Enhancing the Problem Solving Skills of Decision Science Learners

By
Sheila Cheng
Asia e University
and
Fung Han-Ping
Hewlett-Packard Malaysia

1.0 Introduction

- Problem solving
  - an important skill in the development of human capital and upgrading of mental and intellectual capacity of a nation (Malaysia Plan, 2006)
  - increasingly recognized by employers as one of the critical and crucial soft skills attributes in their recruitment of employees

- Decision Science
  - to help improving the quality of decisions about managing valuable but limited resources.

➢Decision Science and problem solving goes hand in hand.

Definition of Problem Solving

- In the context of Decision Science (DS), problem solving was defined as
  - *"the cognitive processes of identifying differences between the actual and the desired state of affairs and then taking action to resolve the differences"*

(Rosenhead, 2001, p.15)

- Thus, it is believed that
  - ✓by understanding the cognitive processes of the successful problem solvers, a pattern might be able to be developed to enhance the problem solving skills of the DS learners.

- Many researchers supported that
  - ✓the success of getting the solution during problem solving is associated with certain mental discipline of the solver.
  - ✓The quality of problem solving and decision making can be improved through prescriptive steps and processes or even specific steps.

(Albert, 1996; Al-Hudhaif, 1998; Bernadette, Elizabeth, Linda, & Roger, 1994; Cai, 1994; Huitt, 1992; Lee, 2002, Polya, 1954; Schoenfeld, 1992; Wallas, 1926; Wang, Wang, Patel, & Patel, 2006; Wang & Chiew, 2010; Wilson & Clark, 1988)

2.0 Research Problem

- general problem solving strategies failed
  - due to research method lacked a systematic way to aggregate data.
- the cognitive research paradigm led researchers away from studies of complex problem solving
- two closely related but unsolvable problems :
  (a) how to aggregate trace data to reveal novel empirical regularities;
  (b) how to formulate a general, task-independent theory of problem solving.
- problem solving research encountered an impasse
  - one of the factors was the widespread rejection of introspection among cognitive scientists
  - an accepted formal theory that could describe how representations and heuristics are attained and adapted was still missing.

(Jakel & Schreiber, 2013; Ohlsson,2012)

2.0 Research Problem, cont'd

- Ohlsson (2012) proposed the structure of a future theory of problem solving

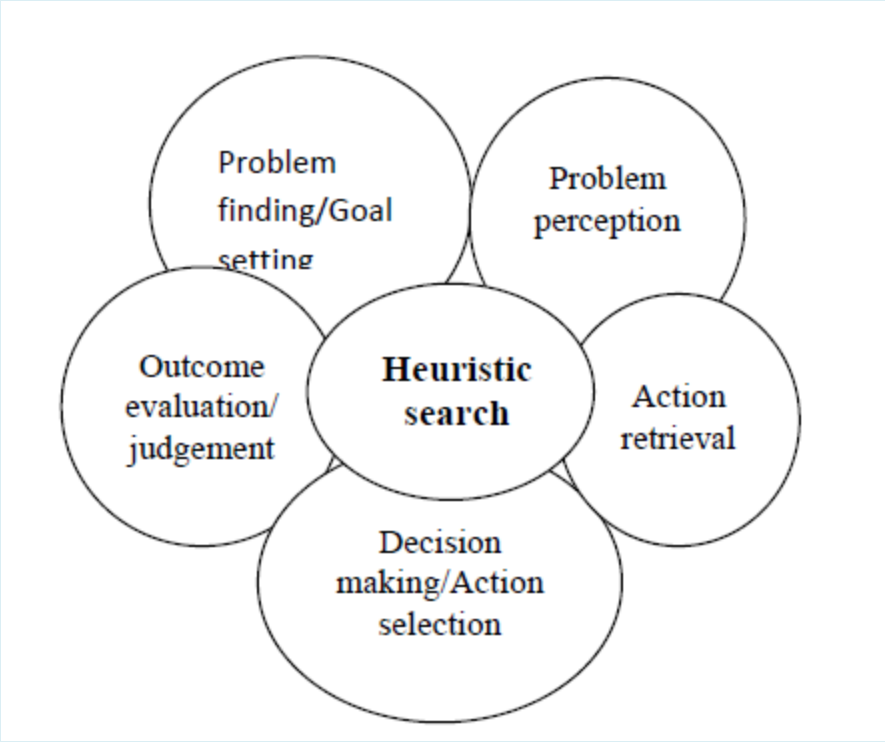

Figure 1 : The structure of a hypothetical future theory of problem solving
(Adapted from Ohlsson, 2012, p.122)

- **However, these five functions were yet-to-be found principles.**

3.0 Research Objectives & Knowledge Contributions

- to explore the cognitive processes of successful problem solvers who were selected from a group of 42 business degree students in Malaysia's higher institute of learning in solving the Decision Science problems.

- adopt "think aloud" method to understand the cognitive processes

- to identify the approach and strategy in problem solving, thus, the problem solving skills of learners could be enhanced by following their footprints

- to provide educators and instructional designers an insight in the curriculum delivery and development.

4.0 Literature Review

Year	Researcher(s)	Findings
1913	Edward Thorndike	•study of animal intelligence the mind has the ability to internalise and act out to connect stimuli and responses which originated in the environment. •Developed "the theory of connectionism" • "the theory of connectionism" was subsequently grounded in Ivan Pavlov's work on conditioned reflexes, which dominated the basic research on cognitive processes.
Early 20 Century	Gestalt psychologists	•mental experience was dependent on the organisation and patterning of experience and one's perceptions (Ellis and Hunt, 1993) •human problem solving ability is related to learning and perception (Ormrod, 1999) •perception is the product of complex interactions among various stimuli. Through our senses, human minds consider objects in their entirety instead of individual parts. When the problem is viewed in different perspectives, the solution can be found with a momentary insight or realization (Kafadar, 2012)

4.0 Literature Review, cont'd

Year	Researcher(s)	Findings
1943	Kenneth J.W. Craik	•"The Nature of Explanation" and he explained the concept of mental models as "symbolism" (models of reality). He described that the symbolism was familiar to human brain but in mechanical devices.
•There was no research methods designed specifically for problem solving in the study of psychology in 1950. • little was known about how professional problem solvers solving unfamiliar problems, came from introspective reports from the thinkers themselves (Ohlsson, 2012).		
1972	Newell and Simon	•the first systematic study of human problem solving •a book called "Human Problem Solving" was published to explain the problem solving process. • developed the problem space theory of problem solving • introduced the "think aloud" protocols •pronounced that the problem solving processes are related with thinking processes and are composed of two stages: the realization of process and the research of process •Their work has been dominating the field of problem solving research for the past few decades (Jakel & Schreiber, 2013)

4.0 Literature Review, cont'd

Year	Researcher(s)	Findings
1975	Eisenstadt and Karaev	•developed an internal representation model • conducted top-down and bottom-up analysis • concluded that "formation of internal representation depends on subjective representations which are stored in memory as an active process." (Kadafar, 2012, p,195)
1988	Sweller	•developed the cognitive load theory •proposed a scheme named "purpose-result analysis" or "means-end analysis" to explain that problems could be solved through the greatest reduction in difference between the current state and goal state. (Kadafar, 2012)
1990	Carpenter, Just and Shell	•adapting the Raven tests and developed a theoretical model •claimed that "the ability of purpose repetition strategy is related to working memory; the purpose towards problem solving behavior was formed and sustained in working memory… Subjects' regularly repeating coding and inductive strategy enable and increase in their operation characteristics." (Kadafar, 2012, p.197)

4.0 Literature Review, cont'd

Year	Researcher(s)	Findings
2010	Wang and Chiew	•asserted that cognitive process of problem solving starts with the identification of object. •Problem solving is at a higher level of cognitive process, it interacts with many other cognitive processes
2012	Kadafar	•concluded that for specific cognitive processes such as working memory, selective attention is needed for solving problems.

❖Overall, these studies highlighted that problem solving is a metacognitive process, a high-level cognitive process which is related to working memory and is task-specific. It can be concluded that the study of human problem solving is the study of the human mind on information processing.

5.0 Methodology

- a phenomenographic approach was used to gather detailed and rich qualitative data.
- 42 DS willing students selected from 6 private education institutions in Malaysia, with age ranging from 19 to 25 years old
- 4 steps :

5.0 Methodology, cont'd

(1) a 5-minute video on "think aloud" technique was introduced to the participant. He/she was then asked to clarify and confirmed if he/she understood the meaning of "think-aloud" method. If not, further explanation would be carried out.

(2) the participant was then interviewed with the structured questions to find out the his/her simple bio data and academic background as well as their degree of exposure to the DS problems.

(3) The participant was given a DS problem (Exhibit 1) with a brief introduction on the problem. However, students were ensured that he/she had the freedom to use whatever method(s) deemed suitable to solve the problem.

(4) once the participant completed solving the problem, based on his/her works, in retrospect, he/she was interviewed with semi-structured questions.

*All participants were highly encouraged to use the "think aloud" method during the problem solving session. The entire problem solving session was video- and audio-recorded and time was also recorded.

* By combining the researcher's observation, field notes, students' works and verbatim, data were collected for analysis.

5.0 Methodology, cont'd

- All participants were highly encouraged to use the "think aloud" method during the problem solving session. The entire problem solving session was video- and audio-recorded and time was also recorded.
- By combining the researcher's observation, field notes, students' works and verbatim, data were collected for analysis.
- The successful solvers and unsuccessful solvers were classified, based on a marking scheme which was validated by two experts.
- Following a general rule of thumb of practice in the institutes of higher learning in Malaysia, above or equal to 40% of the total score is considered a Pass while below 40% is considered otherwise. All 84 written scripts were marked according to the marking scheme and results were validated by two experts.

6.0 Results and Analysis

A random sample of 14 participants' results were further analyzed by SPSS version 16 based on the frequency test, The frequency in Table 6.1 shows that out of the 14 selected cases, there was 71.4% consistency between marker 1 and marker 2. This indicated little discrepancy in the marking of the DS problem.

Table 6.1 Difference Between Marker 1 and Marker 2 for DS Problem

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	-2	1	7.1	7.1	7.1
	-0.5	1	7.1	7.1	14.3
	0	10	71.4	71.4	85.7
	1	2	14.3	14.3	100.0
	Total	14	100.0	100.0	

6.0 Results and Analysis

The difference of marks from marker 1 and marker 2 was also supported by the Spearman's Rho Coefficient

Table 6.2 Pearson Correlations Coefficient and Spearman's Rho Coefficient to compare marks awarded by Marker 1 and Marker 2 for DS problem.

	Marker 1 & Marker 2
Pearson	.997*
Spearman's rho	.997*
*significant level at the $p < 0.01$.	

- Both coefficients showed a similar value and this implied that both marks from marker 1 and marker 2 had a monotonic relationship.

6.0 Results and Analysis

Outcome	Percentage (No.)	Approach	Percentage (No)	Remarks
Successful Solvers (SS)	33% (14)	Graphical approach	86% (12)	50% (or 6) No error
				50% (or 6) minor error
		Others	14% (2)	
Unsuccessful Solvers (US)	67% (28)			

- The graphical method was the most popular approach adopted by these SS.

- One common phenomenon - successful solvers (SS) seemed to follow a particular set of algorithm i.e., the behaviour of retrospection was revealed if they demonstrated after they had overlooked the key information

6.0 Results and Analysis

➢Regardless of what approach/methods the SS used, it was also noted that the problem solving processes of all the successful solvers generally resembled Anderson et al's (2012) 7-step problem solving process closely.

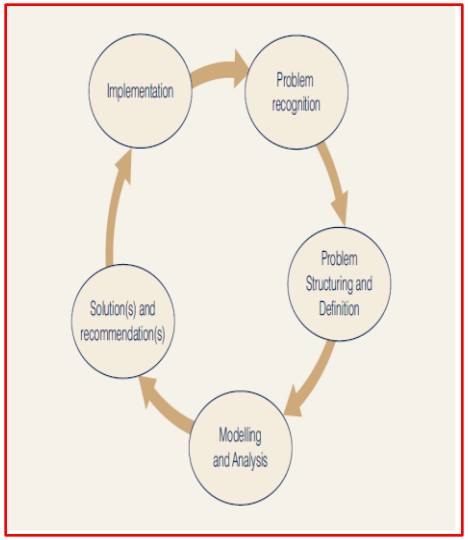

Figure 6.1: The OR Approach (Adopted from Anderson et al, 2009, p. 9)

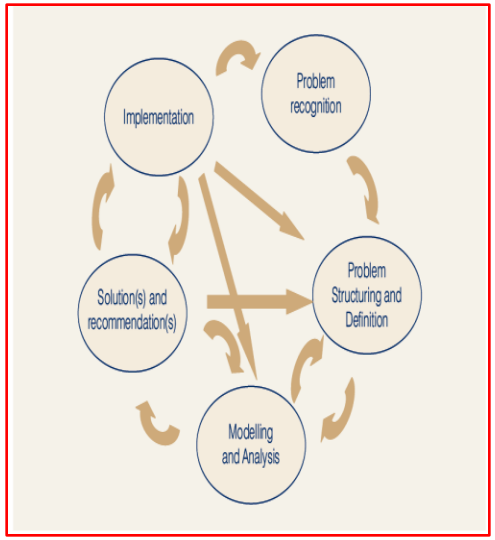

Figure 6.2: The Revised OR Approach *(Adapted from Anderson et al, 2009, p.12)*

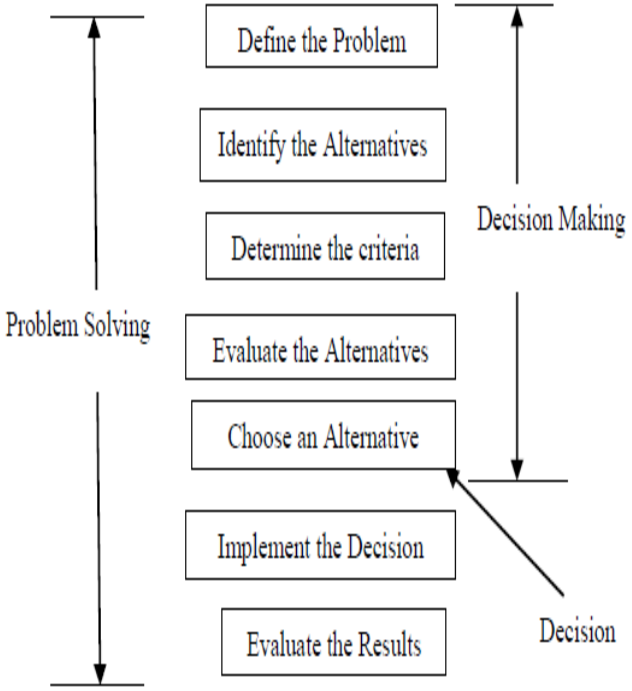

Figure 6.3 The relationship between problem solving and decision making
(Adopted from Anderson et al, 2012, p.5)

6.0 Results and Analysis

- Solvers demonstrated the behaviour of retrospection to varied extent. Some had longer steps and some had shorter steps.

- The difference was due to the retrospection at different solution points when individual successful solver encountered anomaly.

- It depended on which solution point where the anomaly was found during the problem solving session.

6.0 Conclusion

- The cognitive processes of participants followed several discrete steps.

- the solution paths were not in a linearity and retrospection would happen whenever they encountered anomaly

- participants tended to draw upon their prior knowledge which played a very important role in determining the success rate of problem solving.

- retrospection was a common behavior of participants when they dealt with complex problem, they frequently demonstrated this behavior and to varied extent.


Asia University
Thank YOU