PROBLEM STRUCTURING FOR DECISION CONSENSUS AMONG STUDENTS

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ABSTRACT

Decision-problem structuring is conceptualized to be a process comprising activities characterized by the students. The activities are cognitive efforts of a group coming to an understanding and determining the representation of the decision-problem and of what knowledge is relevant to the decision-problem. Cognitive effort refers to the fraction of limited attention with respect to resources that are momentarily allocated to a process. The consensual representation of the decision-problem provides the basis for modeling those activities in some form and order. Knowing how a decision-problem is structured by students based on Management Information System domain will enable the modeling to be based on a simple descriptive behaviour in problem structuring. One such method would be a mathematical model to quantify the problem which ultimately becomes well-structured

Keywords: *decision-problem, problem structuring, modeling, decision consensus.*

INTRODUCTION

Building representations of a problem in a group involve a consultative and iterative process (White, Burger, & Yearworth, 2015). The process provides a succession of representations, each with different perspectives to the problem. Each subsequent perspective alludes to a deeper understanding of the problem as new insights add to the refinement of the representation.

This study is premised on the concept of collective decision-making as a means for understanding how students as a group behave. We introduce and explore the use of activity theory as a means to study the interactions of students in the context of decision-problem structuring. A case scenario was presented to create conditions for a collective behaviour towards decision-problem structuring.

THEORETICAL FOUNDATION

The focus of operational research (OR) on problem structuring has primarily been on the process itself through the lens of critical realism, constructivism, and pragmatism. The social process, through which concepts and actions are negotiated, produces abstract models and representations of the problem. Requisite models were introduced as a form of representation (Phillips, 1984). A requisite model with information and knowledge is sufficient to serve as a guide to collective activities by the group. Additionally, a model represents a facilitative device where there is no clear agreement as to the exact situation (Ackermann, 2012). Ackermann in his role as Jury Duty used his knowledge of problem structuring methods to the messy situation. As he listened to his fellow jurors, he realized that his understanding of the case was different from theirs.

He believed that statements were clear assertions with little or no evidence, were taken as facts. Emotions were running high and 'facts' were embellished. He concluded there were a lot of different issues, facts, assertions, uncertainties, and contradictions. However, they all helped to develop a shared understanding towards an emergent problem structure thereby come to some consensus.

The basic structure of any problem structuring methods comprises the captured representation of various points of view in a rich picture if using Soft Systems Methodology; a design graph if using Strategies Choice; a causal map if using Strategic Options Development and Analysis. This captured material is explored within the group to develop an enhanced understanding so as to negotiate towards a set of improvements and actions to resolve the situation. The exploration adopts a cyclical approach with the actions from one deliberation providing insights for the next iteration while possibly raising questions, demanding a return to a previous consideration.

Activity is the smallest unit of analysis. In OR, the settings for different activities are not determined by the objective features of the problem. Instead, the activities are emergent interactions by the participants who are engaged in the problem.

OR interventions are activities imposed on different situations by the participants themselves (Alberto Franco, 2009). Additionally, Activity Theory offers the concept of activity which emphasizes that people do not just think. They collectively act on the world (White et al., 2015). White and his researchers further explain the nature of activity systems. Mediating mechanisms comprise tools, models, language, social rules, and the division of labour that transform the relationship between individuals and communities in collective activity. These mechanisms are interwoven in a complex web of mutual interactions. Collective or social learning occurs in the community albeit contradictions and dilemma. Participants would construct new conceptions of their actions and develop new activity systems.

Additionally, OR is primarily a consultancy activity focusing on the tactical while providing a strategic advantage to some organisation (Ranyard, Fildes, & Hu, 2015). This was further emphasized with a search in the Web of Science for terms such as "strategy tools" and "problem structuring' yielded no articles from 2010 to 2014. OR interventions were mainly deployed in sectors such as logistic, production, and supply chain.

According to a survey conducted by Liberatore and Luo (2013), problem structuring comprises problem formulation and negotiation towards a set of improvements and actions to resolve the situation. The exploration adopts a cyclical approach with the actions from one deliberation providing

insights for the next iteration while possibly raising questions, demanding a return to a previous consideration.

Problem recognition were more important for the OR analyst. The development of problem structuring methods has been successfully embraced by the OR community. In contrast, problem structuring is more challenging as the problem has to be in the perspective and context of the decision-makers.

It is reasonable to expect students to provide their own structures to the decision-problem in this instance. This paper discusses decision-problem structuring as a process to justify the qualitative approach. This paper presents a model of students' decision-problem structuring which is subsequently expressed mathematically.

METHODOLOGY

The case study can be conceptualized as an activity system whereby the participants are active in the shaping and reshaping the problem representation assisted by auxiliary artefacts. Collaboration among the participants with varying expertise necessitates a dynamic, dialogic relationship between the multiple actors. The decision-problem was constructed out of case scenarios. For this study the knowledge domain of Management Information Systems (MIS) is contextualized through three case scenarios.

Each case scenario presents a complex problem for students to respond to in a fortnight. Structuring the decision-problem was a process by the students to transform an initial state (complex problem in MIS) to a goal state (structured problem). A virtual workspace was created to enable participants to interact and have a close dialogue. The virtual workspace is consistent with the characteristics of a study by von Winterfeldt and Fasolo (2009). In their study on structuring decision-problem, they found that structuring decision-problem is a task that requires close dialogue between participants. This dialogue should be highly interactive (with many exchanges) and iteratively converging towards a consensus (tracking exchanges for structuring the decision-problem). The dialogue would enable participants to participate in the process by providing important inputs. Besides, York and

Richardson (2012) noted that the number of students in an online discussion can impact interpersonal interaction. As the class size increased, students wrote more but shorter discussion posts. This affected the group dynamics and gave rise to unequal participation (Palloff & Pratt, 2007).

The virtual workspace had the affordance of the Internet which enabled participants to explore and possibly to resolve concerns that arose during their reading of the case scenarios. The Internet may also have cued them to previously unrecognised issues. In a nutshell, the Internet affords information acquisition and interpretation for the participants while being engaged on a case scenario. Additionally, the virtual workspace was to function as a meeting room where students with different perspectives come to work on a common problem focus and a shared commitment to action.

The analysis commenced with the examination of the entries in the threaded discussion for each of the three case scenarios by a group of 15 students. Each entry was segmented based on the interpreted activity. An activity was taken as an action that the participant did or caused to happen.

It must be noted that entries that infringed on the decision-making process, such as analysis of factors to the decision-problem and generation of options, were not analyzed for this study.

Students may interact with the environment for information, expertise, experience, and advice while forming their strategies towards structuring the decision-problem. These elements (information, expertise, experience, and advice) are not part of the system. Instead these elements are constituents of other systems besides the students.

DEVELOPMENT AND ANALYSIS

This captured material is explored within the group to develop an enhanced understanding so as to negotiate towards a set of improvements and actions to resolve the situation. The exploration adopts a cyclical approach with the actions from one deliberation providing insights for the next iteration while possibly raising questions, demanding a return of interactions by the participants who are engaged in the problem.

The decision-problem of each case scenario took shape after brainstorming by the students for two weeks, the time duration as determined in the study. The final state of the decision-problem was the representation brought about by the consensus of the group participants.

EMERGENT MODEL

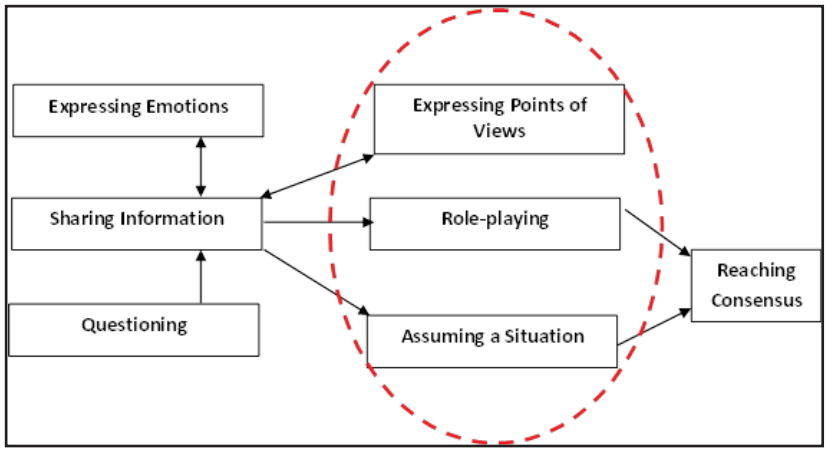

Figure 1: Student Processes in DPS

Figure 1 shows the emergent model of the decision-problem structuring (DPS) of the students. Students expressed ignorance, doubts, fear, and to some extent, self-assuredness when they did not understand or realise the significance of the available information. Their ignorance and doubts led to the sharing of additional information while their fear reflected a perceived threat that relates to worsening of a situation or a situation that is unacceptable.

The sharing of information induced reciprocity and self-assuredness in forming a structure for the decision-problem. The sharing information in some instances required paraphrasing or summarising of facts and ideas. The condensation of the ideas at times elucidated some participants to express their points of views or question for more information. The constructs, "Expressing Points of Views", "Role-playing", and "Assuming a Situation" are iterative processes of students when facing an atypical decision-problem. Keywords were identified for each of the seven constructs. For example,

"Questioning" would comprise keywords such as who, why, what, where, when, and how. "Sharing Information" would have keywords "according", "share", "information", and so forth.

MODELLING THE DPS MATHEMATICALLY

In the text classifying systems vector space model (VSM) is used to transfer the unstructured text data to structured ones. There are two main aspects to construct a classifier based on vector space model. Firstly, an appropriate feature subset is selected along with a measure for evaluating it. Secondly, a classification paradigm is selected.

Vector space model (VSM) is an algebraic model for representing of texts in classification and retrieval. It maps an unstructured text data into structured vectors. In this model, text sample x_i is expressed as $x_i = (w_{i1}, w_{i2}, \ldots, w_{ij}, \ldots, w_{im})$ where w_{ij} denotes the weight of the keyword T_j in text x_i and m is the total number of keywords. Every text is a point in m-dimensionality space. Similarity between two texts, x and y, is calculated by the following formula

$$SIM(x, y) = \cos(x, y) = \frac{\sum_{k=1}^{m} w_{xk} \cdot w_{yk}}{\sqrt{\sum_{k=1}^{m} w_{xk}^2} \cdot \sqrt{\sum_{k=1}^{m} w_{yk}^2}}$$

The weighting formula used is

$w_{ij} = fT_{ij}$ where f is the frequency the term T_j occurs in text x_i.

The early stage of DPS involves participatory visioning of the decision-problem. The importance is for the participants to agree on a series of ways of knowing and understanding the context.

Let us assume there is a collection of i number of text categorized as Sharing Information in the exchanges between the students.

$$S = \{s_1, s_2, ..., s_i\} \quad (1)$$

However, $s_i = (w_{i1}, w_{i2}, ..., w_{ij}, ..., w_{im})$ where w_{ij} denotes the weight of the keyword T_j in text s_i and m is the total number of keywords. Also, $w_{ij} = fT_{ij}$ where fT_{ij} is the frequency the keyword T_j occurs in text s_i.

Information sharing in the context, s_i, is initiated when there is Questioning. Let us assume there is a collection of j number of text categorized as Questioning.

$$Q = \{q_1, q_2, ..., q_j\} \quad (2)$$

As such, a collection of questions can be answered by a particular Sharing Information, s_i. Hence we have,

$$s_j \leftarrow q_j \quad \text{where } n \leq j \quad (3)$$

Sharing Information may embed Expressing Emotions, E, which is a set of emotions.

$$E = \{e_1, e_2, ..., e_i\} \quad (4)$$

In one Sharing Information several emotions may be expressed to address q_j. Thus, we have

$$q_j \leftarrow \sum_{k=1}^{m} e_k \quad \text{where } 1 \leq m \leq j \quad (5)$$

Expressing Emotions may invoke Sharing Information. For example, "I am confused. Excuse me if I sound ignorant. Can someone explain the meaning ...". In this instance, we can write,

$$e_m \leftarrow \sum_{i=1}^{j} s_i \quad \text{where } 1 \leq m \leq j \quad (6)$$

Let us assume there is a set of Expressing Points of Views.

$$P = \{p_1, p_2, ..., p_i\} \quad (7)$$

For each Sharing Information there may or may not have Expressing Points of Views. We have

$$s_i \leftarrow \begin{cases} p_i = 0 \\ \sum_{t=1}^{j} p_t, \ 0 < j \leq i \end{cases} \qquad (8)$$

Sharing Information may lead to Role-playing. Let us assume there is a set of Role-playing.

$$R = \{r_1, r_2, ..., r_i\} \qquad (9)$$

We have,

$$s_i \leftarrow r_i \qquad (10)$$

Sharing Information may lead to Assuming a Situation. Let us assume there is a set of Assuming a Situation.

$$A = \{a_1, a_2, ..., a_i\} \qquad (11)$$

We have,

$$s_i \leftarrow a_i \qquad (12)$$

Assuming a Situation and Role-playing leads to Reaching Consensus, C. Hence, we can write

$$C = A \cup R \qquad (13)$$

A consensus towards the structure of the decision-problem is reached after all the situations were assumed and a fair amount of role-playing.

FINDINGS AND DISCUSSION

A similar model of DPS of novices in decision-making as published in an earlier work (Cheong, 20l4) differs in the iterative processes of students. In Cheong's study, the novices had attended a course in Management

Information Systems but had no work experience. They responded to isolated facts in an *ad hoc* fashion based on the information shared and were expressing points of views in their personal capacity as well as a team. The students in this study lacked knowledge about the complexity or difficult issues in the three case scenarios presented as complex decision-problems. The students did not have deep knowledge of problem structuring. The seven activities detailed as follows were of no particular order except for the activity of reaching consensus which was evident in all three case scenarios. Nevertheless, the activity of expressing emotions would be the first to be addressed.

Students are likely to be subjective and too emotive in responding to a decision-problem without understanding or realising the importance of the available information. Some students expressed ignorance, possibly uninformed. Some may have followed the brainstorming for quite a while before expressing their failure to acquire the relevant information. Besides ignorance, there was doubt. Doubt may involve uncertainty or distrust over an alleged fact as seen in some students. Both instances of doubt bring into question some notion of a perceived representation of the decision-problem and may involve delaying or rejecting relevant action out of concerns for mistakes or faults or appropriateness. As a result, doubt sometimes required additional information. Hence reciprocity which was a correspondence between two participants was evident. It was expressed in the form of gratitude.

There were others who expressed self-assuredness. Self-assuredness relates to one's personal judgment to manage the decision-problem in a time frame. Self-assuredness also relates to the ability in forming a structure for the decision-problem. On the other hand, there was fear. Some students perceived a threat that relates to worsening of a situation, or continuation of a situation that is unacceptable. They expressed fear as an instant reaction to something presently happening to them at present.

Basic information was provided from Internet search. Some of the sharing contained information that could possibly be sourced from the textbook and other reading materials. The shared information required reviews by the students in order to effectively derive its value and meaning. Systems theory refers to this information in this sense as an input comprising

something potentially perceived as a representation to the decision-problem. This was evident in some students that threw a perspective for the others to ponder on.

Sharing information required paraphrasing to keep the same meaning. Paraphrasing was useful when dealing with facts and definitions of the decision-problem. In paraphrasing, some students had aptly put the information in a context that was easily understood by the group. There were other students that took to summarising which was generally used to refer to ideas contained in a long text. Summarising enables such students to reduce all the ideas to key points in an outline of the brainstorming by omitting unnecessary details and examples. The summary was an overview of the information for the decision-problem. The important ideas were condensed. The condensation of the ideas may elucidate some participants to expressing their points of views.

Assuming a situation is a proposition to take a situation for real based upon presupposition without preponderance of the facts of the decision-problem. There were students assuming a situation based on their knowledge with new technologies. Yet there were others assuming a situation where his team mates were not unanimous on a particular issue.

Students role-played by assuming a character role and collaboratively create circumstances.They determined the actions of their characters based on their characterization, and the actions succeed or fail according to a formal system of rules and guidelines. Role-playing may add diversity to the students' perception of the decision-problem. There was a consensus on the terminologies used. When most of the students had participated in building upon each other's concerns and suggestions to shape the decision-problem, there would be a position reached by the group. This position is known as reaching consensus on a representation of the decision-problem. The decision-problem was ultimately structured by the activity of reaching consensus towards a conceptual representation. In case scenario#1(see appendix), the group was contemplating on favoring the traditional use of technology.

In case scenario #2 the group was bent on employees' issues to represent the decision-problem while it was new technologies for business

in case scenario#3 (see appendix). Reaching consensus may happen before the brainstorming is at its peak (Case Scenario#3). In questioning a form of words were used to address the team in order to elicit information or evoke a response. It is also an expression of inquiry that invites or calls for a reply. Questioning might take place at the beginning of the brainstorming as in Case Scenario#2 (see appendix). Additionally, questioning from one student might elicit information of another to a search on the Internet. Students might seem eager to acquire further information on the decision-problem. They could have shared information with the team but were perplexed at not knowing more and they would like other participants to enlighten them (Case Scenario #3).

CONCLUSION

We developed a model to describe students' decision-problem structuring. The content developed by students during a participatory process is iterated between "Expressing Points of Views", "Role-playing", and "Assuming a Situation". The model of students' DPS constituted seven activities that transform the actual decision-problem into one that is structured. The structured problem can be translated as an input model that triggers structured activities in problem structuring method.

APPENDIX

Summary of CASE SCENARIO#1

An ethical issue here is what happens to the RFID tags. If they are not removed after you pay, it is theoretically possible for someone to track your whereabouts, which may be considered an invasion of privacy. But removing these tags costs money and takes time, an added burden to retailers.

Source: Turban et al. (2006). Information Technology for Management 5th ed. Chapters 1, 5 and 7. John Wiley & Sons, Inc.

Summary of CASE SCENARIO#2

Conducting a supply chain management project may result in the need to lay off, retrain, or transfer employees. Should management notify the employees in advance regarding such possibilities? What about those older employees who are difficult to retrain? Other ethical issues may involve sharing of personal information, which may be required for a collaborative organizational culture, which some employees may resist.

Finally, individuals may have to share computer programme that they designed for their personal use on the job. Such programme may be considered the intellectual property of the individuals. Should the employees be compensated for the programme if they are used by others?

Source: Turban et al. (2006). Information Technology for Management 5th ed. P. 309. John Wiley & Sons, Inc.

Summary of CASE SCENARIO#3

While Wi-Fi provides guests with Internet access to date it has had minimal impact on other sorts of hotel services (e.g., check in). However, a small number of hotels are testing use of the Bluetooth technology. Guests are provided with Bluetooth-enabled phones that can communicate with access points located throughout the hotel. This technology can be used for check-in and check-out, for making purchases from hotel vending machines and stores, for tracking loyalty points, and for opening room doors in place of keys.

Source: Turban et al. (2006). Information Technology for Management 5th ed. p. 215. John Wiley & Sons, Inc.

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