# Collaboration Gaps in Disabilities Sensemaking: Deaf and Blind Communication Perspective


Gahangir Hossain
Electrical and Computer Engineering
The University of Memphis TN 38152
ghossain@memphis.edu

Mohammed Yeasin
Electrical and Computer Engineering
The University of Memphis TN 3815
myeasin@memphis.edu



## ABSTRACT

Collaborative sense making is the process by which people assign meaning to experience in collaborative information sharing and decision making. Recent technological advances made it possible for people with disabilities to collaborate among themselves using smart phones. The main research goal of this pilot study is to investigate the suitability and utility of modern technology (e.g., android apps) in modeling reducing disability gaps that is prevalent in people with disability. In particular, observation and study was performed in a collaborative scenario (e.g., communication between deaf and blind) to understand the challenge and usability of technology solutions. In addition, study was performed on technology tools that are useful in effective interaction design and some recommendations were made in bridging the communication, expectation and perception gaps in sense making.



## Categories and Subject Descriptors

D.2.1 [Requirements/Specifications] K.4.2 [Computers and Society]: Social Issues—Assistive technologies for persons with disabilities; H.5.2 [Information Interfaces and presentation]: User Interfaces—Evaluation/methodology, Input devices and strategies, User-centered design, Voice I/O.

## General Terms

Design, Experimentation, Human Factors.

## Keywords

Collaborative Sensemaking, Disability, Communication Systems, Android Apps,


## 1. INTRODUCTION

Over one billion people around the world have some type of disability [1]. Three hundred fifty million people with disabilities live in areas where related services are not available [1]. Twenty five percent of the population in a given country is adversely affected by the presence of some form of disability [1]. As many as eighty percent people with disabilities live in isolated rural areas in developing countries. Hundreds million children who are not in school, thirty to forty million have disabilities [1]. Two and half trillion is lost from global GDP because of the presence of disability [2]. Over fifty four million people in US have some disability [2]. Out of seventy million families twenty million have at least one family member with disabilities. Canada, Bangladesh, Pakistan, and Egypt reported to have four million, seventeen million, nine million and seven million people with disabilities, respectively [3,4].



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The same world is designed for individuals with disabilities and peoples with different capabilities. People with disability are becoming more technology aware, and are adopting emerging applications with mobile phones. With premium training and assistance they can adopt modern technology for social networking as well as managing their daily lives. While assistive technology solutions are helpful in many cases they are not interoperable to bridge communication gaps between people with mutually exclusive types of disabilities (for example, deaf vs. blind). Designing an effective, assistive, and adaptive interpersonal coordination system remains a challenge in assistive technology research. The goal of this paper is to investigate several issues related *collaborative sensemaking* for people with disability. In particular, we are researching on recent advances in assistive technology solutions can be made useful to improve collaboration among people with disabilities. Main goals are to: (i) review assistive technologies used by people with complementary disability in communication, (ii) identify effective tools for successful social coordination and (iii) design a prototype for Android phone based effective coordination system that reduces collaboration gaps. We applied Russell et al.'s ideas about cost structures in sensemaking [11] into disability gap model [10] to develop a theoretically informed approach to analysis collaborative gaps in disability sensemaking. We focus on these two approaches because their semi-formalized descriptions of representational change provide useful accounts of cognitive processes which are central to disability sensemaking.


Figure 1: A meeting scenario in disability collaborative sensemaking

A conversation scenario on "useful assistive technology tools (e.g. smart phone application and their integration)" was performed among four people: one with speech impairment (deaf), one with vision impairment (blind), the third with both speech and vision impairment (deaf-blind) and the moderator. The role of the moderator is to allow meeting members to express their opinion and vote on questions on different apps based designs considerations.

In the following sections, we first describe the problems that distributed teams are faced with when they are trying to "make sense" in collaboration. Then we explain how CSCW tools can facilitate collaborative sense-making. Finally, we present methodology to test our theory and conclude the paper with few recommendations and possible future research efforts.

## 2. SENSEMAKING

This section provides a brief idea about sensemaking concept in collaboration scenario and its importance in reducing communication gaps.

### 2.1 Collaborative Sensemaking

Sensemaking is a critical process through which individuals view and interpret the world and then act in the environment. It is the way in which people respond to uncertain events and construe their perceptions regarding goals, priorities and problems they sense by their sensory organs [5].

Collaboration is defined as a process of joint decision-making among key stakeholders of a problem domain about the future of that domain [6].

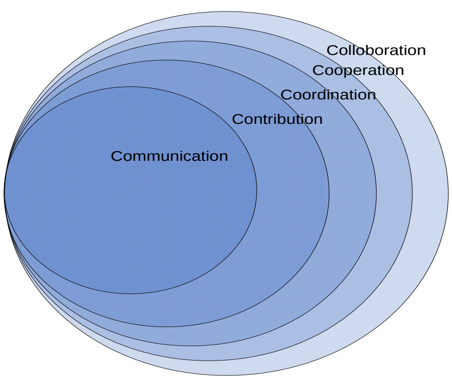



Figure 2: A model showing steps to a meaningful collaboration. [7]

Tailor-Powell et al. [7] showed that a true collaboration requires a tighter form of integration of five components: communication, contribution, coordination, and cooperation as essential steps toward collaboration (please see Figure 2.). The model structure and information integration properties are summarized in the table 1.

Table 1: collaboration structure [7]

| **Process** | **Structure** | **Information Integration** |
|---|---|---|
| Communication | Network, round table | Very Low |
| Contribution | Support group | Low |
| Coordination | Task Force, council, alliance | Average |
| Cooperation | Partnership, coalition, consortium | High |
| Collaboration | Collaboration | Very High |

Collaborative sensemaking aims to support a group of two or more people explicitly working together to make a successful communication or sensemaking task. In collaborative sensemaking, collaborative systems should provide collaborators capability "to infer some idea what they have, what they want, why they can't get it, and why it may not be worth getting in the first place" [5]. Collaborative sensemaking can be thought as drawing from individual level cognitive processes up to social interaction processes. More specifically, sensemaking in collaboration signifies meaningful retrieved information by collaborative information seeking. Such a description is given in diagrams in Figure 3.

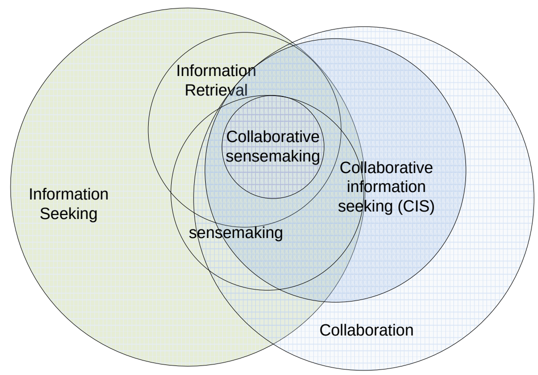



Figure 3: Contextual depiction of Collaborative sense making.

A collaborative system should satisfy some requirements to better support collaborative sense making activities including interpersonal social communications. Some essential requirements are summarized in Table 2.

Table 2. Summary of essential requirements in collaborative sensemaking [8]

| | Requirements : Support for |
|---|---|
| 1. | Creating explicit representation |
| 2. | Co-existence of different representations |
| 3. | Developing shared representation |
| 4. | Creating representation using templates |
| 5. | Providing workspace for developing shared representations |
| 6. | Consensus building and reaching agreement |
| 7. | Facilitating and moderating interactions |
| 8. | Exchanging documents |
| 9. | Retrieving and visualizing information |

Individual sensemaking should satisfy 1,2,4 and 9; the collective sensemaking should satisfy 3,4,5,6,7,8 requirements [8]. As a prerequisite requirement 2 dependents on 1; the requirement 3 depends on 1, 5 and 6.

### 2.2 Communication gaps among people with disability

Traditional, people with disability use hand-over-hand or hand-over-face for communication (e.g, hand-over-face Figure 4.). Hand-over-hand sign language is also called tactile signing. It can be used by people who are either deaf and blind (DB). It requires the blind to have previously been sighted so as to have knowledge of what he/she says. It requires the interpreter to put his hand on the client's hand and ride along the signing up. Helen Keller, an American author who was deaf-blind and Anne Sullivan who was her tutor, also visually impaired. Anne was able to teach Helen to speak using the 'Tadoma' method which involved touching the lips and throats of others (Figure 4) as they spoke [9].

Figure 4: Hand over face - Helen Keller (left) "hears" her teacher Anne Sullivan by reading Sullivan's lips with her fingers. Source: AP/Wide World Photos Helen Keller/ Anne Sullivan

Later on, TTY (TeleTYpe), TTD (Telecommunication Device for the Deaf), and TT (Text Telephone) all refer to the text-based telecommunications device that the deaf, hearing impaired, and deaf blind use to communicate on the telephone. The sighted person types a message on a small keyboard and the deaf blind user receives the message on a Braille display. The deaf blind responds by typing on a standard or Braille keyboard and the sighted person reads the message on the screen.

Presently, TTY and TTD based communication system supported android apps are also available in smart phone [18]. In this work such apps are demonstrated to see whether it makes sense in future communication design. A snapshot of the conversation scenario among four people, Bob (Blind, B), Doris (Deaf, D), Debra (Deaf-Blind) and moderator (experimenter) is shown in Figure 5 (Name changed to preserve confidentiality). Bob can communicate through speech, audio feedback and tactile (Braille), but prefers audio based communication. Doris likes sign language rather than texting or others. Debora loves Braille based communication tools, although she knows signing, understand animal behavior, auditory feedbacks etc.

**Moderator:** Good morning everybody. How do you feel today? *[also translates in sign language]*
**Bob:** I'm pretty good.
**Doris:** *[Shows some sign language]* I am fine, thank you.

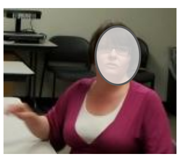


Fig. a. Doris answering using sign

**Debra:** *[using a hearing aids, shows similar sign language for the question asked by moderator]*

Fig. b. Debra showing sign to deaf

**Debra:** *[Translates the sign to speech]*. We are fine. How can we help you?

**Moderator:** I want to know how you guys communicate with each other. **Bob:** I can understand you easily. I always like audio based feedback.

Fig. c. Blind like auditory conversation

**Debra:** I don't like audio feedback; I love my Braille Display. Do you want to see how I use it?
**Moderator:** Of course, Can you text or email?
**Debra:** Let me show you how I text. *[She typed using a Wireless Braille Display and sent a message to moderator's iphone. Message content: What do you think of weather today?]*

Fig. d. Debra using wireless Braille display

**Moderator:** *[Responds verbally] sunny. [and typed sunny ]*

Fig. e. Debra sending text to iPhone

**Bob:** Isn't it hot today?
**Moderator:** Yes, it is hot, too.
**Debra** *[replied via text]* Yes, it will get hot soon.

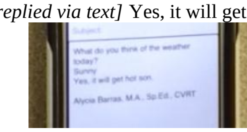


Fig. f. Final conversation between Debra and moderator showed

**Moderator:** What do you think if we have a common app in our smart phones to communicate? *[Shows the questions written to the deaf]*
**Bob:** It will be awesome.
**Doris:** It will be a blessing to me.
**Debra:** Do you think to incorporate any Braille Display?
**Moderator**: We are working on that.
**Debra:** That will be excellent.

Figure 5. A snapshot of conversation scenario among disabilities.

This conversation gives us a thought to consider different modes of communication and user preferences in disability research. Designing such a robust cross communication requires more in-depth analysis and synthesis in collaborative sensemaking. In next section, we analysis some models to understand user's level of disability and sensemaking costs in technology interaction.

## 2.3 Models

A brief discussion on the gap model of disability and cost model of sense making are analyzed to understand collaborative gaps in cross disability communication.

### 2.3.1 The Gap Model of Disability

Disability is a very complex phenomenon, reflecting an interaction between features of a person's body and features of the society in which he or she lives [1]. Disabilities include physical impairments, sensory impairments, and cognitive or developmental disabilities. Psychiatric or psychosocial disability (Mental disorders) and various types of chronic disease may also qualify as disabilities.

Disability creates incongruity, or gap, between person's abilities and the demands of the environment. Figure 6 shows the gap model with consideration of tangible gaps between persons' abilities and demand of environment in rational communication.

Disability can be formalized as the difference between environment demanded cost parameters and individual's ability related parameters [10]. Environmental demand is the function of physical/sensory demand, psychological demand and social demands. Similarly, individual's ability can also be defined by a function of his physical/sensory ability, psychological ability and social abilities. Finally, a difference equation measures the cognitive or disability gaps in collaboration.

$$Demand = f(P_d, Ph_d, S_d); \quad (1)$$

Where, $P_d$ is the physical demand, $Ph_d$ is the psychological demand and $S_d$ is the sociological demand. The function on the right side of the equation is the demand function.

$$Ability = f(P_a, Ph_a, S_a); \quad (2)$$

Where, $P_a$ is the physical ability, $Ph_a$ is the psychological ability and $S_a$ is the sociological ability. The function on the right side of the equation is the ability function.

$$Disability = K(Demand – Ability); \quad (3)$$

Where, K is a normalized constant.

These qualitative data can be collected through, video recording, pretest and post-test interviews. While the ability data are biased towards person's skill and experiences the demand seems constant for technology tools or communication design requirement.

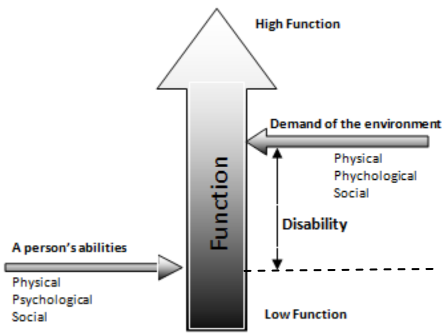



Figure 6: The Gap Model

## 2.3.2 The Cost Model of Sensemaking

Sense making in disability collaboration involves multiple interactions between environment, person with the disability, and other with respect to time and space. A cost model can be adopted from micro-cognitive process [13] that explains how people solve problems in the real world outside control laboratory setting and focuses on higher order models [14] that are meaningful in making sense of sensemaking.

According to the cost structure of sensemaking [11]:

FR: finding a representation schema to support the required operators in the target task,
IE: instantiating the encodons,
FD: finding data to create the encodons, including both finding the documents and selecting the information,
TT: the target task

The costs of sensemaking are the combined costs of the steps in the learning loop complex. The total cost, $C_T$, is the cost of sense making, $C_{SM}$, plus the cost of the target task, $C_{TT}$,

$$C_T = C_{SM} + C_{TT} \quad (4)$$

where

$$C_{SM} = C_{FR} + C_{IE} + C_{FD} \quad (5)$$

In case of new assistive technology use if a representation is supplied at the beginning of a task, then $C_{FR}$ is zero, and more effort may be placed into other areas (e.g., increasing the amount of information).

## 2.4 Example Android Apps

At this point we review some useful android apps that might be useful in bridging the gap and provide a sense of solutions that has potential in addressing some of the challenges.

### *2.4.1 Blind Ambition*

The "blind ambition" is one of the signature project at the CVPIA Lab, The University of Memphis. The main goal of the project is to develop a suit of assistive technology solutions to improve the quality of life and enhance the interaction experience of people who are blind or Visually Impaired or Deaf. Goal is to design enabling technology solutions that will assist them to efficiently perform their day-to-day activities with a relative ease. The key objectives are to develop solutions that are light weight, low cost, un-tethered and have an intuitive and easy to use natural interface that can be reconfigured to perform a variety of tasks. Also of importance is to make the technology available at zero cost to one who cannot afford and provide affordable, efficient, scalable and reliable services. The project "Blind Ambition have been developing Assistive technology solutions to provide a number of key services through Smart Phone using the Cloud Computing and Cyber Physical systems as backbone of application development.

- **Reading out loud service** for reading envelopes/letters, medicine bottles, labels on food containers. The R-Map is a fully integrated, stand-alone system with easy-to-use interface to reconfigure an Android mobile phone [11].
- **Navigation** aid in walking straight, crossing traffic intersections, obstacles, finding references in an open space and improved navigation in semi-structured environment such as Office, Mall etc.
- **Preparedness** during extreme conditions, such as flood, hurricane, or earthquakes .
- **Social Interaction** such as shopping and browsing; education and employment and access to non-verbal Communications (for example, emotions and affective states, dialog acts and gestures).
- **Bridging communication gap** with different types of disabilities (such as, Deaf and Blind).

Figure 7: RMAP – in operation for visual impaired people [15].

### *2.4.2 Virtual Voice and Electric Ears*

With text to speech (TTS) and Speech recognition of your Android device, the deaf can communicate with others without the need for sign language or lip reading. It has a very simple 3 button interface useful for visually impaired. Text To Speech App with Pitch, Speed Control, Multiple Languages [12]. A snapshot of virtual voice and digital ears is shown in figure 7.

Figure 8: A snapshot of virtual voice and digital ears apps.

### *2.4.3 Sign Language to Speech Conversion and applying over Avatar*

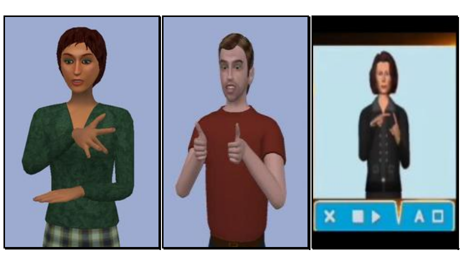
Some recent study revealed that there has been neither subsequent research to update the exact estimates of the prevalence of signing nor any specific study of ASL use. An estimated population size is stated greater than 500,000 appear use ASL [13]. Some new instrumented approach for translating ASL into sound and text and a combinational method with hardware and software interface are proposed in [8][9]. In disability studies, if is revealed that the blind or deaf are less fan of use of instruments rather than cell phone [13]. Android Apps based ASL or Braille and related apps to translate them seems to be the promising research. "Sign Language!" is another app is most downloaded Sign Language app in the world now (over a million). Features includes: how to fingerspell words, numbers, express basic sentences, idioms and learn about Deaf Culture. This app is free and based on demography of deafness estimates. Following are two such research (*SiSi*, *Mimix.me*) that work on British sign Language (BSL) and American Sign Language (ASL) respectively.

#### *SiSi*

SiSi is an innovative 'speech to sign language' translation system is demonstrated by IBM research 2007 and works for BSL. It has potential to make life easier for the deaf community [15]. An example is shown in figure 10(a).

#### *Mimix.me - a new technology*

Mimix translates spoken and written words into American Sign Language (ASL) and text into speech [16]. The mimix engine translates speech to text and then animates a 3D avatar with the equivalent sign language. The avatar is ergonomically positioned on the screen and as a first phase it translates English to ASL (American Sign Language). It is compatible on Android mobiles and Desktop and hopefully good for the deaf-blind communication. Among a number of research, this study conducts a theoretical basis for deaf-blind communication through Android apps in collaborative sensemaking perspective.



**(a)** **(b)** **(c)**

Figure 9: snapshot of avatars (left two a, b: IBM avatar in BSL, right c: Mimix with ASL) [16,17].

In figure 9, (a) An avatar translates the spoken word 'performance' into the corresponding sign from British Sign Language. The new technology -- which can be adapted for any country specific sign language -- allows a person giving a presentation in business or education to have a digital character projected behind them signing what they are saying.(b) An avatar translates the spoken word 'good' into the corresponding sign from British Sign Language. The new technology -- which can be adapted for any country specific sign language -- allows a person giving a presentation in business or education to have a digital character projected behind them signing what they are saying.(c) mimix me avatar, showing ASL, "Nice to meet you".

## 3. RESEARCH METHOD

We performed an empirical study to gain knowledge by means of direct and indirect observation or experience from end users (blind or deaf people) using these systems.

### 3.1 Experiment

In a collaborative experimental setting, moderator initiated different topics for conversation and recorded three types of data from usability questionnaires, user observation and post-task interview. The rating results are considered as quantitative data and statistical mean and standard deviation is performed on that data set as a part of usability measure. User's critical behavior is considered as qualitative data that was collected from conversation video and processed as conversation flow sequences to find the sense and interest of such task. Similarly, user's subjective reports are considered as qualitative data, collected through users' post conversation comments, which is useful for the cause analysis of user interaction. All results are shown in result section. In a within subject experimental design scenario, all participants scored Nielsen's usability questioners (strongly agree =7 to strongly disagree=0) for different design options. Finally some rational observations are noted based on the score from gap model and usability scores.

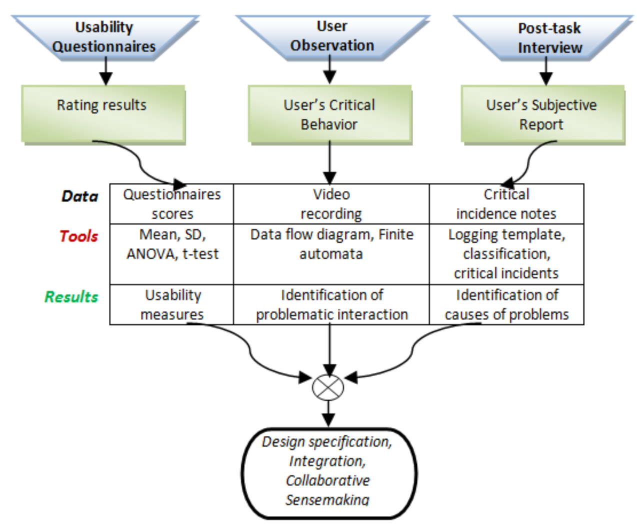



Figure 10. The experimental data processing

All participants are expert in their own assistive technology operation and serving as instructor in local disability center, Clover nook [19]. Subjects are instructed to experiment the four proposed communication designs (Speech-text-speech, Speech-sign-speech, Braille-text-Braille and Braille-sign-Braille) without any time bound. Such a design is shown in Figure 10.

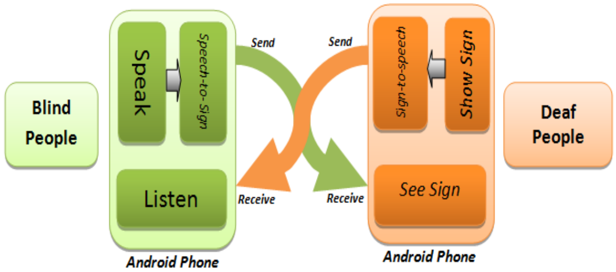



Figure 11: Design TWO (speech-sign-speech) : Bod and Doris conversation.

All participants are interviewed after completion of each design evaluation.

**Design Task ONE:** (*Speech-text-speech)* – Speech from *B* can be encoded and sent to *D* and she can read and text her reply that is decoded as speech to *B*.

Considerations: B cannot type, but speak and listen on the other hand D cannot speak or listen, but read text and type.

**Design Task TWO:** (*Speech-Sign-Speech)* - Speech from *B* can be encoded and sent to *D* and played by the avatar to mimic the sign (ASL) to *D*, and finally *D* replays by sign that is encoded to speech and sent back to *B*. (Figure 11).

Considerations: B cannot type, but speak and listen on the other hand D cannot speak or listen, but read text and type.

**Design Task THREE:** *(Braille-Text-Braille)* - Braille from *B* can be encoded and sent to *D* as text and she can read and reply text to *B* that is decoded to Braille again.

**Design Task FOUR:** *(Braille-Sign-Braille)* – Braille from *B* can be encoded and sent to *D* and played by the avatar to mimic the sign (ASL) to *D*, and finally *D* replays by sign, that is encoded to Braille and send back to *B*.

Other preferable design with training: B may text with audio feedback and D may text reply. B may use Braille display and Braille and D may use Signing (ASL) display to understand the message. Due to less popularity evaluation of other design strategies are skipped.

After each design discussion they are asked to answer usability questioners based on Nielsen's usability metrics (scored as 0-7 scale). All participants are also interviewed (allowed to critic) on three cognitive load points (intrinsic load, extraneous load and germane load). These critical incidences are processed to find inherent causes and used to estimate qualitative cost of sensemaking.

Table 3: Nielsen's five usability criteria with cognitive load

| **Question category** | **Question** |
|---|---|
| Intrinsic load and Memorability | How difficult was the experiment instruction content for you? |
| Extraneous load and Learnability | How difficult was it for you to learn with the instruction format? |
| Germane load and efficiency | How much did you concentrate during experiment? |
| Errors | What do you think about the chances of errors during the experiment? |
| Satisfaction | How pleasant are you to participate in this experiment and to use the design? |

# 4. RESULTS

Results obtained through the three way of processing are explained in this section.

## 4.1 Usability Measures

Usability scores are obtained based on Nielsen's usability metrics (Table 4). Statistical mean and standard deviation are computed.

**Table 4: Usability scores**

| **Nielsen's Usability metrics** | **Design ONE** | | **Design TWO** | | **Design THREE** | | **Design FOUR** | |
|---|---|---|---|---|---|---|---|---|
| | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** |
| ***Memorability*** | 5.25 | 2.06 | 7.12 | 1.10 | 7.25 | 2.75 | 5 | 2.58 |
| ***Learnability*** | 5.75 | 2.06 | 5.4 | 1.15 | 8.3 | 1.82 | 5 | 2.16 |
| ***Efficiency*** | 8.25 | 2.36 | 9.15 | 1.24 | 8.01 | 1.41 | 6 | 2.16 |
| ***Errors*** | 6.75 | 1.5 | 9.45 | 1.104 | 7.2 | 1.41 | 6.25 | 1.5 |
| ***Satisfaction*** | 9.5 | 1.02 | 5.04 | 1.14 | 7.25 | 2.45 | 6.5 | 2.38 |

A one-way repeated measure ANOVA was conducted to compare the effect of design types on the usability scores. There was a significant effect of design type speech based system lambda = 0.10, F (2,3) =13.43, p = 0.032. Four paired sample t-test was used to make post hoc comparison between conditions. The first paired sample t-test indicate that there was a significant difference in the score of satisfaction (M = 5.04, SD = 1.14) and efficiency (M=9.15, SD =1.24) conditions, t(4) = -5.67. A second paired sample t-test indicate that there was a significant difference in the scores for learnability (M =5.4, SD=1.15) and memorability (M=7.12, SD =1.10) scores, t(4) = -4.781, p =.009. The third paired sample t-test indicates that there was no significance difference in the score of memorability (M =7.12, SD =1.10) and error (M=9.45, SD=1.104) scores, t(4) =-3.75, p =.02. The fourth paired sample t-test also indicates no significant difference on error (M=9.45,SD=1.04) and efficiency (M =9.15, SD=1.14) scores, t(4) = -2.23, p=.024.

## 4.2 Conversation Flow Diagram Comparison

Communication flow diagrams (CFDs) are mostly data flow diagrams (DFDs) [20,21] useful to maps conversation scenario with entities, processing and flow lines. Unlike, traditional data flow diagrams, CFDs map four key parts to a conversation, telling, asking, listening and thinking. In broad sense, telling can be considered as speaking, showing, sending or writing; listening as seeing, receiving; asking as requesting, questioning; thinking as understanding, waiting etc. Thus, processing modules can be considered as of four categories and can be shown by different colors telling (yellow), asking (red), listening (green) thinking (blue). In this research, participants CFDs are compared to understand problematic interactions. Qualitative measures considered: number of entities used for particular task, number of processing needed, number of different processing modules, if there is any loops in data flow, number of loops and their nature (locked/not) mental model. Subjective cognitive processing capability, Miller's magic number 7+-2 may also be applied to check abnormal interactions. A sample CFDs of communication between Doris and Debra with design task TWO are drawn in figure 11.

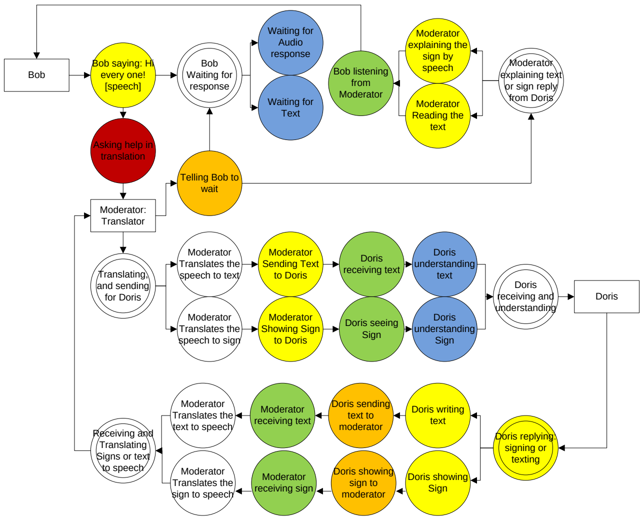



Figure 12: Conversation flow diagram between Bob and Doris: telling/saying/speaking/showing/writing (yellow), asking (red), receiving/listening (green) thinking/waiting/understanding (blue).

## 4.3 Sensemaking Cost Comparison

In case of disability in communication, due to psychological inconsistency and physical (sensory) impairment participants sometimes fail to infer others' thought process (theory of mind concept), the gap increases instead of sensemaking. Therefore, analysis of a faster communication media over mobile phone network is important. If a task is in same mode (without translation), takes less cost for finding a representation schema to support the required operators in the target task, therefore $C_{FR}$ score is considered low in same mode. FR score corresponds with germane cognitive load of participants. Low FR score means low germane load. Translation tasks, make the process slower, increase complexities in instantiating the encodons, and finding data to create the encodons, including both finding the documents and selecting the information increases the costs $C_{IE}$, $C_{FD}$ respectively. IE score is analogous to intrinsic cognitive load whereas the FD corresponds to extraneous cognitive load. According to post-subjective critic, design having translation in any end, increases time complexities, treated as moderate or higher costly design to subject. Table 5 summarizes a comparison of the different task setting communication with approximate sensemaking cost in qualitative scale (Low, Moderate and High scale).

Table 5: Design comparison in terms of gap model and cost model

| Design Type | Communication type (Bob-Doris-Bob) | Sensemaking Cost (Bob) | Sensemaking Cost(Doris) |
|---|---|---|---|
| **ONE** | Speech-text-speech | Moderate | Moderate |
| **TWO** | Speech-Sign-Speech | Low | Low |
| **THREE** | Braille-Text-Braille | Low | High |
| **FOUR** | Braille-Sign-Braille | Moderate | Low |

## 5. CONCLUSION

Sensemaking is the one of the major determinants of effectiveness in disability communication assessment. Each individual (with speech or vision impairment conceives the environment (situation) in different ways and very often the communication framework become incompatible in communication and collaboration. It was observed that cognitive gap based disability model with cost structure of sensemaking model can be useful for evaluating assistive App based solutions for disability communication tools and can facilitate collaborative sensemaking in distributed teams. As of now, they communicate through multiple devices and translators. The proposed smart phone based systems will reduce difficulties in communication. The research is being conducted on limited targeted users due to the lack and access to such population. In the future, detailed usability and specific problems in distant communication will be included.

## 6. ACKNOWLEDGMENTS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