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Problem-solving is decision-making

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ABSTRACT

In the following paper I argue that problem-solving and decision-making are just different aspects of the same multi-stage goal-oriented cognitive process. I prove my hypothesis by comparing stage by stage both the decision-making and problem-solving prescribed strategies and the description protocols. If indeed problem-solving and decision-making processes are homological, scientist, studying the same process from different perspectives, might be able to learn from each other and their dialogue may be facilitated through the common vocabulary suggested in this paper.

KEYWORDS: problem-solving, decision-making, naturalistic, algorithm, strategy.

INTRODUCTION

The review of literature reveals that contemporary accounts of the relationship between problem-solving (PS) and decision-making (DM) are contradictory and confusing. In this paper I attempt to clarify the terms and to put them in order.

The thesis that I present in this paper is that PS and DM refer to the same process. I prove my thesis by comparing these processes stage by stage.

Problem-solving is often considered to be based upon application of an algorithm, while decision-making is considered to be based upon experience and intuition. I argue that the division between “algorithmic” and “naturalistic” or experience-based thinking cannot serve as a basis of distinction between problem-solving and decision-making, as problems are often dealt with haphazardly and decisions are often made methodically, and vice versa. In fact, algorithms for problem-solving and decision-making bear striking resemblance. Moreover, I demonstrate that “naturalistic” problem-solving and decision-making patterns, both productive and unproductive, are similar.

The first chapter starts with the various definitions of the term “problem”, stemming from the different approaches. Then, the various types of categorizations of problem are presented. Next, the term “solution” is investigated and a “proper” five-stage PS strategy is described, phase by phase. The conditions under which the problems are being properly solved are discussed further. As most problems are not properly solved by people, an account of the different ways in which they cope with unsolved problems is also provided. *Coping* is described as a correlate to the stress that problems cause. A theory of two cognitive systems - rational and experiential - is presented in brief. The distinction between the two systems explains what makes people solve problems properly or hastily, or not at all.

The second chapter starts with the investigation of the concepts of “decision” and “decision conflict” and their relationship to problems. Next, an “optimal” five-stage DM strategy is described and compared to the “proper” PS strategy, stage by stage. Further “sub-optimal” DM patterns are then presented and correlated with coping mechanisms and the functioning of the experiential cognitive system. Next, the context and the conditions that are conducive for using the rational, procedural system is discussed, including when it is preferable and when it is not. Finally, the expert and novice use of the two cognitive systems are discussed.

The paper concludes with a list of suggested definitions of the concepts relating to PS and DM.

LITERATURE REVIEW

Regarding the question of the relationship between problem-solving (PS) and decision-making (DM), no option has been eliminated from the current scholarly discourse. The full range of answers - from “they are the same” to “they have nothing in common” - all have their champions. Some claim that they overlap and argue about where the true division lies. Others claim that one is part of another or the other way around. In numerous articles, PS and DM related terms are interchangeable (Sadler and Zeidler, 2005; Lee and Grace, 2012; Papadouris, 2012).

Cenkseven-Onder and Colakkadioglu (2013) present a survey of different perspectives on the relationship between PS and DM which are still relevant today. The authors note that some researchers argue that problem-solving and decision-making processes share similarities; thus, these concepts must be used together (Adair, 2010; Ivey et al., 1993; Churney, 2001). According to another popular opinion, decision-making and problem-solving are entirely different (Baron and Brown, 1991; Elstein and Schwartz, 2002; Isen, 2001). PS-oriented and DM-oriented researchers perceive these concepts and their interrelation differently. In a series of works dedicated to social PS, D’Zurilla (D'Zurilla and Goldfried, 1971; D'Zurilla and Chang, 1995; Nezu, D’Zurilla and Nezu, 2012) recognizes DM, or selecting the best solution out of many, as one of the five stages of PS. The conflict theory of decision making (Janis and Mann, 1977) sees systematic search for information, careful consideration of all viable alternatives and the unhurried, non-impulsive making of the final decision, in other word, PS, as one of the five DM-patterns.

The task of categorizing the different conceptions of PS and DM is complicated by the variety of domains and contexts in which they appear. In different branches of science, medicine, management, customer services, the classroom, and the social lives of adolescents, different aspects of PS and DM are considered central and marginal. For example, in medicine, PS refers to the ability to formulate and test good hypotheses, while DM refers to the ability to avoid biases (Elstein and Schwartz, 2012). In customer services, PS is considered good if it is creative, diverse, and flexible in categorization, while quality DM is considered good if it is fast, thorough, and efficient (Isen, 2001). In the social lives of adolescents, good decisions are those that one would not regret upon reflection (Baron and Brown, 1991).

The situation is further complicated by researchers relying upon different mind-theories and world-theories. For example, Adair (2010) believes that problems and decision situations are distinct and that decisions create problems. However, he also believes that the mental framework used in PS and DM is similar.

Ohlsson (2012), while criticizing the classical approach to PS (Newel and Simon, 1972), argues that PS involves five distinct cognitive actions: to perceive the problematic situation, retrieve relevant actions, conceptualize the top goal, activate and apply action selection preferences, and assemble a way to evaluate problem states. Theories of these five cognitive functions might be forthcoming from

psychological research on perception, memory, intentionality, decision making, and judgment, in which case there is nothing specific to say about them in the context of problem solving. If so, PS is not a proper field of study, and there might not be a distinct theory of PS.

In other words, contemporary conceptualizations of both PS and DM are confusing and contradictory. In this paper I attempt to clarify the terms and the *quid-pro-quos*.

HYPOTHESIS

Among the numerous theses regarding the relationship between PS and DM I support the thesis that states that these concepts refer to the same complex process, compound of distinct stages, each stage demanding different cognitive operations. This process may be defined as any goal-directed sequence of cognitive operations. This definition does not distinguish between a sequence of actions that one *knows* will achieve a goal and a sequence of actions one undertakes when one does *not* immediately know how to reach the goal (Anderson, 1980, quoted by Robertson, 2001).

According to Anderson (1990), PS is a generic term used to cover deciding which action to take. DM also appropriately refers to the same process, but this term emphasizes the evaluation of alternatives, whereas research on PS has traditionally focused on the combinatorial explosion of sequences of action that occur in PS search.

Thus, the hypothesis that I try to defend is one among the others, it is not original or new. The new element that I present in this paper is the systemic approach, considering different approaches to the subject, and the argumentation supporting the hypothesis.

METHODOLOGY

In the numerous items written on the subject, the authors' approach to the conceptualization of DM and PS, including Anderson and others, is usually unquestioned by them. It is either postulated or quoted from another source. In this paper I would like to investigate all the possible conceptualizations of DM and PS, and present an argument in support of the hypothesis stated above.

I will rely on the methodology of conceptual analysis as well as process analysis. Both DM and PS processes are thoroughly described and prescribed in professional literature. There is no need for me to add to add a new protocol or to suggest a new algorithm. I will only compare the existing prescribed and the described DM and PS algorithms and protocols in different contexts.

I will argue that both the prescribed and the described PS and DM processes are homological, stage by stage. In other words, if to each stage of proper PS there is a corresponding optimal DM stage and vice versa, we are prescribing about the same algorithm or strategy. We are talking about the same artificial algorithm or strategy for dealing with problems. If the reasons why people do not solve problems properly and make sub-optimal decisions are the same, if the blunders they make at each stage are the same, DM and PS processes are the same.

Problem-solving is often considered to be based upon application of an algorithm, while decision-making is considered to be based upon experience and intuition. I argue that the division between "algorithmic" and "naturalistic" or experience-based thinking cannot serve as a basis of distinction between problem-solving and decision-making, as problems are often dealt with haphazardly and decisions are often made methodically, and vice versa. In fact, algorithms for problem-solving and decision-making bear striking resemblance and "naturalistic" problem-solving and decision-making patterns, both productive and unproductive, are similar.

PROBLEM SOLVING

What is a “problem”?

According to Anderson (1990), finding a rest room or getting two diet sodas are exemplary problems. In a footnote, Anderson writes that finding a rest room might not seem like much of a problem, but in certain cases (details purposely omitted) it was.

A *problem*, in the broadest sense, is a gap between the given situation and the desired one. Bridging the gap is solving the given problem (Laughlin, 2011; Cenkseven-Onder & Colakkadioglu, 2013). For example: "How much is two plus two?" or "Who was the first president of the United States?" are problems, while “4” and “George Washington” are solutions, in the broad sense, *ad hoc*. This definition is intuitive and simple, but it is not accepted by all experts on the subject. It stems from the classical definition of a problem as the gap between the given and the desirable, which the individual does not immediately know how to bridge (Newel and Simon, 1972). This definition has been accepted by different scholars until this day (Beyth-Marom et al., 1989; Brest and Krieger, 2010; Shoenfeld, 2013). According to this view, the above questions are not problems - for those who know the answers.

This definition of a problem depends on the person solving it. However, it is important to note that finding a solution to a problem does not or should not mean that the problem has ceased to be a problem. For example, a booklet in which I have solved all the problems does not stop being a booklet with problems, either for me or for others. Therefore, we must distinguish between a problem, in the broad sense, and a "real" problem, in relation to an individual who does not know how to solve it immediately.

Dewey’s (1910) approach is very close to that of Schonfeld, with one significant difference. In Dewey's terms, a problem is ”real“ if it arises out of the real life of the one facing it, if it is interesting, and if it is grounded in the social context. Such problems can be called “real life” problems. If this is indeed the case, a number of math problems may be real problems for a student, but may not necessarily represent problems in his life.

This is the primary source of confusion regarding the concept of a problem: if someone does not acknowledge a problem to be a problem, is it still a problem? Well, of course it is. A person may be in denial about having a problem or a problem might not really concern him; nevertheless, it is still a problem.

A problem in itself is timeless and often impersonal. Its “realness”, however, relates to the subject facing it. Its “real-lifeness” refers to the subject within a specific time-frame. With a real-life problem, it is a given that unless something changes, life will become worse at a certain point in time. This will happen either because one will no longer be satisfied with the persisting conditions, or because something is threatening to change these conditions for the worse.

What types of problems are there?

In fact, there are many types of problems. According to Robertson (2001), a problem is defined by the following four factors: the given situation, the desired state, the types of actions that can be taken to resolve the problem, and the problem-solving restrictions. Problems can be sorted into category pairs: problems requiring great or little knowledge (domain-specific or generic), well or ill-defined problems (closed or open), semantically rich or poor problems (requiring familiarity with the type of problem or not), problems of insight or problems requiring the application of an algorithm (Robertson, 2001).

Laughlin (2011) defines a problem by its domain, complexity, detail (well or ill-defined), and relationship to other problems.

Each type of problems calls for different sets of skills, knowledge, and *tactics* to solve it. The overall *strategy* for PS is the same for all types of problems. One of the stages of PS strategy, though, is recognizing the type of problem one is facing. Ploya (1957), for example, suggests a four-step strategy (understanding a problem, devising a plan, carrying out the plan, looking back) and numerous tactics for solving mathematical problems.

Newel and Simon (1972) have attempted a titanic challenge of formalizing both the strategy and the tactics of PS at once. Their work proved to be extremely influential; yet in the 1990s, their approach stumbled upon difficulties as it became obvious that the cognitive processes involved in PS are of a distinct and separate nature (Ohlsson, 2012). Research in cognitive psychology, however, has helped classify and order these processes into a sequence of stages.

How do people solve problems?

PS *proper* refers to the rational search for a solution through the application of PS skills and techniques that are designed to maximize the probability of finding the "best" or most adaptive solution for a particular problem (D'Zurilla and Chang, 1995). D'Zurilla's five-phase process of successful social PS can serve as a model for overall PS strategy. It differs from Ploya's model in one particular, but significant, step.

The first phase of PS, *orientation*, involves the formation of a set or an attitude to recognize and accept problematic situations when they occur and to inhibit the tendency to either respond automatically or avoid the problem by doing nothing. In other words, PS starts with a particular mindset: one is oriented towards finding problems. One must first be dissatisfied with the situation in order to be proactive and seek out problems. This is not a natural attitude. PS is by no means a natural process; it just achieves better results than anything else.

In the second phase, one must *formulate* the problem. In the first stage, the question was a matter of recognizing a problem as a problem; in this phase, the question is recognizing the problem type and its parameters. In other words, one must recognize the given situation and the desired outcome(s), as well as what kind of a problem one is dealing with: whether it is domain-specific or generic; open or closed, semantically rich or poor, and whether it is a problem of insight or a problem requiring the application of an algorithm.

During the third phase, one *produces* different courses of action (COA) for solving the problem, based on his understanding of the type of problem he is facing and the heuristic schemes he knows. This is the phase in which the math teacher from Schoenfeld's (2011, 2013) example finds himself when a student suddenly reveals a major misconception or it becomes apparent that the class does not have a good grip on something that the teacher thought they understood. In such a case, the current "game plan" has to be revised on the spot, and replaced with something else. This is the point where the teacher must come up with several good tactics for solving what is now apparent as a specific problem. If the teacher were to follow Ploya's strategy (assuming that it was applicable to our case), he would only need to come up with one good plan and carry it out.

During the fourth phase, called the DM phase by D'Zurilla, one anticipates the possible consequences of each alternative, the value and likelihood of these consequences occurring, and selects the most satisfactory alternative. It is called the DM phase because it involves a rough estimation according to one's intuition and experience. This is the least formal, "managerial" phase. Our math teacher must

now make a calculated guess as to which pedagogical tactic has the best chance of dispelling the misconception or tightening the classes' grasp of the subject matter. This would be redundant if the teacher were to follow Ploya's strategy.

The final phase, *verification*, involves trying out the chosen decision. The teacher must implement his tactic and make sure that it works. Of course, if the attempt fails, one has to regress to the previous phase: the teacher must reassess the remaining strategies available to him, pick the one he thinks is the best, and give it a try. After several failed attempts, one might be forced to either give up or regress back to previous phases - perhaps all the way to phase two, or even phase one, if the problem is deemed unsolvable. The idea behind the present strategy is that the time invested in coming up with and weighing different tactics would be returned in the form of the time saved, as the person using this strategy is likely to regress through stages fewer times, compared to the one using Ploya's strategy of testing the first good plan that comes to mind.

Among hybrid PS strategies inspired by both Ploya's concepts and D'Zurilla's scheme one could count TIPS (Newton et al., 2012) and DECIDE (Welch, 1999). Team-Initiated PS (TIPS) begins with establishing the readiness to solve problems. It then divides understand the problem into two steps: understanding the conditions and understanding the reasons. The team is encouraged to hypostatize both the reasons that lead to the problem and come up with different possible solutions to the problem. The solutions are then discussed, and upon the democratically selected solution, action plan is developed and implemented. TIPS turns the PS process into a cycle by adding another step: evaluating and revision. As soon as one problem is solved, environment is scanned for new problems, and the cycle continues as life goes on. Data is collected through all the stages of the cycle.

DECIDE begins with three conceptualization stages: Define a problem, Examine the environment, Create a goal statement. The next step, Invent an intervention plan, includes both brainstorming for multiple hypotheses and identifying an intervention, taking into account the availability of resources. Further, the team Delivers the action plan and then Evaluates it.

What does it take to solve a problem?

According to Schonfeld (2013), one's ability to solve a "real" mathematical problem is determined by four factors: one's knowledge; the use of problem-solving strategies (heuristic strategies); monitoring and self-regulation (aspects of meta-cognition); and, finally, one's beliefs about the domain, problem-solving, and himself.

Another theory, the information capacity, demand and processing model of PS, attributes one's failure to solve a problem to *working memory overload* (Johnstone and El-Banna, 1986). One's cognitive capacity is limited by a number of mental space units he can handle at once, usually 7±2. One's ability to organize information allows him to process bigger amounts of information. Thus, if a problem is represented in one's mind through more units than he can handle at once, he will not be able to solve it. If he knows how to reconceptualize the problems through less units of information, below his working memory limit, he may be able to solve it. The conceptual scheme that helps organize the information also takes chunks of working memory, but it is obviously worth the cognitive space it eats up. The more conceptual schemes one is familiar with, the better his PS chances are, which is consistent with Schoenfeld's second factor.

This model is not without limitations, though. Tsaparlis (1998) examined the limitations of the model and stated the necessary conditions that must be fulfilled in order for the model to be valid. These are as follows: (a) the logical structure of the problem must be simple, (b) the problem has to be nonalgorithmic, (c) the partial steps must be available in the long-term memory and accessible from it,

(d) the students do not employ chunking devices, and (e) no “noise” should be present in the problem statement, “noise” meaning the irrelevant and potentially misleading information that might be included in a problem.

According to a number of studies cited in (Stamovlasis and Tsaparlis, 2012), besides working memory space, other factors such as *logical thinking* and *disembedding ability* (the ability to decontextualize and transfer knowledge), predict success or failure to solve a problem. To sum it up: cognitively developed individual’s ability so solve a “real”, close, non-algorithmic, domain-specific problem is dependent on his domain knowledge, ability to manipulate his cognitive state and familiarity with conceptual schemes.

The question is: What happens when one does not have the cognitive capacity or the will to solve a problem?

One cannot properly solve all the problems in the world. Most problems do not concern an individual. Some of the problems that do concern him cannot be objectively solved by him, i.e., the conditions cannot be changed from the given to the desirable. In such cases, he must *cope* with the problems subjectively, i.e., accept the given as, if not desirable, then at least acceptable.

According to Lazarus (1966, 1999), coping has to do with the way people manage stressful life conditions. To some extent, stress and coping could be said to be reciprocals of each other. Coping works through two functions: the PS function and the emotional function. Problems lead to stress, but human organisms can only take a limited amount of stress. People have two ways to reduce stress: solve their problems or regulate their emotions related to the stress situation – by either avoiding thinking about the threat or reappraising it – without changing the actual reality of the stressful situation.

For example, when facing a test on American history featuring the question: “Who was the fourth president of the USA?”, one may recognize this problem as being semantically simple, closed, domain-specific, and demanding the application of an algorithm. The individual taking the test will come up with a list of possible candidates (Adams, Madison, Jefferson), logically eliminate the wrong answers, and confidently commit to the remaining option. On the other hand, he may give the answer without thinking much, relying upon memory. In such a case, the answer may or may not be correct. While in the first case the problem was solved properly, in the second case it was solved *hastily*. The sooner the problem is solved – the less stress and emotional turmoil one experiences. Another option is not answering the question altogether. If the answer turns out to be wrong, one will need to cope with the ramifications. He may decide that he needs to improve his knowledge, or that he needs to refine his PS technique in history or adapt his PS strategy altogether. Another option is to decide that nothing needs to be done, as the problem is not very important: the question is meaningless; the test is inconsequential; knowledge and education are over-valued. In this case, one is said to be dealing with the problem on a purely emotional level. If one cannot change the outcome, one will change the attitude.

The Two Systems

Numerous authors (Epstein, 2003; Evans and Frankish, 2008; Kahneman, 2011; Evans and Stanovich, 2013) suggest there are two distinct systems operating within our minds: one is rational and the other is experience-based.

In order to take full advantage of this paradigm, its terminology must be further clarified. It should be noted that the word “rational”, as used in the rational system, refers to a set of analytical principles and has no implications with respect to the reasonableness of one’s behavior, which is an alternative

meaning of the word. The experiential system in humans is the same system by which non-human animals adapt to their environments (Epstein, 2003). These systems operate in parallel and are interactive. One does not just solve problems while completely detaching from the emotions. Surveying the thinking patterns of adolescents solving socioscientific problems, Sadler and Zeidler (2005) report that all the adolescents taking part of their study engaged in at least one of the three distinct informal reasoning patterns while problem-solving: rationalistic; emotive; and intuitive.

It is a misconception to identify rational, algorithmic thinking with PS and experience-based, "naturalistic" thinking with DM. As we shall see, people often solve problems by relying on their past experiences and make decisions through the application of algorithms.

By default, our experiential system is activated. One has to suppress his automatic reactions in order for the rational system to take over. This is not like turning on a switch – one has to continuously maintain the rational process, such as proper PS. Otherwise, the experiential system, which is permanently present, will once again take over. Thus, one must continuously monitor oneself throughout the process.

The most important factor to be monitored is one's stress level. If one's stress level is too high, he will "take a shortcut" through the process. If one's stress level falls too low – he will slip into nonchalance. We will further discuss which factors influence stress levels in the coming sections.

How do People not solve Problems?

D'Zurilla's (1971) five-phase process of solving a social problem presumes the potential to either fail or opt out of the process at each phase. One always has an option of acting automatically, either successfully or not. Once again, already in the first phase, facing social or work-related problems, one can either refuse to acknowledge that a problem exists, and either do nothing or act automatically. Acting automatically does not necessarily lead to bad results. Experienced professionals, such as athletes, pilots and even teachers, may act out of instinct - before they have time to cognitively register their actions (Feldon, 2007). They do this in order to avoid *cognitive overload* which happens whenever the total processing demands of external stimuli and internal cognitions exceed available attentional resources (Sweller, 1989). They alleviate their cognitive load by acting automatically. There is a functional dynamic between deliberate (i.e., conscious, rational) and automatic (i.e., non-conscious, experience-based) processing. The mental events available for conscious manipulation and control occur in the working memory, function more slowly, and require more effort than other processes (Feldon, 2007). There is a limit to the capacity of our consciousness, a fact which is vividly evident in novice teachers. The attempt to attend to the needs and behaviors of an entire classroom, while also trying to remember and implement a lesson plan, inundates their available cognitive resources. Therefore, this cognitive overload limits the abilities of novice teachers to effectively adapt to complex classroom dynamics (Doyle, 1986). Expert teachers have no need to consciously address every problem that comes up in the classroom because they automatically rely on their experience. The more problems one can delegate to the automatic cognitive system, the more resources become available to the conscious system. To put it conversely: if one cannot rely on his experience-based automatic behavior, his cognitive abilities will be severely impaired by cognitive overload.

Experts are better than novices primarily at pattern recognition (Fadde, 2009). Where a novice perceives a problem, an expert recognizes a familiar pattern, particularly because he has solved a multitude of similar problems. Now he no longer has to. It is a routine situation for him; he can push the "auto-pilot" button.
The second phase is that of *interpretation*. Textbook problems usually make the job of interpretation easy for the students, but this is not to say that students always understand textbook problems

properly. Tversky and Kahneman's (1974, 1981, 1986) groundbreaking research on decision problems showed that people who possess enough knowledge to solve a decision problem often fail, in most cases, at the phase of reformulating it. This happens because they naturally and automatically settle for the first interpretation that comes to mind, instead of going through the process of solving the problem properly. In Tversky and Kahneman's experiments, the phrasing of the problems was controlled by them, influencing which interpretation was perceived by the subjects first.

During emergency situations, however, there is often no time to solve all the problems by orderly going through the PS stages. Thus, opting out of the PS process may be the right course of action.

Another good way out of a problem was exemplified by Alexander the Great. The Gordian knot could not be untied by any problem-solver, through any algorithm. Alexander opted not to even attempt to untangle the knot, but rather to cut through it.

In the third phase, one may fail because his knowledge or tactical repertoire may not suit the type of problem he faces, or one may skip to phase four or even five, trying to implement the first idea that comes into one's head. When a good idea seems to come to mind, one tends to get swept away in a "eureka" moment. This is sometimes referred to as "opportunistic problem-solving" (Kuo, et al., 2013) or "dodge" (Johnstone and El-Banna, 1986). The proper way to go about PS is, of course, to keep producing ideas before attempting to evaluate them, let alone try them out. There is an old saying, often attributed to the mathematician and the second Chess World Champion, Emanuel Lasker: "If you find a good move, look for a better one". This, however, does not apply to blitz games.

The question is: When should one stop producing ideas and move onto evaluating them? How does one make this decision? "Had we but world enough and time…", it would be prudent to prolong this phase *ad infinitum*,… "But at my back I always hear Time's winged chariot hurrying near". There are three options available: to set a timetable before beginning to produce strategies; to determine, in advance, the number of strategies to be produced; or to move on to the next phase as soon as the first tactic or course of action (COA) comes up. In the latter case, if the COA seems plausible, one tries to implement it immediately. If not, one returns to phase three and repeats the process. The first two options seem to fit the spirit of PS, while the third option is more "naturalistic", and may only be considered proper within certain frameworks to be discussed further. *Brainstorming*, in which ideas are suggested without being immediately judged or critiqued, is not a natural procedure.

In the fourth phase, the process of evaluating the alternative strategies may drag into infinity as well. It is hard to estimate whether a COA will be successful without actually trying it out. Thus, the most natural thing to do is to try and implement the first COA that seems promising.

In the fifth phase, one might fail to implement the COA successfully, because it was flawed, he was not adept at using it, or because he gave up too soon.

B: DECISION MAKING

What is optimal decision-making?

A *decisional conflict* refers to simultaneous opposing tendencies within the individual to accept and reject a given course of action (Janis and Mann, 1977). When there is no conflict, no decision or choice among alternatives needs to be made - one goes on doing what he normally does. On the most basic level, any decision is a choice between doing what one normally does and doing something else. If there is no problem with one's normal routine, then there is no conflict, and no decision needs to be

made. One only starts deliberating about changing when there is a problem: a given state is no longer desirable or the existing conditions are threatened.

Whenever a problem arises, one continuously decides whether he wants to follow through with the proper PS process or return to "normal" functioning: doing what nature or experience has taught him to do. Thus, *proper* DM must be similar to proper PS: a series of successive stages through which the decision to change the situation is carried out.

If this hypothesis is correct, one would expect to see rational decision-makers actually solving their problems. In fact, the protocols describing *optimal* DM procedures are very similar to the prescribed PS procedures such as those suggested by D'Zurilla, stage by stage. In other words, people who make good decisions in fact approach decision conflicts by identifying the problems and solving them properly.

Like D'Zurilla, Janis and Mann (1977) describe a five-stage proper DM process. These stages are: appraising the challenge; surveying alternatives; weighing alternatives; deliberating about commitment; and adhering despite negative feedback.

In the first stage, one appraises the challenge. This stage corresponds to D'Zurilla's second phase (problem statement and definition). Janis's protocol refers to situations where a problem is already salient, thus D'Zurilla's first phase (orientation, involving the formation of a set or an attitude to recognize and accept problematic situations when they occur and to inhibit the tendency to either respond automatically or avoid the problem by doing nothing) is presupposed. Being aware of a problem is a pre-condition to successfully dealing with it. In Janus's terms, the right orientation is labeled as vigilance, as opposed to inertia, different types of avoidance, and hyper-vigilance. In other words, one must be able to regard an issue with the appropriate seriousness in order to even begin the process leading to a good decision.

There are, of course, different aspects of the first stage that Janis and Mann emphasize more than D'Zurilla and Nezu. In this stage or phase, according to both approaches, one tries to make sense of the challenge, interpret the information, and categorize it. However, while the PS approach accentuates the wording and the conceptualization of the issue, the DM approach accentuates the assessment of the issue's seriousness or, in other words, whether it is important enough to be taken seriously, and if so, then how seriously. If it is not very important, i.e., no grave consequences are foreseen, one is unlikely to bother making a quality decision about it, and rightfully so.

In the second stage, corresponding to D'Zurilla's third phase, one surveys alternative COAs. Both Janis and D'Zurilla believe that quality coping with a serious issue necessitates producing or finding numerous coping tactics: seeing only one or two options is perceived as lackadaisical.

In the third stage, corresponding to D'Zurilla's fourth phase, one weighs the alternative COAs and decides which one is most likely to be the best. This is the decision stage of the decision-making process. The problem of choosing the COA that is most likely to yield the best results is often referred to as *decision problem*.

In the fourth stage, corresponding to D'Zurilla's fifth and final phase, one implements the decision reached in the previous stage. What is emphasized in DM is the commitment to the decision. In Schoenfeld's paradigmatic example, a teacher, deciding upon a particular course of action which he deems the most appropriate, will probably consider what will happen if it fails. If a teacher asks a student which COA he will choose to solve a problem, the student might hesitate; he most likely would

not have hesitated, had he not been asked, but rather allowed to proceed without declaring his COA aloud.

The final stage of DM, adhering despite negative feedback, is not accounted for in PS, because it is considered by D'Zurilla (1971, 2012) to be a separate issue. In DM literature, post-decisional activity received its share of attention, particularly in the context of the Differentiation and Consolidation theory (Svenson, 1992, 1996; Verplaken and Svenson, 1997). According to this theory, the process of DM consists of three major parts: identifying the problem; differentiating among alternatives until there is only a single satisfactory one remains; and manipulating data to bolster the decision made. Svenson's protocol can be refined into an eight-stage protocol (Lee and Grace, 2012), but it would still describe the same process. It has two identification stages, four distinction stages and two consolidation stages. In addition to the previously considered protocols, a "formulating criteria for evaluating options" stage is inserted into this one.

This additional stage deserves special attention. Setting different criteria for weighing the alternative COAs will probably lead to choosing different COAs. In the most important cases, with human lives or large amounts of money on the line, decision problems are solved through application of algorithms that take multiple criteria into account (Olcer and Odabasi, 2005; Yang et al, 2015). These algorithms assign different value to different criteria. Moreover, there is competition among these algorithms as well (Naili et al., 2014). Thus, in order to make the absolutely best decision, one has to decide upon the relevant criteria, their relative weight and the algorithm that would calculate them.

In light of the above, decision problems are well-defined, domain specific, semantically rich problems, requiring application of algorithms. However, in most cases, they are treated as ill-defined, generic problems, stated in general terms and solved relying upon previous experience (Tawfik and Jonassen, 2013). This is how a customer decides which yogurt he should by, but this is not how a large supply chain should.

What is sub-optimal decision-making?

People do not always make optimal decisions. People do not always approach DM vigilantly or in the optimal manner. It is safe to assume that people neither can nor should optimize each of their decisions. Buying a house and selecting a door-knob should not be approached similarly, and normally are not. In a general sense, involvement in an issue, product, or decision is often considered as a motivational factor that affects the cognitive effort that individuals expend on a problem, and on strategies that are used to form a judgement or make a decision (Verplanken and Svenson, 1997; Johnson and Eagly, 1989). The outcome of the decision ought to be worth the mental resources invested in it. Thus, in most cases it is optimal not to optimize the outcome.

According to Herbert Simon (1956), decision-makers are normally oriented towards *satisficing* rather than optimizing the outcome of their decisions. In other words, most decision makers are oriented towards making decisions which are good enough, but not necessarily the best. Since one cannot make all of his decisions optimal, one should try to at least not make outright bad decisions in most cases. Adapting the amount of mental resources one invests in making a decision to the issue's level of seriousness makes a lot of sense. If a teacher makes hundreds of non-trivial decisions a day (Danielson, 2007), he cannot make all of them in an optimal manner. Most of them just have to be good enough not to disrupt the learning process.

According to Janis and Mann, using a satisficing DM strategy does not preclude some or even all of the criteria for vigilant information processing. In other words, one may take a matter seriously and with confidence, and yet decide not to resolve it optimally.

People are generally reluctant to make decisions because DM is very stressful. People seek out different ways to alleviate stress, while the (oh, so long) optimal process of DM means that the stress lingers. For this reason, people tend to resolve issues in a sub-optimal manner. This also explains why people would rather opt out of the prescribed PS procedure. If the levels of stress and mental strain are too high for a person to handle, one will either drop the issue altogether (which ultimately leads to failure and negative consequences) or rush the process and skip stages, reaching sub-optimal (yet, perhaps, satisfactory) results.

How do people cope with problems and conflicts?

Janis and Mann (1977) described 5 distinct patterns of coping with decisional conflicts, which as we have seen, stem from problems. Later, the list of coping patterns was revised to fit the results of empirical research (Mann et al., 1997); yet, the overall division remained intact. If a person pays little or no attention to the problem, either because he fails to notice it or he does not find it serious enough, he will display a pattern of *unconflicted inertia*, or doing nothing new, characterized by low levels of stress, until the problem becomes too serious to ignore. By that time, however, it might be too late to deal with it effectively. The next pattern is *unconflicted change* to another course of action. When a problem seems serious and something needs to be done, varying levels of stress may arise. However, if a new course of action (suggested by someone else or generated spontaneously) promises to suffice to fix the problem, the switch will be made and the levels of stress will diminish. This “repair job” might not necessarily be optimal, but unless the situation changes dramatically, it will not drain mental energy from the decision-maker. If neither non-action nor the new course of action will suffice to fix the problem, one could begin to vigilantly produce new ideas. Alternatively, thinking (perhaps after failing to produce good ideas over a period of time) that he will not be able to produce an idea that will be good enough or that he will not be able to carry them out (perhaps after a few failed attempts), he will fall into one of the patterns of *defensive avoidance*: buck-passing, procrastination, bolstering/rationalization (the latter dropped in 1997). He will avoid investing energy on a project that he has no hope of successfully finishing. His levels of stress will fluctuate from low to high, as he feels the eminence of failure, but is too afraid to think about anything that would remind him of his helplessness and the consequences. *Hyper-vigilance* occurs when one feels that he can find a solution; yet, he does not have enough time to carry out a proper DM process step by step. People are under a lot of stress in such a state, and they tend to rush the process, skipping stages, depending on the level of stress they find themselves under. Being *vigilant* means avoiding all the pit-falls of the other patterns: the temptation to lower the level of stress by ignoring problems or rushing the process, having enough knowledge, believing in one’s ability to solve the problem, and having enough meta-cognitive skills to manage one’s time and levels of stress.

Vigilancy corresponds to Schoenfeld’s four predictors of successful PS: one’s knowledge, the use of heuristic strategies, monitoring and self-regulation, and one’s beliefs about the domain, problem-solving, and himself. Again, one is vigilant if he can manage his levels of stress, knows enough to come up with good ideas, is familiar with heuristic strategies, and believes in himself.

Does context matter?

As we have seen in the previous chapter, several conditions must be satisfied in order for the proper DM or PS procedure to be followed and effective. One needs knowledge of the subject matter and the heuristic strategies, confidence, some meta-cognitive skills, and plenty of time to resolve complex issues. Following the optimal procedure does not automatically mean success, but it maximizes one’s chances. Not following the procedure does not guarantee failure, and under various circumstances it is even preferable.

Klein (1999, 2008, 2009) suggests that “naturalistic”, as opposed to “procedural” DM is preferable in numerous situations. In his latest book (2009), he tries to figure out which situations call for which type of DM; yet, he admits that the task is immensely complex. The same can be said of Kahneman’s latest opus (2011). There are paradigmatic cases where following a prescribed routine is preferable and there are paradigmatic cases where it is not. Most cases, however, are in the grey areas.

In the context of classroom, social, scientific PS or complex strategic DM, the prescribed protocols are effective. Not following the correct procedures in these contexts when time is abundant is considered ineffective coping, stemming from either negative belief systems or either avoidant or impulsive DM styles (D’Zurilla and Chang, 1995). Coping, or stress-management, has two main functions: problem-focused and emotion-focused (Lazarus, 1999). If one cannot solve a problem, one should at least find a way to save mental energy.

On the other hand, experienced military personnel, pilots (Klein, 2009), athletes, and even teachers (Feldon, 2007, Fadde, 2009) are not advised to use PS or DM procedures in their professional activities, as they work under conditions where time is chronically limited. A lack of time is not naturally conductive to vigilant information processing. Under such conditions, experts are the best decision makers. Experts tend to rely on their vast concrete experience and pattern-recognition, rather than theoretical knowledge and procedures. They excel at problem detecting and problem recognition because etched in their minds are accurate mental models that generate expectancies and alarms when these expectancies have been violated (Klein et al., 2005). They tend to have good intuition about how to proceed in unclear and extreme situations (Klein, 2009).

Different types of people excel in different situations because different situations call for different sets of skills. What fighter pilots rely upon is not what theoretical scientists rely upon. Analysis is no substitute for experience and vice versa.

Decision-making under limited time conditions by experts and novices

A recognition-primed DM model conceived by Klein’s think-tank was adopted by the US and Swedish military for its commanders (Ross et al., 2004). It relies on military commanders’ experience-based problem detection and recognition. Thus, it is non-applicable for novices. Problem detection and recognition are the first two phases of any PS and DM strategy; however, as I mentioned earlier, experts excel at these two phases, while novices, even if they are well acquainted with the procedures do not do quite as well. The third stage, Klein suggests, should be over as soon as a satisfactory COA is conceived. According to Elstein and Schwartz (2002), expert physicians form hypotheses and their diagnostic plan rapidly, and the quality of their hypotheses is higher than that of novices. This is true of experts in other areas as well. Thus, instead of investing time producing several different tactics, an experienced commander’s expertise is trusted to invoke in him a working COA at once. In other words, he makes the decision “naturalistically”, rather than rationally. This also saves the trouble of going through phase four, as there are no strategies to compare. Next, the COA is tested and operationalized (details are added) by the staff. Thus, instead of contributing in phase three via brainstorming, the staff only contributes as critics. The roles are reversed. If, in the midst of testing or adding details, a better COA comes up, the two COAs are compared. This means that the process regresses to phase four which, in the case of the ideal scenario, is skipped. Back in phase five, the staff “wargames” the COA to see if the plan would hold up against presumed enemy COAs. If it seems to work well (if not – regression to stage three is eminent), the commander and his staff will commit to the COA and prepare operation orders, based on testing and operationalization.

Thus, a recognition-primed DM procedure is rational in its strategy, but relies upon experience-based decisions. This is not at all unusual. Klein's four-step procedure is structurally similar to Ploya's. In mathematics, just like on the battlefield, experience and intuition matter most. In science, where the big questions are often wide open, breakthroughs may occur from a hunch or the inspiration of a brilliant mind, rather than as a result of thorough research. If one is an expert and his experience and intuition is to be trusted, it makes sense to save valuable time and effort by rushing through stages. Novices and those who do not operate under time pressure conditions should go through the prescribed procedures without skipping stages. Adolescents at schools, like experts in the field, tend to rely upon informal heuristics, but their results are not as good as when they are taught to follow a heuristic strategy (Sadler and Zeidler, 2005; Papadouris, 2012; Lee and Grace, 2012). The suggestion, based on interviews with two students, to teach opportunistic problem-solving to introductory level university students (Kuo et al., 2013), also seems imprudent.

CONCLUSION

I would like to suggest the following nomenclature of terms, relating to PS and DM. Using the common nomenclature should bring the two scientific domains closer together and provide the scientists from both domains with tools to better communicate and understand each other.

Problem is a gap between the given and the desired.

Real problem is a gap which the person facing it does not immediately know how to bridge. It always relates to the person facing the gap.

Real-life problem is a real problem in the social or professional life of the one facing it. The gap in such problems can be stated as dissatisfaction with the given conditions (one would like to graduate, get promoted, etc.) or as a threat to the existing conditions (one would not like to get expelled or fired).

Solution to the problem is that which bridges the gap.

Optimal solution means that there is no better solution to the problem. If two or more solutions are equally good or they cannot be compared, they are each called optimal.

Coping refers to managing life conditions that are stressful. Coping works through two functions: the problem-solving function and the emotional function.

Constructive coping is attempting to deal with a problem through changing the environment.

Emotional coping is attempting to deal with the problem by reappraising it without changing anything in the environment.

Effective solution is any solution that allows one to cope with a problem, either constructively or emotionally.

Sufficient solution is any solution that satisfies the minimal requirements for bridging the gap, but is not necessarily optimal.

Proper solution is the existing optimal solution. Sometimes a problem has no proper solution.

Proper problem-solving process is a five-stage process that gives the one facing a problem the best chances to optimally solve the problem. Trying to solve the problem properly does not guarantee that one finds the proper solution.

Proper decision-making process is a five-stage process, similar to the proper problem-solving process.

Decision refers to a choice between alternative courses of action. Usually, continuing with the current course of action is one of the alternatives. Deciding upon a course of action is a part of the decision-making process.

Decision conflict refers to simultaneous opposing tendencies within the individual to accept and reject a given course of action. It stems from real-life problems. Decision conflict does not stop until the problem is effectively solved. Thus, while going through the stages of the problem-solving process one experiences decision conflict continuously.

Strategy is a conscious, rational approach to PS in general. Proper PS procedure is one of the possible PS strategies.

Course of action or *tactic* is a particular approach to solving a concrete problem or a type of problem.

Decision problem is the problem of choosing the COA that is most likely to yield the best results. They are often problems within larger problems.

Expert is someone who's experiential cognitive system allows for achieving better results than his rational system, particularly in complex situations under time constraints. Experts should not be advised to follow standard procedures under such circumstances. In some contexts, such procedures should be tailored to take advantage of their vast experience.

Rushing through stages occurs when one feels that one will reach a satisfying solution to his problem while saving time and alleviating stress and cognitive load.

Regression through stages occurs when an obstacle interferes with PS at any stage. In such cases, one may suspect that redoing a previous stage could lead to better results.

Experience-based cognitive system is the same system by which human and non-human animals adapt to their environments.

Rational cognitive system is a set of analytical principles and has no implications with respect to the reasonableness of the behavior, which is an alternative meaning of the word. The two systems operate in parallel and are interactive. One does not just solve problems while completely detaching from emotions. It is a misconception to equate rational thinking with problem-solving and the application of experience with decision-making.

References:

Adair, J. (2010). *Decision making and problem solving*. Philadelphia: Kogan Page.

Anderson, J. (1990). *The adaptive character of thought*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Baron, J. and Brown, R. (1991). Toward improved instruction in decision making to adolescents: A conceptual framework and pilot program. In J. Baron and R.V. Brown (Eds.), *Teaching decision making to adolescents* (95-122) Hillsdale, NJ: Lawrence Erlbaum Associates.

Beyth-Marom, R., Fischhoff, B., Jacobs, M., Furby, L. (1989). *Teaching decision making to adolescents: A critical review*. Washington, D.C.: Carnegie Council on Adolescent Development.

Brest, P. and Krieger, L.H. (2010). *Problem solving, decision making, and professional judgment:A guide for lawyers and policymakers*. Oxford: Oxford University Press.

Churney, A.H. (2001). *Promoting children's social and emotional development: A follow up evaluation of an elementary school-based program in social decision-making/social problem-solving*. Dissertation Abstracts International Section A: Humanities and Social Sciences, 62 (1-A): 75.

Danielson, C. (2007). *Enhancing professional practice*. Alexandria, VA: Association for Supervision and Curriculum Development.

D'Zurilla, T. J., and Goldfried, M. R. (1971). Problem solving and behavior modification. *Journal of Abnormal Psychology*, 78, 107-126.

D'Zurilla, T.J. and Chang E.C. (1995). The relations between social problem solving and coping. *Cognitive Therapy and Research*, 19(5), 547-562.

Dewey, J. (1910). *How we think*. Boston: D.C. Heath.

Doyle, W. (1986). Classroom organization and management. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (392–425), New York: Macmillan.

Elstein A.S., Schwartz A. (2002). Clinical problem solving and diagnostic decision making: Selective review of the cognitive literature. *British Medical Journal*, 324, 729–732.

Epstein, S. (2003). Cognitive-experiential self-theory of personality. In Millon, T., &
Lerner, M. J. (Eds), *Comprehensive handbook of psychology (5): Personality and social*

psychology (159-184), Hoboken, NJ: Wiley & Sons.

Evans, J. and Stanovitch, K.E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives on Psychological Science* 8(3), 223–241.

Evans, J. and Frankish, K. (Eds.) (2009). *In two minds: Dual processes and beyond.* New York: Oxford University Press.

Fadde, P.J. (2009). Expertise-based training: Getting more learners over the bar in less time. *Technology, Instruction, Cognition and Learning*, 7, 171–197.

Feldon, D. (2007). Cognitive load and classroom teaching: The double-edged sword of automaticity. *Educational Psychologist*, 42(3), 123–137.

Frauenknecht, M. and Black, D.R. (2010). Is it social problem solving or decision making? Implications for health education. *American Journal of Health Education*, 41(2), 112-123.

Ivey, A.E., Ivey, M.B., Simek-Morgan, L. (1993). *Counseling and psychotherapy: A multicultural perspective* (3rd ed.), Boston: Allyn and Bacon.

Isen, A.M., (2001). An influence of positive affect on decision making in complex situations: theoretical issues with practical implications. *Journal of Consumer Psychology* 11(2), 75-85.

Janis, I.L., Mann, L. (1977). *Decision making: A psychological analysis of conflict, choice and commitment*. New York: Free Press.

Johnson, B.T. and Eagly, A.H. (1989) Effects of involvement on persuasion: A metaanalysis, *Psychological Bulletin,* 106, 290–314.

Johnstone, A. H., & El-Banna, H. (1986). Capacities, demands and processes—A predictive model for science education. *Education in Chemistry*, 23, 80 – 84.

Kahneman, D. (2011). *Thinking, fast and slow*. New York, NY: Farrar, Straus and Giroux.

Klein, G. (1999) *Sources of power: How people make decisions*. Cambridge, MA: MIT Press.

Klein, G., Pliske, R., Crandall, B. and Woods, D. (2005). Problem detection. *Cognition, Technology and Work*, 7, 14-28.

Klein, G. (2008). Naturalistic decision making. *Human Factors,* 50(3), 456-460.

Klein, G. (2009) *Streetlights and shadows: Searching for the keys to adaptive decision making*, Cambridge, MA: MIT Press.

Kuo, E., Hull, M. M., Gupta, A., and Elby, A. (2013) How students blend conceptual and formal mathematical reasoning in solving physics problems. *Science Education*, 97(1), 32–57.

Laughlin, R.P. (2011). *Group problem solving*. Princeton: Princeton University Press.

Lazarus, R.S. (1966). *Psychological stress and coping process*. New York: McGraw-Hill.

Lazarus, R.S (1999). *Stress and emotion: a new synthesis*. Bristol: Springfield.

Lee, Y.C. and Grace, M. (2012). Students' reasoning and decision making about a socioscientific issue: A cross-context comparison. *Science Education*, 96(5), 787–807.

Mann, L., Burnett, P., Radford, M., & Ford, S. (1997). The Melbourne Decision Making Questionnaire: An instrument for measuring patterns for coping with decisional conflict. *Journal of Behavioral Decision Making*, 10(1), 1-19.

Naili M., Boubetra, A., Tari, A., Bouguezza Y., Achroufene, A. (2014) Brain-inspired method for solving fuzzy multi-criteria decision making problems (BIFMCDM). *Expert Systems with Applications*, 42, 2173–2183.

Newell, A. and Simon, H.A. (1972). *Human problem solving*: Englewood Cliffs, N. J.: Prentice-Hall.

Nezu, Arthur M.; D'Zurilla, Thomas; Nezu, Christine Maguth (2012). *Problem-solving therapy: A treatment manual*. New York: Springer.

Ohlsson, S. (2012). The problems with problem solving: Reflections on the rise, current status, and possible future of a cognitive research paradigm. *The Journal of Problem Solving*, 5(1), 101-128.

Olcer, A.I. and Odabasi, A. Y. (2005) A new fuzzy multiple attributive group decision making methodology and its application to propulsion/maneuvering system selection problem. *European Journal of Operational Research*, 166, 93–114.

Papadouris, N. (2012) Optimization as a reasoning strategy for dealing with socioscientific decision-making situations. *Science Education*, 96(4), 600–630.

Ploya, G. (1957). *How to solve it*. New York: Doubleday.

Robertson, I. S. (2001). *Problem solving*. East Sussex: Psychology Press.

Ross, K. G., Klein, G. A., Thunholm, P., Schmitt, J. F. and Baxter, H. C. (2004). The recognition-primed decision model. *Military Review* (July-August).

Sadler, T.D. and Zeidler, D.L. (2005). Patterns of informal reasoning in the context of socioscientific decision making. *Journal of Research in Science Teaching*, 42 (1), 112–138.

Schoenfeld, A.H. (2011). *How we think: A theory of goal-oriented decision-making and its educational applications*. New York: Routledge.

Schoenfeld, A.H. (2013). Reflections on problem solving theory and practice. *The Mathematics Enthusiast,* 10(1&2), 9-34.

Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review* 63 (2): 129–138.

Stamovlasis, D., & Tsaparlis G. (2012). Applying catastrophe theory to an information-processing model of problem solving in science education. *Science Education*, 96(3), 392–410.

Stanovich, K. E. (2011). *Rationality and the reflective mind*. New York, NY: Oxford University Press.

Svenson, O. (1996). Decision making and the search for fundamental psychological regularities: What can be learned from a process perspective? *Organizational Behaviour and Human Decision Processes*, 65, 252 – 267.

Svenson, O., Salo, I., & Lindholm, T. (2009). Post-decision consolidation and distortion of facts. *Judgment and Decision Making*, 4(5), 397 – 407.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science,* 12, 257–285.

Tawfik, A. and Jonassen, D. (2013) The effects of successful versus failure-based cases on argumentation while solving decision-making problems. *Education Technology Research and Development*, 61, 385–406.

Tsaparlis, G. (1998). Dimensional analysis and predictive models in problem solving. *International Journal of Science Education*, 20, 335 – 350.

Tverski, A. and Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science* 185, 1124-1131.

Tverski, A. and Kahneman, D. (1981). The Framing of Decisions and the Psychology of Choice. *Science* 211, 453-458.

Tverski, A. and Kahneman, D. (1986). Rational Choice and the Framing of Decisions. *The Journal of Business*, 59(4), 251-277.

Verplanken, B. and Svenson, O. (1997). Personal involvement in human decision making: conceptualizations and effects on decision processes. In R. Ranyard,W. R. Crozier, & O. Svenson (Eds.), *Decision making: Cognitive models and explanations* (pp. 40 – 57). London: Routledge.

Yang, T., Kuo, Y., Parker, D. & Chen K. H. (2015). A multiple attribute group decision making approach for solving problems with the assessment of preference relations. *Mathematical Problems in Engineering,* 1-10.