects […] from individual-level characteristics […], the choice of a model with centered variables and group means as predictors is preferable" (p.83).

Results

Table 2 provides descriptive statistics and correlations of the study variables. It is worthwhile noting that all the predictor variables of our interest, i.e. habit, knowledge articulation and knowledge codification, are positively and significantly associated with the response variable, i.e. problem solving, which hints at providing some support to our theoretical arguments. Of the predictor variables, knowledge articulation exhibited a significant correlation with knowledge codification ($r = .55, p < .05$), thus raising issues on the interpretability of the results due to potential collinearity.

Insert Table 2 about here

The HLM results are shown in Table 3. First, we tested the null model (Model 1) without predictors to be estimated. Next, we added the individual-level control variables (Model 2) and then the task habit (Model 3). Finally, we introduced the organizational-level variables in sequence: first, knowledge articulation (Model 4) followed by knowledge codification (Model 5).

Insert Table 3-4 about here

In Model 3 we found that the higher the task habit that an individual exhibits the higher his or her ability to engage into a rational and systematic problem solving process, thus supporting Hypothesis 1. To check for the mediating role of knowledge codification in the relationship between knowledge articulation and individual problem solving (Hypothesis 2), we performed Baron and Kenny (1986)'s model. First, an OLS regression showed that knowledge articulation is significantly and positively related to knowledge codification (Table 4), second the effect of knowledge articulation on problem solving decreases when knowledge codification is taken into account (Models 4-5 in Table 3). Though additional tests are required (it will be done after concluding our survey so that an adequate sample size will be available), our preliminary findings provide support to Hypothesis 2. Finally, our Hypothesis 3 suggested that plants in which the deliberate learning mechanism of knowledge codification is more developed are more likely to influence the problem solving of their workers. Model 5 showed that knowledge codification impacts positively individual problem solving, thus supporting Hypothesis 3.

Referring to the control variables (Model 2), we found that gender can signal proclivity toward problem solving, being male workers more inclined to solve problems in a systematic fashion. Moreover, it is worthwhile noticing that personal characteristics can influence individual problem solving. Extravert individuals tend to be ambitious, they strive for obtaining rewards in their work and they look for increasing their status (Barrick et al., 2013). It is not surprising that they show a proclivity toward individual problem solving, which may be a means for distinguishing themselves among their colleagues. On the contrary, irritated workers tend to have a significant negative impact on problem solving. This might be due to the fact that irritated individuals show limited patience, low tolerance and scarce attitude in confronting with others (Bruck and Allen, 2003), which may impair his or her ability to solve problems. Finally, job complexity is significantly positively related to problem solving (Model 3-5). Workers performing complex tasks might face problems more complicated or more frequently, hence affecting the number and complexity of schemata in memory (Wofford, 1994) and, as a consequence, the ability of systematically solve problems.

DISCUSSION

In this research, we have synthesized and bridged key constructs from the cognitive and behavioral psychology literature, on one side, and from the literature on organizational learning, on the other side, in order to improve our understanding on individual problem solving. Workers are constantly challenged with job problems and, as the studies by Newell and Simon suggest (Newell et al., 1958; Newell and Simon, 1972), engaging in problem solving is not a simple, mundane and inarticulate task but it encompasses a complex generation and interaction of possible alternatives (Kauffman, 1993) through (concretely or figuratively) successive states of the problem which ultimately lead to the implementation of a solution. Finally, "the solving of a problem is an event which needs to be classified, so far as the individual's behavior is concerned, as an act of learning . . . [since] . . . the observed events in problem solving comprise a change in human performance, and this in turn leads us to infer a change in human capability" (Gagne,1966: 130). It is therefore important that research sheds some light on this aspect, which is not only useful for understanding individual behaviors at work but more generally for improving overall organizational performance. Conceptualizing task habit as a way of freeing up cognitive resources, the present study highlights the importance to engage individuals into stable, standardized and repetitive tasks in the pursuit of performing problem solving. Further, we emphasize that the way knowledge is presented and accessible to individuals in their organizations is important to support the development and implementation of solutions.

Moreover, the present research contributes to the literature on problem solving at the organizational level. Extant literature on problem-solving has been mostly focused on exploring the most effective practices for identifying problems, generating possible alternatives, selecting and implementing solutions at the organizational level (PDCA cycle, DMAIC cycle, etc.). This is evident also in the literature on lean manufacturing. Continuous improvement is one of the main tenets of lean organizations that enables firms to systematically chasing non-value-added activities in order to reduce waste and increase performance (Womack et al., 1990), through ongoing cycles of problem solving. Of course, practices related to problem solving are important but previous studies have scarcely investigated the linchpin of these practices, i.e. individual problem solving. As these problem solving practices embed knowledge codification, our fine-grained study provides some insights on how they affect the individual in dealing with problems. Finally, our research has a number of limitations. First, future research should test our theoretical model on a larger sample size in order to provide further support on our findings. Next, future research should investigate whether task habit, knowledge articulation and knowledge codification interact with each other in strengthening or lessening the effect on individual problem solving. Lastly, future research should shed some light on understanding how individual problem solving and its antecedents affect organizational characteristics such as routines and dynamic capabilities and performance.

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FIGURE 1
Conceptual Model

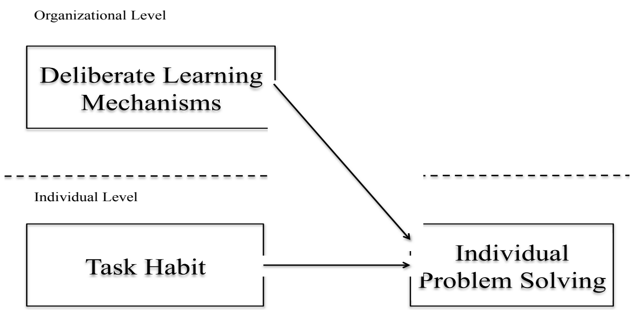

TABLE 1
Overview of the plants

Plant	A	B	C	D	E	F	G	H	I	J	K	L	M
Turnover 2013 (in millions)	€360	€50	€70	€17	€107	€40	€38	€32	€250	€32	€35	€110	€102
N. employees	590	125	310	130	580	273	65	100	170	200	180	200	306
Industry	Production of metal furniture	Baby strollers and other baby products	Industrial machinery and equipment merchant wholesalers	Production of aquariums, ponds and terrariums and appliance components	Production of heating, ac and air quality appliances	Production of gas burners	Wine bottling	Production of systems to insulate doors and windows	Production of intermediates for pharmaceutical companies	Production of blast chillers and food preservation systems	Production of automation systems	Production of automation systems	Produ-ction of agri-cultural equipment

TABLE 2

Means, Standard Deviations, and Correlations

	Mean	s.d.	1	2	3	4	5	6	7	8
Among individual level variables										
1. Gender	0,82	*0,39*	1							
2. Age	1,16	*0,63*	-0,14*	1						
3. Education	1,38	*0,54*	0,07*	-0,42*	1					
4. Years of Tenure	13,46	*9,20*	-0,0	0,66*	-0,29*	1				
5. Extraverted	4,46	*1,77*	-0,19*	-0,16*	0,12*	-0,10*	1			
6. Irritated	3,73	*1,72*	0,01	0,07*	-0,11*	0,07*	0,14*	1		
7. Task Habit	3,52	*1,40*	-0,20*	0,18*	-0,15*	0,20*	-0,05	0,07*	1	
8. Problem Solving	5,86	*1,01*	-0,01	-0,10*	0,07*	-0,07*	0,29*	-0,10*	-0,10*	1
Among team level variables										
1. Size	280	*196*	1							
2. Kld Articulation	5,15	*1,25*	-0,13*	1						
3. Kld Codification	5,52	*1,15*	-0,14*	0,55*	1					

TABLE 3
Hierarchical Linear Regression

	Model 1	Model 2	Model 3	Model 4	Model 5
			Individual Problem Solving		
Gender		0.14**	0.13**	0.13**	0.13**
		(0.06)	*(0.06)*	*(0.06)*	*(0.06)*
Age		0.04	0.06	0.06	0.06
		(0.04)	*(0.04)*	*(0.04)*	*(0.04)*
Education		0.01	0.01	0.02	0.02
		(0.04)	*(0.04)*	*(0.04)*	*(0.04)*
Tenure		-0.00	-0.00*	-0.00*	-0.00*
		(0.00)	*(0.00)*	*(0.00)*	*(0.00)*
Extraverted		0.03***	0.03***	0.03***	0.03***
		(0.01)	*(0.01)*	*(0.01)*	*(0.01)*
Critical		-0.02**	-0.02**	-0.02**	-0.03**
		(0.01)	*(0.01)*	*(0.01)*	*(0.01)*
Job Complexity		0.07***	0.07***	0.07***	0.07***
		(0.02)	*(0.02)*	*(0.02)*	*(0.02)*
Task Habit			0.04***	0.04***	0.04***
			(0.01)	*(0.01)*	*(0.01)*
Plant Size				0.04	0.06**
				(0.03)	*(0.02)*
Kld Articulation				0.04	-0.01
				(0.03)	*(0.03)*
Kld Codification					0.11**
					(0.04)
Constant	1.75***	1.75***	1.75***	1.33***	0.91***
	(0.02)	*(0.02)*	*(0.03)*	*(0.21)*	*(0.25)*

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

TABLE 4
OLS Regression

	Kld Codification
Plant Size	-0.157
	(0.115)
Kld Articulation	0.449***
	(0.0881)
Constant	4.008***
	(0.807)
Observations	142
R-squared	0.262

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1