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A Study of Perceived Sensemaking and Uncertainty When Using Sense Map

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A STUDY OF PERCEIVED SENSEMAKING AND UNCERTAINTY WHEN USING SENSE MAP

ABSTRACT

This paper describes a research proposal to study and measure sense-making processes in ambiguous situations with the support of information systems. It performs the design of a sense-making tool to be blended with an IR information retrieval system to achieve a sensemaking task. This intended user study aims to understand how users use this Sense Map (SM) tool to build and organise their conceptual models of a network of concepts and relationships.

INTRODUCTION

The purpose of this qualitative user study is to develop, examine, and refine a sensemaking model that is built upon previous sensemaking research, learning theories, cognitive psychology, and task-based information seeking and use. The main aim is to understand the complex process of sensemaking, and it focused on the activities, conceptual changes, and cognitive mechanisms used during users sensemaking process. Making sense of the information found during a Web exploration task can be challenging. With the recent appearance of tools to support Web search, the associated sensemaking task has become even more complicated, requiring sensitivity to be made not only of the results of a search (i.e., results found) but of the process, as well (i.e., Sensemaking and decision-making). We present the findings of a developmental study illustrating the sensemaking challenges addressed by sensemaking tools. Based on these findings, our research will focus on Sense Map, a system that supports sensemaking for Web search tasks by providing several rich, interactive views of user's search activities. We describe an evaluation of Sense Map, reflecting on how its features supported different aspects of sensemaking, and how future search systems can benefit from these findings. It's essential to understand the users' sense-making process and how automated tools like SM (Sense Map) for sensemaking may help them with this process. Consequently, we derive our primary research question is:

RQ1. Does Sense Map (SM) tool support sensemaking process?

PROBLEM STATEMENT

As the complexity of technology increases, users may experience difficulty adjusting, navigating, and operating new systems, resulting in a technological gap. This gap is a separation between advanced technology and the user's ability to comprehend the technology. Based on cognitive science and psychology research, part of the reason for this increasing gap is due to the user's inability to form accurate mental representations, or schema, of the information needed to improve sensemaking performances. Researchers have studied sensemaking to understand how human structure, organise, perceive information, make decisions, and modify behaviour in various environments. To combat information and cognitive overload, while browsing the internet to perform a task many tools may have introduced for their information records for more accessible and directly archival access and retrieval.

Internet information lacks reliability as the Web's search engines do not have the abilities to filter and manage information and misinformation. Narrowing one's concentration as a result of the interruption is expected to result in the loss of information signals, some of which may be important to complete the task. We eventually loose the schemas that we already formed. Under these events, performance is likely to deteriorate. As the number or severity of the distractions/interruptions increases, the decision maker's cognitive capacity is extended, and performance declines more severely. In addition to reducing the number of reasonable cues attended to, more severe distractions/interruptions may assist decision makers to use heuristics, take alternatives, or opt for a satisficing decision, resulting in lower decision certainty.

RELATED LITERATURE

Sensemaking tasks often involve searching for information that is relevant for a task and then extracting and analysing information to create an understanding on which to base decision or actions. Sometimes researchers refer to sensemaking strictly as the analysis, synthesis, and conceptualisation part of the process, for example, the process of creating a representation and encoding data in that representation to answer task-specific questions [1]. However, since the searching activities and sensemaking activities are often closely intertwined, some researchers also refer to sensemaking as the overall process of creating an understanding, which includes both finding and understanding information [2]. Sensemaking is characterized as a series of continuing gap-defining and gap-bridging activities between situations [3] [4].

Two types of distinctive activities emerge from the literature.

1. Seeking for information, followed by extracting and filtering the information found.

2. The iterative creation and updates of an understanding of the situation, especially connections (for example, people, places, and events) to anticipate their direction and represent effectively [5]; [6] Through cognitive task analysis, [2] proposed a notional model of sensemaking, with two loops of activities: An information foraging loop that involves processes aimed at seeking information, searching and filtering it, and reading and extracting information into some schema.[1]The production of task output follows the path —Information → schema → insight → product.

The act of conducting research (either quantitative or qualitative) is necessarily a sensemaking process. Researchers start with a lack or discontinuance of knowledge, recognise the gaps to be filled (research questions), and conduct research using various methods to bridge the gaps. For example, CoSearch [7] supports group awareness through the use of a [7]. The Sensemaking- Supporting Information Gathering (SSIG)[8] system, provides tree structures to represent information found during a Web search. Each folder in the tree corresponds to a topic or sub-topic that the user is interested in. Distinct features are provided to help the user search the Web. The importance of structure associated with the processes is recognized: not only do structures influence how people search for information, but they are also critical to the creation of an understanding. It seems quite clear that sense makers seek structures in sensemaking tasks and their sensemaking processes are firmly related to the structural representation of task situations. Several software packages belong to the category of representational tool, known as concept mapping software (also referred to as idea mapping or mind mapping). Concept mapping software allows users to externalise their internal representation of a topic, task, or problem. The existing tools by and large provide similar functions with some variation in input and output format,

representation of nodes and arcs. Sensemaking tools should provide information organisation mechanisms that are flexible enough to support different stages of tasks.

In this paper, we will be doing a qualitative observation of the sensemaking process by using Sense Map. This tool generally allows users to construct, manipulate, and sometimes share their knowledge models represented as concept maps (History and Knowledge Maps) through provenance as this can support different stages on task to be performed online. The three main aspects of these tools are *curate, capture, and communicate* sensemaking findings for a task [9]. Our research study will be based on using a similar tool on sensemaking called Sense Map (SM). [9]. The sensemaking questionnaire described by Alsufiani's[10] was developed by conducting a review of how sensemaking has been described in the literature and from this deriving a series of features. The questionnaire consists of five scales, and each represents a different dimension of sensemaking. The scales are *gaining insight*, *understanding connections*, *structuring*, and *reducing confusion, uncertainty, and ambiguity*. Alsufiani's [10] reports Cronbach's alpha and exploratory factor analysis (EFA) to demonstrate the reliability and validity of the instrument as an instrument for measuring sensemaking. This questionnaire will serve the purpose of this study to measure sensemaking performances (perceived sensemaking and perceived uncertainty) by using tool Sense Map.

Task-based Information Seeking

Sensemaking is often embedded in work tasks (as opposed to information tasks) [11]. Information tasks include both search tasks and sensemaking tasks. Among several task characteristics recognized in the review by Kim and Soergel [12] the tasks that require at least some degree of sensemaking often involve:

- New situations or problems
- Complex, less structured conditions or problems
- A new domain
- An unclear information

Most sensemaking research involved some work task(s). Sensemaking, as a cognitive task, can be considered as a distributed representational system with internal and external representations as two indispensable parts [13]. Different forms of representations were found useful to varying stages of sensemaking [14]. The representations constructed during sensemaking process need to fit the task, or they must be updated [1] information tasks, and work tasks are compounded. For example, learning (an information task) and decision-making (a work task) are the most studied sensemaking tasks. Kulthau's [15] suggested that information that is relevant in general terms is used at the beginning of the task performance, whereas information that is more specific, more pertinent to a chosen focus, is used at the end of the task. To summarise, sensemaking needs to be investigated about tasks. Sensemaking activities may differ in different stages of a task and require different types of support.

We are motivated by a prior study of Alsufiani's[10], in which an analysis is looking at the effect that externalizing thinking had on participants to perform an information-gathering task. This paper will aim to build on these findings to investigate how the relationships between a piece of information and a task may be used in a sensemaking tool. To help users throughout the various stages of sensemaking, focusing primarily on how to organise different sources and formats of information based on these relationships in the visual workspace for creating a conceptual structure. The inverse correlation between perceived sensemaking and perceived uncertainty supports the idea that sensemaking and uncertainty are to be measured: when one increases, the other decreases and with the tool to be

tested. We will be using Sense Map (SM) as a tool for sensemaking with taking cues from reviewing literature.

THE SENSE-MAKING TOOL TO SUPPORT SENSEMAKING

SenseMap (SM) a sense-making tool is designed to assist users in building their sensemaking model of a task situation by organising their search results, identifying and recording concepts and relationships, and outlining a task report (SM Json files) for further use. Compliments the system's search functions to provide better support for sense-making. The sense-making tool (SM) has the following primary features:

- Search: users can use the regular search box to issue a query or initiate a search from the SM workspace (Knowledge Map and History Map) in a sense Map tool on a part for data and a frame [6].
- Support the user to curate the collected information according to its relevance. Users can merge, modify, and delete concepts and relationships in the SM workspace;
- Manipulation of concepts and relationships in History and knowledge maps by using features of SM Tool; Users can create concepts or relationships from the search results that are found relevant and useful;
- Visualisation and display: users can switch between SM representation (KM & History Map) and template-based displays of concepts and relationships;
- Information extraction: IE is used to automatically form concepts and relationships with different levels of user involvement through nodes and links using the SM tool.

For many cognitive tasks, the interaction of conceptual knowledge between internal representations and external representation is crucial. External representations can give people access to knowledge and skills that are unavailable from internal representations. A broad categorisation of external representation given by Zhang [16] includes:

- The knowledge and structure in the environment
- Physical symbols, objects, or dimensions
- External rules, constraints or relations embedded in physical configurations

The knowledge and structure may be represented in the following forms and sense map tool able to deal with the following:

- Graphical/diagrammatic representations: support users that can recognise features easily and make inference directly. Diagrams, graphs, and pictures are a few typical types of graphical/diagrammatic representation, used in many cognitive tasks such as problem-solving, reasoning, and decision-making [13]. Graphic organisers [17] are developed to provide diagrammatic representations for such cognitive tasks.
- Textual forms: can be more nuanced, and complete, as well as more detailed and precise than graphical/diagrammatic representations.

OBJECTIVE

The purpose of this research is to highlight the impact of Sense map on sensemaking and qualitative study of their relationship for the task they perform and interplay of their outcomes**.** The research and

concepts based on this paper is a foundation of Alsufiani's[10] paper for measuring the sensemaking process, and this paper will study specifically sensemaking tools called Sense Map.

RESEARCH QUESTION- DOES SENSE MAP TOOL SUPPORT SENSEMAKING PROCESS?

HYPOTHESIS

The study to be tested the following hypotheses:

- H1 SM increases perceived sensemaking.
- H2 SM reduces perceived uncertainty.

EXPERIMENTAL PROCEDURE AND DESIGN METHODOLOGY

Participants to be seated at computer workstations in a controlled laboratory environment. Participants were asked to complete an Informed Consent Form to be approved by Middlesex University (Appendix A) and completed a demographic questionnaire (Appendix B). After obtaining the signature on the authorised consent form participants, they should be provided with the overall instruction about the experiment task using the tools. Before starting the session, participants listened to an overview of the task, tools and experiment Participants to be provided with a printed copy of an example task (Appendix E) to ensure understanding and make sure they were comfortable performing and completing the tasks.

The research design will cover user studies of the sense-making tool for structuring an SM concept space ie, creating a representation of information. Users will consist of participants. Participants to be recruited (students from Middlesex University), to perform a mock investigation task using a Sense Map tool. The task involves constructing simple queries over Sense Map, searching for information to decide for their sensemaking objective.

Group of users (A) and (B) will perform each task separately to ensure more focus on a given assigned task session and to avoid knowledge merge. Each participant will do only one session task. Group A will be assigned for task without the sense-making tool while group B will be performing the task with the use of Sense Map tool.

- an assigned task without the sense-making tool;
- an assigned task with the sense-making tool;

Users will be instructed their ability to think-aloud performing such tasks. Each task sittings takes about 90 minutes. The initial 30 minutes the users will be given a short introduction of the tool and a practice task for the training. The task will take around 60 minutes. The assigned task will vary from information finding, judgment, to sensemaking and decision making.

TASK: PREDICT WHO WILL WIN NOBEL PRIZE FOR PHYSICS IN 2019?

The task requires participants to search and predict Nobel Prize winner for Physics for the year 2019. This task involves sensemaking abilities to make a connection between peoples, entities, places, and activities. There will be top 5 contenders for the Nobel Prize for this year. This task is based on key findings and objective judgment to support arguments to lend more credibility to conduct this sensemaking task.

DATA COLLECTION METHODS

To avoids systematic bias; the researchers used several data-collection methods: think-aloud protocols, recordings of screen movements, interviews, and questionnaires (Potter [18]; Creswell [19]; Yin [20]; Maxwell [21]). The combination of these data collection methods will be provided with a complete picture of the users accomplishing sensemaking tasks with the assistance of computer tools like Sense Map.

Training to be conducted one-on-one to make sure the students following the training instructions step-by-step and their questions answered. At the beginning of the training session, users will be informed about the purposes and procedures of the research.

Below Section does describe the data collection methods. It illustrates how the data collection to be done chronologically.

The data collection methods involved were:

1. User background questionnaire will provide information about the user's demographics, age, gender and educational level. This questionnaire will offer to create a balance and uniform mix of samples to categorise into two groups to perform the assigned task.
2. A) Logs generated by Sense Map as *Sense Map.JSON files to be called a SenseMap log.* The JSON file will *record URL, searches, start and end time, images, notes and highlighting.*
3. User activity automatically will be recorded by screen capture software (OBS studio). The recordings, along with the think-aloud protocols, capture user interaction with the system and changes users made in a while performing the task by using the SM tool. Think-aloud protocols will record as users work on their tasks. These protocols will shed light on users evolving sensemaking processes, especially on cognitive mechanisms used, and user's internal representation of the knowledge structures. Think aloud protocols to be recorded along with screen movements using a program (OBS studio).
4. A post-task Questionnaire for User Interaction for Sensemaking (QUIS).
5. NASA-TLX for workload assessment of SM tool.

USER BACKGROUND QUESTIONNAIRES

User background questionnaire and characteristics will be useful in understanding the user context and for the researcher better interpreting the results. The User Background Questionnaire will be administered as part of the screening process during participant recruitment. The user background questionnaire collected information about users' demographic information, as well as background information that will be relevant to the study, such as educational background, computer skills, and problem-solving skills. These questionnaires will provide to choose balance and a real mix of samples to categorise into two groups to perform the assigned task. Refer to Appendix B for details.

SENSEMAP LOGS

The SenseMap will automatically record screen movements including all search, note-taking, mapping in SM, and browsing activities: The *SM JSON* file data capturing can be done automatically yet still provides a reasonable amount of semantics to the researchers. The following four aspects of actions are to be captured. The SM tool is implemented as a Chrome extension consisting of two components. The first one is a background process running in the participant's browser to automatically capture all the required analytic provenance during the observation stage of the qualitative study. The second component includes a set of four linked visualisations of the captured provenance data.

• Type: The type of action such as search and filter to search engine /system to be and queries once issued and results retrieved from the SM tool.

• Timing: The start and end time of an action.

• Context: Page title, URL, screenshot and contextual information such as “keyword” for search and “selected text” for a highlight for the documents to be examined.

• Relationship: Providing how a web page is activated including revisiting an already opened page, direct link from an existing page, manually type a new address, and open from a bookmark Addition, modification, and deletion of concepts and relationships in the SM using History and Knowledge Map.

"id": 1550060021101,

"text": "The official website of the Nobel Prize - NobelPrize.org",

"url": "https://www.nobelprize.org/",

"type": "link",

"time": "2019-02-13T12:13:41.101Z",

Figure: a sample of Json File generated using SM tool

THINK-ALOUD PROTOCOLS AND RECORDINGS OF SCREEN MOVEMENTS

This paper will aim to understand the user’s cognitive processes in sensemaking by using tool Sense Map, which cannot be observed easily at the behaviour level. Think-aloud protocol analysis described by [22] has been widely used in several domains to elicit the cognitive processes responsible for the user ’s behaviour. The participants were also be given a training task, preparing the participants for the think-aloud exercise and familiarising them with the system. The data to be collected as part of think-aloud protocol and transcript recorded will support for coding and breaking-down *low-level sensemaking code*, *on-screen activity* coding and further classification into *data-frame model code.*

A POST-TASK QUESTIONNAIRE

A post-task session Questionnaire for User Interaction for Sensemaking (QUIS) will be to measure about how users think about the SM tool for sensemaking. Do refer appendix D. The concept of this questionnaire is being drawn from previous paper researched by Alsufiani’s, based on perceived sensemaking and uncertainty. The theory or definition contributed to a subscale in the questionnaires. [10]. Each of the 16 sub-questions incorporated a statement to foreground a feature drawn from sensemaking theories supported by relevant literature. The post-task session interview is intended to learn about how participants perceived the changes that happened to their understanding of the topic of the task, how they thought about the tool, and to provide a chance for participants to give input to system design.

It also will serve as another source to verify the think-aloud protocols generated by the participants during the process. Participants to be asked to recall some critical instances of when and how their conceptual model changed. The post-task session interview may have the long-term influence of the experience of using sensemaking tools for tasks on the participant’s approaches to similar tasks, and to get suggestions from users on designing tools.

NASA-TLX

NASA-TLX Mental Work Load Index survey (Appendix E). A multidimensional assessment tool that rates the perceived **workload** . In our experiment we will use to assess the SM system Tool and users workload.

Mental workload ratings are based on six subscales ratings: mental demand, physical demand, temporal demand, performance, effort, and frustration. The Online-TLX can be accessed at http://www.NASATLX.com [23]. NASA-TLX Mental Work Load Index survey (Appendix D). Participants to be instructed to complete the surveys about performing the task or using the SM interface. If a participant is needed to answer the TLX queries, they solely have to answer the 15 pairwise comparisons once per task sort. If a participant's workload must be measured for as such completely different tasks, then revisiting the pairwise comparisons could also be needed. Using this software http://www.nasatlx.com/ four variables are created User description (user ID, experimental ID & participant ID) automatically, *Scales* which is based on ratings when the User checkboxes [23]. Similarly, *Workload* assessments and *Workload Weighted* will be measured for further analysis for different participants for group A and B. Below is the example figure showing the output(.csv) generated after each user of the two groups when complete the experimental task.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
userID	experimer	participan	tlx_Score	scale_mer	scale_phy	scale_tem	scale_per	scale_effc	scale_frus	workload	workload	workload	workload	workload
amit10974	1	10974	54.4	41	68	58	42	57	58	0.13	0.2	0.13	0.2	0.13

Figure1.Output.csv file in Excel sheet generated using http://www.nasatlx.com/.

DATA ANALYSIS

Data from multiple sources will be collected and to be analysed in relation to other data. Together, they will provide a complete and detailed picture of the user's sensemaking processes. The think-aloud protocols and screen movements were the primary data sources, correlated by the time stamp that the screen capturing software (OBS studio) recorded. In post-session interviews, the researcher will ask users to describe the general processes they went through so that the interpretation of the think-aloud and screen movements could be cross-validated Interviews and think-aloud protocols were transcribed. All types of data which are to be collected about each case are to be put together to generate the individual case report. Once after the individual case analysis is done, the researcher will conduct cross-case comparisons by participant and task to discover any common patterns in multiple cases. The data which is to be generated by the questionnaire were coded, manually entered and we will perform descriptive statistics in terms of means, range and standard deviations of the responses of the participants were calculated using version 20 of SPSS.

USER BACKGROUND QUESTIONNAIRE

The User Background Questionnaire will work as part of the screening process during participant recruitment. The user background questionnaire collected information about user demographic information, as well as background information that is relevant to the study, such as educational background, computer skills, and problem-solving skills. The background questionnaire will provide relevant information for this study to give a balanced mix of diverse samples for analysis. Weighting is on of the successful as a technique where slight adjustments can be made; The sample collected will have to be categorised into groups for evaluative study for the hypothesis. Refer to Appendix B for details. The sample collection and categorisation will be based on age, gender, and educational level, and categories will be evenly distributed and each data point can uniformly fall in one group or the

other. The primary goal of weighting and sample balancing is to improve the quality and analytic strength of sample data after it has been collected. Results which better align with a broader population to be achieved, by employing proper technique as well as caution to avoid unintended impacts to obtain a fair result to support for testing hypothesis H1 and H2.

ANALYSIS OF SENSEMAP LOGS

For the analysis of activity logs on Sense Map**, T**he *JSON* files extracted will record the activities of the participants performing the assigned task. The key four activities include Text, URL, type, and time.

For example:

"text": "The official website of the Nobel Prize NobelPrize.org",

"url": "https://www.nobelprize.org/",

"type": "link",

"time":"2019-02 13T12:13:41.101Z"**.**

The activity captured by SM will be converted into pre-defined codes for further analysis**.** The data objects in Sense Map may include users, sessions, queries, search result pages, clicks on search results, and follow-up clicks. The purpose of this analysis is to find the comparison of sequences to find similarity, often to infer if they are related. The analysis of sequence will be automatically carried out by using a sequence analysis tool.

Think –aloud transcript	Video	SM log	Low-level SM activity code	On-screen activity code	Data- frame Theory code
C57 Oh my Goodness. I am [50:33:50: 45] also going to look at the other website too, which has good info. I think is the one not as good I think to see Nobel Prize	text entered/edited	"text": "The official website of the Nobel Prize - NobelPrize.org", "time": "2019-02-13T12:20:27.476Z End Time": "2019-02-13T12:20;01	Typed text [TT]	Focused search for data [FSD]	Questioning the frame(Q) Elaborating the frame [E]
C58 now I am going to do more of the reading. [51:33::51:45] I am going to [51:50:51: 55] I feel that this Knowledge Map is good… but I don't know if I really want to use it. [52:06:52 22] hmm, I need this detail about John McCain and I need this "best scientist in 2019", because I think it is important.	titles of pages opened	"url":"https://cen.acs.org/people/nobel-prize/win-2018-Nobel-Prize-Chemistry/96/web/2018/09",	Clicked URL [CU]	Comparing results [CR]	Seeking the frame (S) Re- framing [R]
C59 [52:06:52:22] I don't know how I feel about this particular tool SM (History Map)… yes, I think this might be a good start for now.	Re- opened page	"type": "click-node",	Created node [CN]	Gaining knowledge [GK]	Data [D] Frame[F]
C60 We should to look at this website too. That might be good. … "I think this might be handy to guess"… Latest prediction of Nobel prize wow!!… I am going to look at archive.	Hovering on screen	"type": "collection-zoom-out", "time": "2019-02-13T12:21:46.930Z"	Zoomed out [ZO]	Reviewing [RE]	Preserving the frame [P]
C61 Oh! And this is	Looking at	"type": "link"	clicked	Finding	Data[D]

Figure 3. An example of activity logs and coding of the transcript into activities

Analysis of Think-aloud Protocol and Screen Recordings

The software will record what happened on the computer screen along with the think-aloud audio input from the participants. The recording was exported as a video file (.avi) and played using a regular media player or the OBS Studio player. Analysis of Think-aloud Protocol and Screen Recordings will measure and support for ***How does SM support Sensemaking? (by using D/F model*).** The transcript will be analysed and coded, and this is to be classified with the think-aloud transcript gathered, all participants for the assigned task into low-level SM activity code versus on-screen activity code, after that the interpretation of different compositions of the data-frame model to be done. The table in Figure 3 shows part of an example transcript. The User activity Column will describe the user actions, including activities happening in Web browser in Sense Map tool and the browser user to use for the assigned task, the note-taking done by researcher together with the Sense Map mapping tool application (History and knowledge Map), Word or Excel, and any other program that were used for the sensemaking task**.** The Think-aloud protocol column will report the thinking aloud data as the user to be involved in the activity shown during the sensemaking activity in a similar period. The coding of data for the think –aloud transcript will be processed with viewing the sense map log generated as a user

perform the sensemaking task. In the above example *C57 "Oh my Goodness. I am [50:33:50: 45] also going to look at the other website too, which has good info". "I think this is the one not as good I think to see Nobel Prize".*

INTEGRATIVE ANALYSIS OF SENSEMAKING- TO SYNTHESISE CODE

As sensemaking is a dynamic process, Integrative Thinking as the process of integrating intuition, reason and imagination in a human mind with a view to developing a holistic continuum of strategy, tactics, action, review and evaluation for which individual synthesise the information to form ~~a~~ meaningful experiences. We will employ heuristic methods to combine the pre-defined code generated during the task. *Transcript, Video*, *and screen recordings* will connect the dots and fill the gaps to represent data and information to corroborate analysis. So, in this analysis of think-aloud protocol and screen recordings we aim to create sensemaking harmony of thought, speech, and action to understand sensemaking loops. We are to examine *Low-level SM activity code*, *On-screen activity code, Data- frame Theory code* to find a generic *sequential pattern code* to determine the correlation between speech, thoughts and actions. This transcript, using the sense map log will be coded first as Low-level SM code. So, for the user as they do their activity, this can be coded as 'Typed text' as (TT). Subsequently, for the activity at a cognitive level, codes labelled as on-screen activity code as (FSD). Finally, then using the concept of data –frame theory once the transcript is broken down into a different element(Questioning the frame,elaborating the frame and so on), and further, the pattern can be explored for frequency pattern analysis an ***n*-gram** is a contiguous sequence of *n* items from a given sample of text or speech coded for the transcript. Description of user activities as recorded by the screen recording software (OBS studio) and the think-aloud protocol will be aligned to periods, which is to be segmented at natural, logical breaks (such as switching of applications and breaks in think-aloud) of the sensemaking sessions.

Figure 4 . Think –aloud trancript coded using Klein's Data-frame Model

ANALYSIS OF A POST-TASK QUESTIONNAIRE

A post-task session Questionnaire for User Interaction for Sensemaking (QUIS)(extracted from Kholo d's paper) will be used to measure about how users think about the SM tool for sensemaking which will test our Hypothesis **H1** and **H2.** For the hypothesis test, a paired sample t-test is to be done to understand the relationships between perceived sensemaking and perceived uncertainty relationship by obtaining the results of descriptive statistics. Means and statistical test results relating to self-reported sensemaking and self-reported uncertainty. Using the sensemaking questionnaire, participants report different levels of sensemaking in using Sense Map condition and without using Sense Map condition. A paired samples t-test will be shown where the difference will be highly significant (t=+ve value, $p<0.05$). Hence, H1 is to be determined

Using the uncertainty questionnaire (included in Sensemaking questionnaire), participants report higher or lower levels of uncertainty in the condition using Sense Map and condition two without using Sense Map (mean=value). A paired samples t-test to be shown that the difference is also highly significant (t=+ve value, $P<0.05$). Hence, H2 is to be determined.

ANALYSIS OF NASA-TLX

With the two groups (Group A will be assigned for a task without the sense-making tool while group B will be performing the task with the use of Sense Map tool.) will be tested. The purpose of this analysis was to measure users' "mental workload" compared to a task between the groups for users' sensemaking efforts to use SM in realising tool to support sensemaking processes. Correlation analysis will be performed to analyse the relationship between SM mental workload and perceived Sensemaking for tool SM. The outcome of this experiment will support to determine ***How does SM support Sensemaking by using D/F model*?.** Each of the six factors will contribute to determining SM workload the specific task to be evaluated from the raters perspectives, is determined by their responses to pair-wise comparisons among the six factors. The NASA Task Load Index is a two-part evaluation procedure consisting of both weights and ratings. Three separate computer programs are provided: 'WEIGHTS" is used to collect weights; RATINGS" is used to collect ratings; and "COMBINE" is used to combine them into an overall weighted workload score. The weights and ratings may or may not covary. The results will help to find the overall workload score for each subject is computed automatically by software multiplying each rating by the weight given to that factor by that subject. The sum of the weighted ratings for each task is divided by 15 (the sum of the weights)[23] .

CONCLUSIONS AND IMPLICATIONS

Assisting users to retrieve the right information using the SM tool is only half the action; aiding users with forming a sense of what they found is the next verge in information system design. This study will present to our understanding of sense-making processes and tools in the following aspects, and thereby give better grounds for system design:

- A better understanding of how users organise their conceptual model, and how the different ways of business would inform the design of sense-making tools;

- A solid understanding of user processes of finding and using the information to build a conceptual model of a problem or condition

- What features of the sense-making tool do or do not help users with their sense-making processes; what additional features are recommended;

- What is the best approach to realise the useful features in the human-computer interface;

- Exploring the types of information used and how they have been handled through the eyepiece of users' sense-making process of a task situation, suggestions may be presented as to how automated information extraction techniques may be adopted in information systems to help users with their task.

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