



**UT-YCC**

# **Two Fingerspelling Keyboard Layouts for Myanmar Sign Language with Myanmar Sign Writing**



**OpU**

*Sign Writing Symposium 2018*

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- Nandar Win Min

# Outlines of Presentation

- Introduction
- Contributions
- Objectives
- Myanmar Sign Language
- SignWriting
- Fingerspelling Keyboard Layouts for MSW
- Evaluations
- Discussion
- Conclusion
- References

# Introduction

- Myanmar deaf people mainly use Myanmar Sign Language (MSL) as an essential communication language among them.
- They have difficulties in relation to written languages with orally spoken words.
- SignWriting is used for writing sign language in other countries for their deaf people.
- There is no Myanmar language specific SignWriting text editor for Myanmar Deaf society yet.

# Introduction (Cont'd)

- SignWriting will be useful for Deaf children education and documentation of sign language literature in Myanmar.
- In the our paper, two fingerspelling keyboard layouts was proposed, one is based on pronunciation of Myanmar characters and another is based on the shapes of SignWriting symbols.
- A user study with both hearing-impaired and hearing users was conducted and the comparisons are made between two keyboard layouts in terms of CPM and Likert scale feedbacks.

# Contributions

- This system is the **first SignWriting text input interface** for Myanmar fingerspelling characters with SignWriting
- **Building Myanmar SignWriting dictionary** will be useful for future researchers who want to do researching about SignWriting and Myanmar Sign Language

# Objectives

- To develop Myanmar SignWriting Dictionary for Myanmar Sign Language
- To implement Myanmar SignWriting Text Input Interface
- To provide writing system for Myanmar Deaf people
- To improve the quality of Deaf Education in Myanmar

# Schools for the Deaf in Myanmar

- Four Schools for the deaf in Myanmar:
  1. Mary Chapman School for the Deaf in Yangon (est. 1904)
  2. School for the Deaf, Mandalay (est. 1964)
  3. Immanuel School for the Deaf in Kalay (est. 2005)
  4. School for the Deaf, Tarmwe Yangon (est. 2014)
- In Myanmar, sign languages used in each region are not the same.

# Myanmar Sign Language (MSL)

- MSL that Myanmar Deaf people use is also different with Myanmar language in grammatical structure.

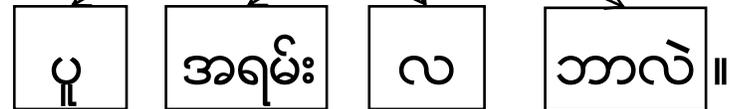
Example:

**Myanmar Written Language:**



(“What is the hottest month ?” in English)

**Myanmar Sign Lanugae:**



# Myanmar Sign Language (Cont'd)



Yangon Sign of  
'Mathematics'



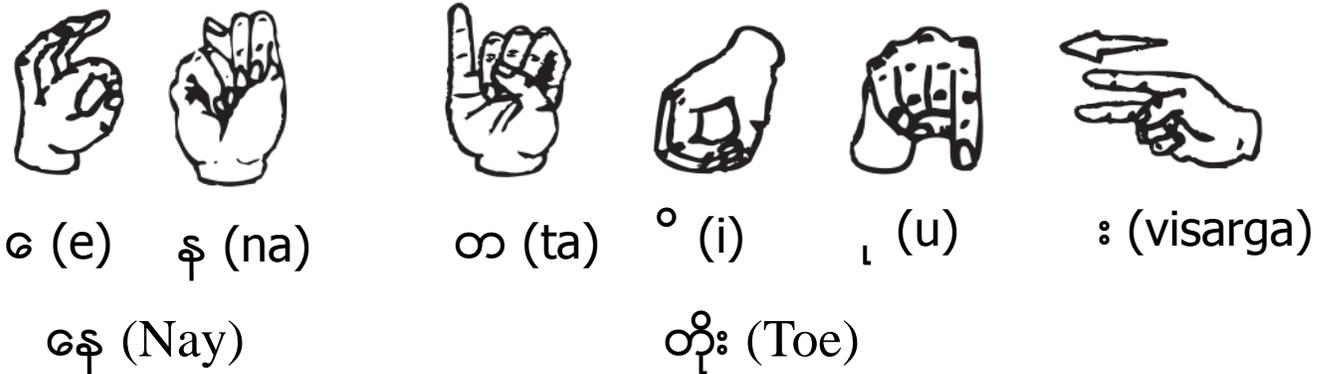
Mandalay Sign of  
'Mathematics'

Figure 1. Example of MSL Difference between Yangon and Mandalay

# Myanmar Fingerspelling

- It is the basic language of sign language for Myanmar deaf people.
- It can be used to represent Myanmar consonant, vowel, and numbers with hands.
- It is used for signing names, city names and words that are not existing in sign language.

▪ Example:



# Myanmar Fingerspelling (Cont'd)

- Some of Myanmar fingerspelling characters can be seen as follows:

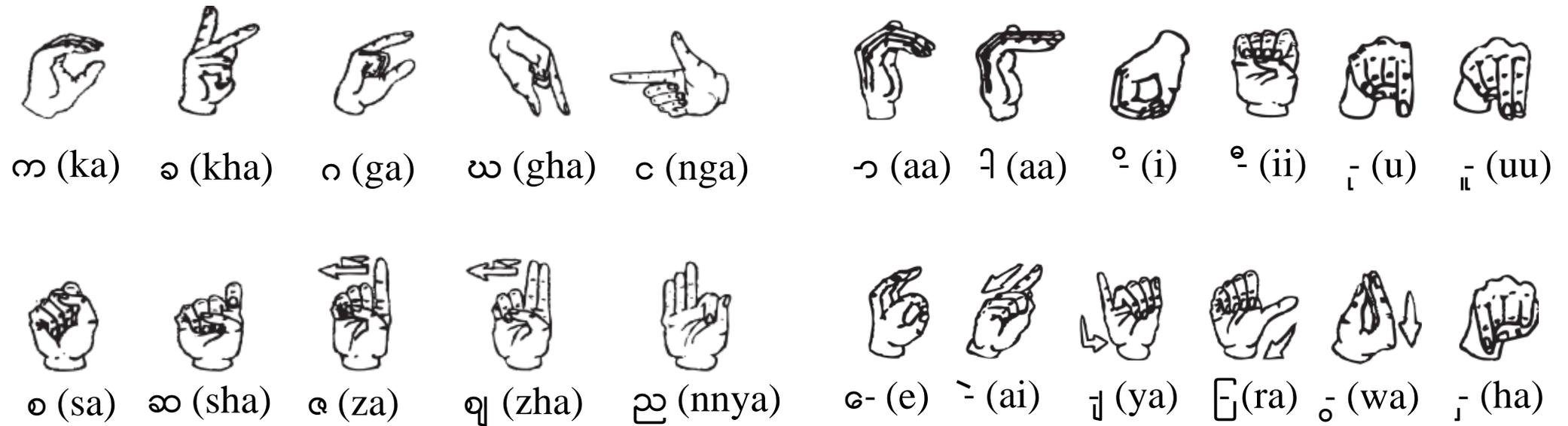


Figure 2. Some of MSL Fingerspelling for Myanmar Consonant and vowel

# Myanmar Fingerspelling (Cont'd)

- There are two different fingerspelling character sets for Myanmar language.
  1. One is used in southern Myanmar
    - e.g. used at “Mary Chapman School for the Deaf”, Yangon city
  2. The another is used in northern Myanmar
    - e.g. used at “Mandalay School for the Deaf”, Mandalay city
- They are similar in consonant but mainly different in vowel, medial and symbols.
- In our paper, fingerspelling character set recognized as a standard in 2007 is used for designing two SignWriting keyboard layouts.

# Myanmar Fingerspelling (Cont'd)



Yangon Sign of  
'  (Ya)'

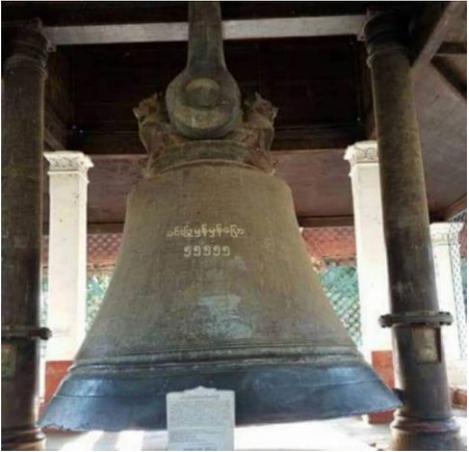


Mandalay Sign of  
'  (Ya)'

Figure 3. Example of Myanmar Fingerspelling Difference between Yangon and Mandalay

# Classifier (CF)

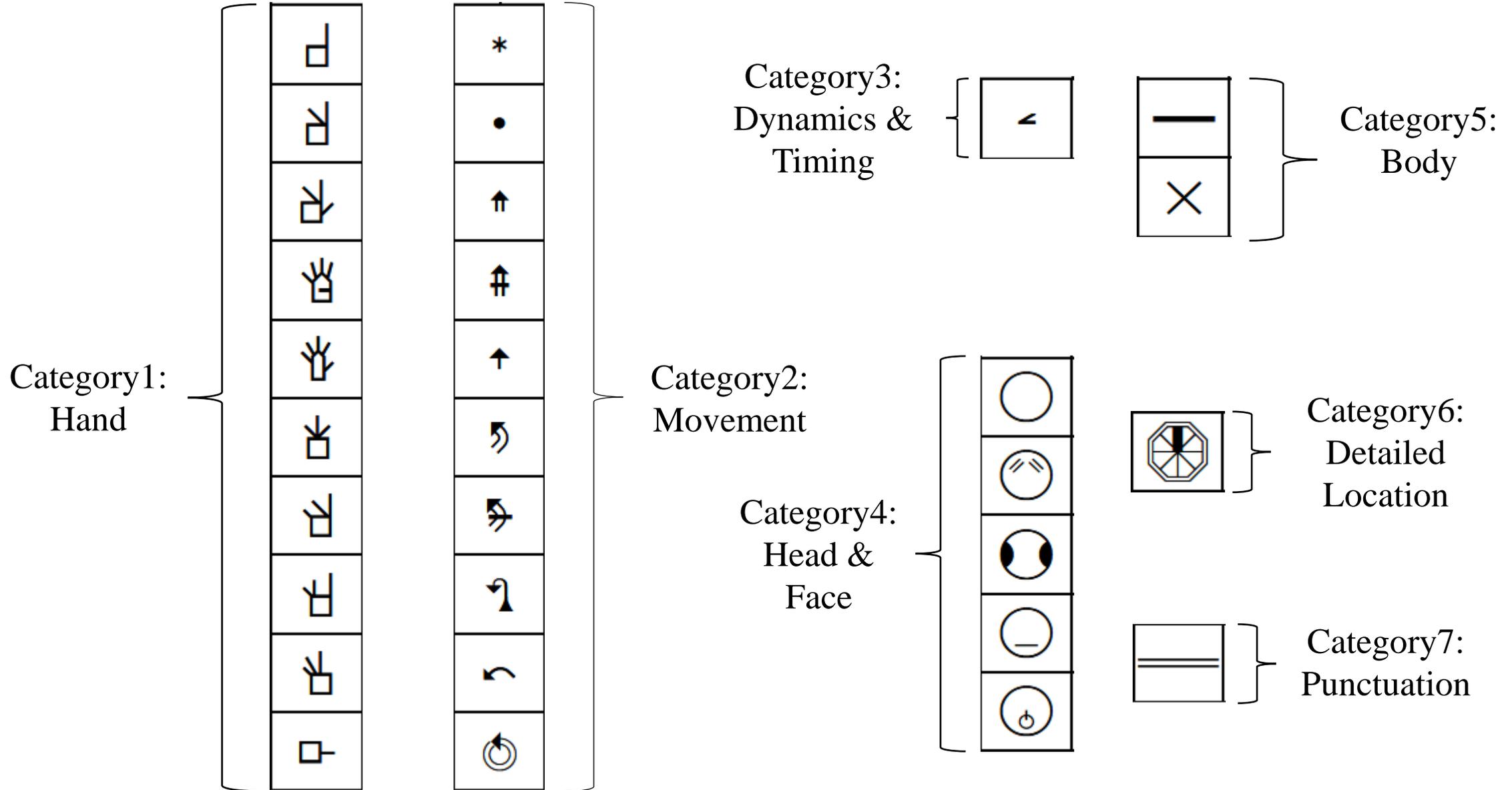
- One of Myanmar sign language that expresses sign according to the figures of objects
- Example:

<p><b>Min Guon</b></p>		
<p><b>Inn Lay</b></p>	 <p><small>Joe Mye (Arr Mam Thin)</small></p>	

# SignWriting

- In the 1974, Valerie Sutton invented for deaf people to write and read sign languages.
- It is becoming the written form for sign language in over 40 countries.
- There are two view-points: the **signer's viewpoints** and the **addressee's viewpoints**.
- There are two main perspectives: **front** and **top**.
- International SignWriting Alphabet (ISWA) includes all symbols used to write the handshapes, movements, facial expressions, and body movements.

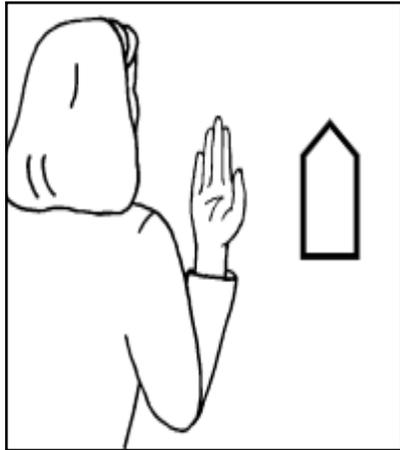
# 7 Categories and 30 groups of SignWriting Symbols



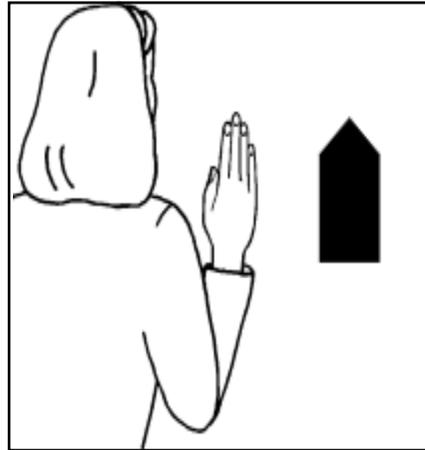
# SignWriting (Cont'd)

- **Hand Orientation** is also important

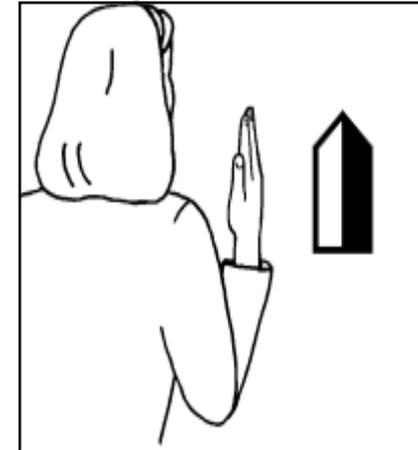
The Palm



The back of the hand



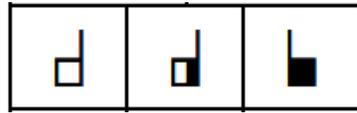
The side of the hand



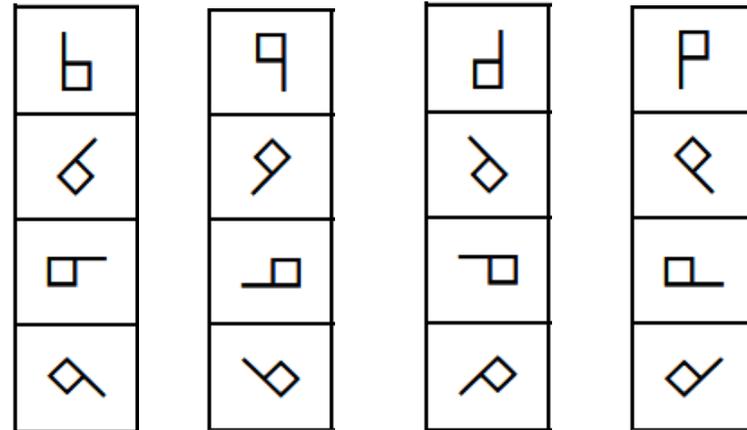
# Sign Writing (Cont'd)

- Each basic symbol can have

➤ **3** different fillings



➤ **16** different spatial rotations



- There are almost 35,023 symbols with various conditions

# SignWriting (Cont'd)

- Each symbol is defined with corresponding **Unicode** value.
- Sutton Unicode block is U+1D800 to U+1DAAF including Unicode value for **fill modifiers** and **rotation modifiers**:

➤  = U1D800

➤  = U1D801

➤  = U1D802, and so on.....

# Challenges

- We are considering to propose a user-friendly Myanmar SignWriting text input interface
- The main challenge is how to organize or grouping many SignWriting symbols for Myanmar SignWriting
- So as a first step, we only focus on typing Myanmar fingerspelling characters with SignWriting

# Fingerspelling Characters with SignWriting

- Some of Myanmar fingerspelling characters with SignWriting symbols can be seen as follows:

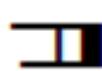
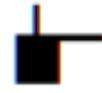
Myanmar Characters	မ	ခ	ဂ	ဃ	င	ဆ	ဇ	ဇ	ဇ	ဇ	ဇ
Myanmar Fingerspelling											
SignWriting											

Table1. SignWriting for Some of MSL Fingerspelling Consonant and vowel

# Two Fingerspelling Keyboard Layouts for MSW

- In the proposed paper, two Myanmar fingerspelling keyboard layouts for Myanmar SignWriting are implemented.
- Typing SignWriting symbols are different with typing Myanmar characters.
- To type a SignWriting symbol, at least two keys (i.e. symbol modifier and fill modifier keys) are needed to press.
- The typing order is **symbol key**, **filling key** and **rotation key**.

# Two Fingerspelling Keyboard Layouts for MSW (Cont'd)

- Example of typing Myanmar word with SignWriting symbol is as follows:

Myanmar Words	ကလေးငယ်	က	လ	ေး	င	ယ	ယ်	်
Myanmar Fingerspelling	-							
Myanmar SignWriting	Symbol							
	Filling							
	Rotation	-	-	-				-

Table2. Example of typing Myanmar word 'ကလေးငယ်' (Children in English) with SignWriting

# Two Fingerspelling Keyboard Layouts for MSW (Cont'd)

- These keyboard layouts were implemented for Linux or Unix like operating system computers using X Keyboard Extension (XKB).
- The XKB is a part of the X Window System that extends the ability to control the keyboard and provides access to internal translation tables of keyboard codes.
- In our paper, TrueType font of Sutton SignWriting built with the SignWriting 2010 Tools was used to display Myanmar fingerspelling characters with SignWriting.

# Phonetic-based Keyboard Layout for Myanmar SignWriting

- The mapping of Myanmar characters on English QWERTY keyboard based on their phonetic similarities with English characters such as
  - Symbol of “က” (Ka) on k key
  - Symbol of “ဂ” (Ga) on g key
  - Symbol of “စ” (Ca) on s key
  - Symbol of “ဆ” (Cha) on S (Shift + s) key and so on
- The concept is same with the kKg (ကခဂ) Myanmar keyboard.

# Phonetic-based Keyboard Layout for Myanmar SignWriting (Cont'd)

- Most of the SignWriting symbols for fingerspelling characters are same shapes such as “” (Ga) and “” (Gha), “” (Nga) and “” (La) etc.
- Every fingerspelling character are not needed to map on the keyboard.
- Some Myanmar fingerspelling characters are mapped on English keys based on the similar shape of characters
  - Example: Myanmar consonant "c" (Nga) is mapping to English small c key

# Phonetic-based Keyboard Layout for Myanmar Sign Writing (Cont'd)

- The phonetic-based keyboard layout for MSW can be seen as follows:

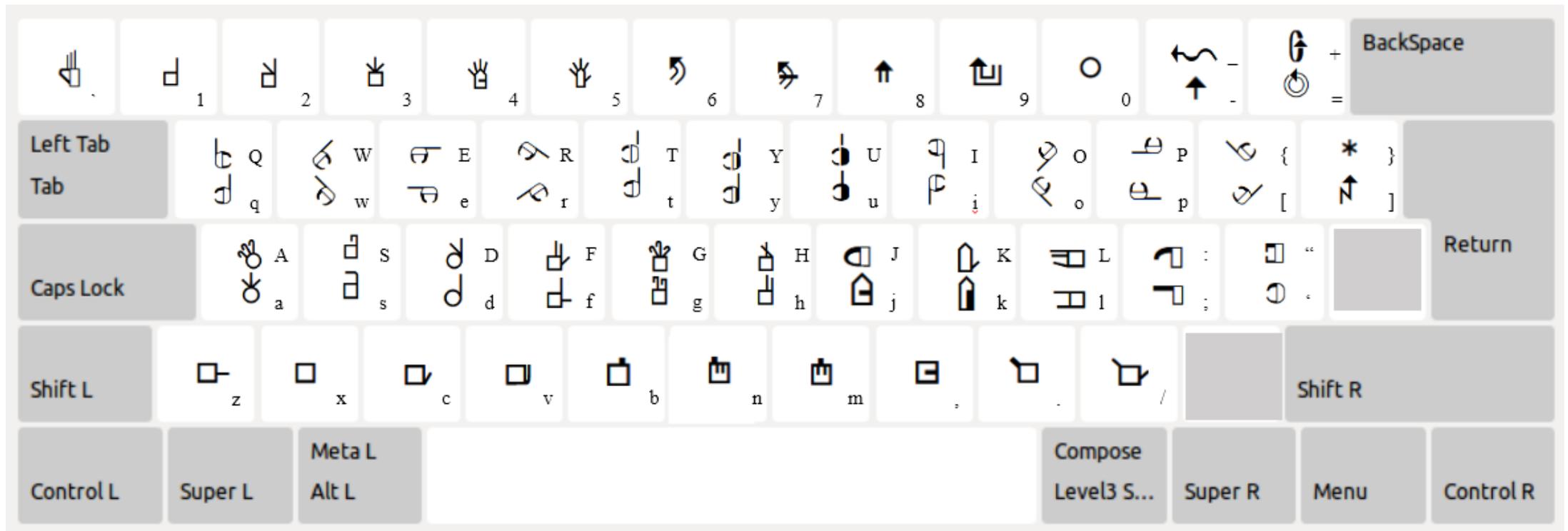


# Symbol-based Keyboard Layout for Myanmar SignWriting

- The mapping is based on the shape similarities of SignWriting symbols.
- MSW symbols are grouped by the shape of the symbols.
- Example: the same shape  and  are mapped on s key and S (shift + s) key,  and  symbols are on d key and D (shift + d) key, respectively and so on.
- Thumb group of SignWriting symbols such as “” (Le gaung), “” (Ca), “” (a) are mapped on the bottom row keys of QWERTY keyboard layout.
- This keyboard mapping concept might be difficult for the first-time users who are unfamiliar with Myanmar fingerspelling and SignWriting symbols.

# Symbol-based Keyboard Layout for Myanmar SignWriting (Cont'd)

- The symbol-based keyboard layout for MSW can be seen as follows:



# Methodology

- For User study,
  - Participants → 19 volunteer participants (9 males and 10 female)
  - Two types of users → Hearing-impaired users and  
Hearing users
  - Location → School for the Deaf, Mandalay
- None of them had prior experience with SignWriting symbols for Myanmar fingerspelling characters.

# Methodology (Cont'd)

- The printouts of the two keyboard layouts and three SignWriting poems (parallel sentences with Myanmar language) was provided.

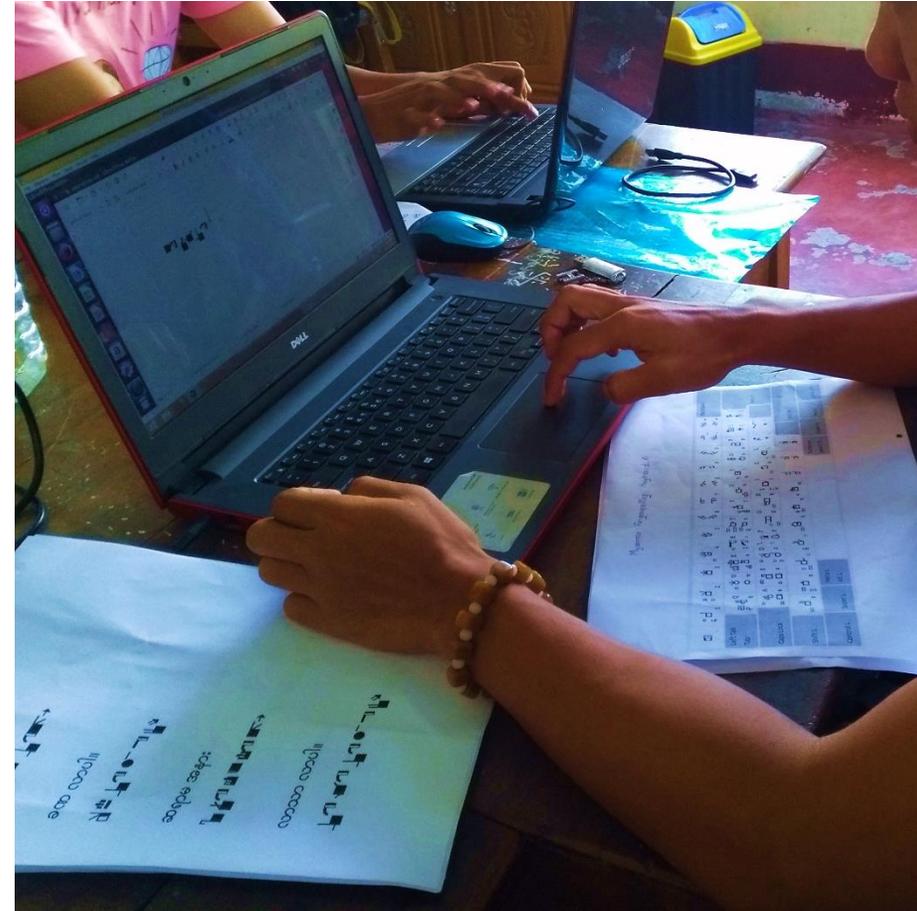


Figure 4. Experimental Environment with hearing-impaired users

# Methodology (Cont'd)

- Three poems from Myanmar language Primary School textbook were selected for user study.
- They cover most combination patterns of vowels and medials with a consonant.
- One of three poems is as follows:

- စာရသလား      
- ခဏလာပါ။      
- ဆရာမအနား      
- လာ သာ လာပါ။      

# Procedures of User Experiment

1. About SignWriting and two keyboard layout mapping concepts are introduced to all participants.
2. How to type Myanmar SignWriting characters for all Myanmar consonants (characters Ka to A) are demonstrated.
3. All Myanmar consonants (characters Ka to A) are allowed to practice typing for two times to get some level of understanding on two keyboard layouts.
4. Typing speed of all participants for each poem for 10 times are recorded.
5. Participants are made discussion and their feedbacks, suggestions and comments are collected.

# Procedures of User Experiment (Cont'd)



Figure 5. Experimental Environment with hearing-impaired users

# Typing Speed Evaluation

- To measure the typing speed of participants, **Character per Minute (CPM)** is used.
- The formula of CPM is as follows:

$$CPM = \frac{|T| - 1}{S} \times 60$$

where,

- $|T|$  = length of string
- T may contain SignWriting Symbols
- S = seconds spent from the entry of the first character to the last

# CPM Evaluation Results of Hearing-impaired Users

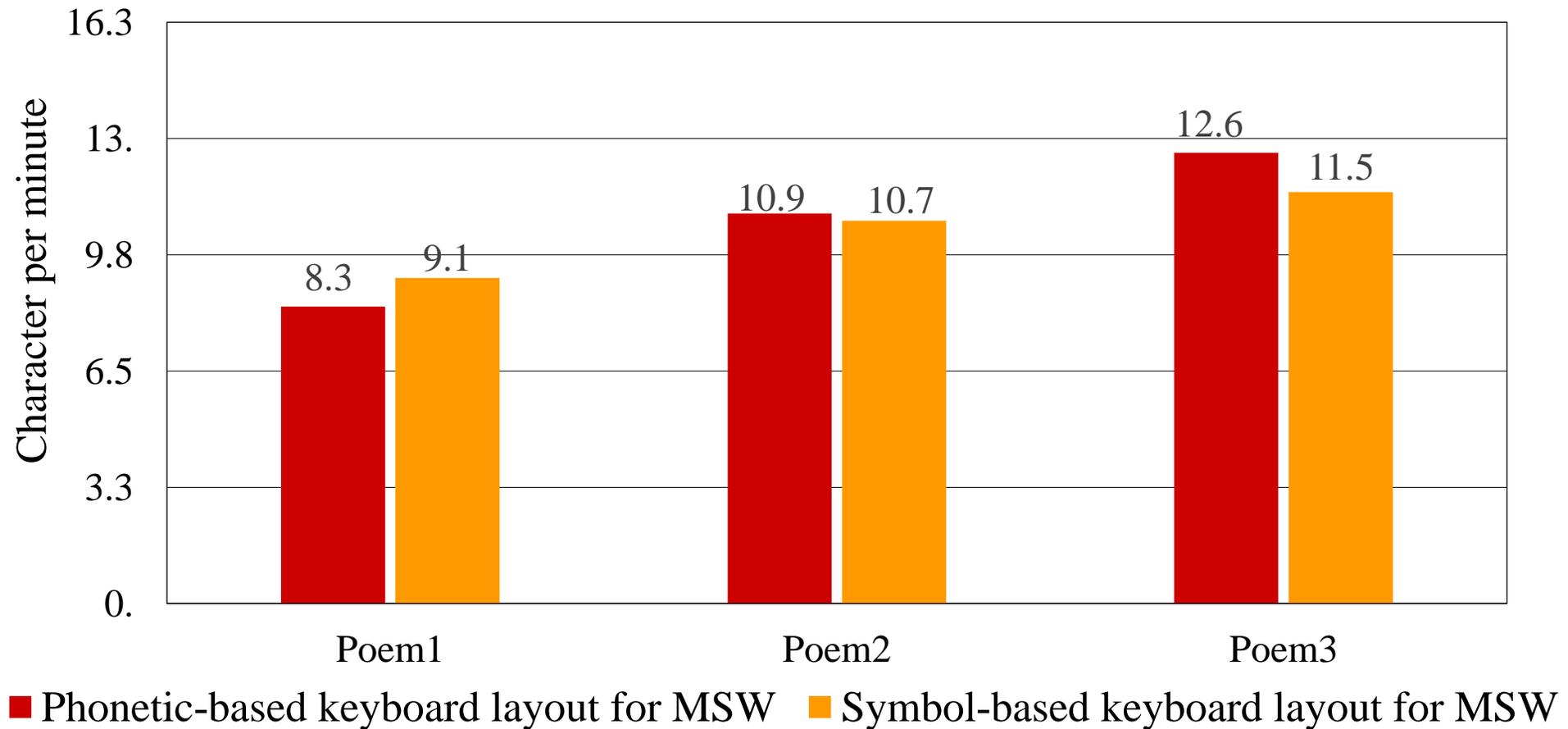


Figure 6. Average CPM of hearing-impaired participants' typing for three poems with both two fingerspelling keyboard layouts for MSW

# CPM Evaluation Results of Hearing Users

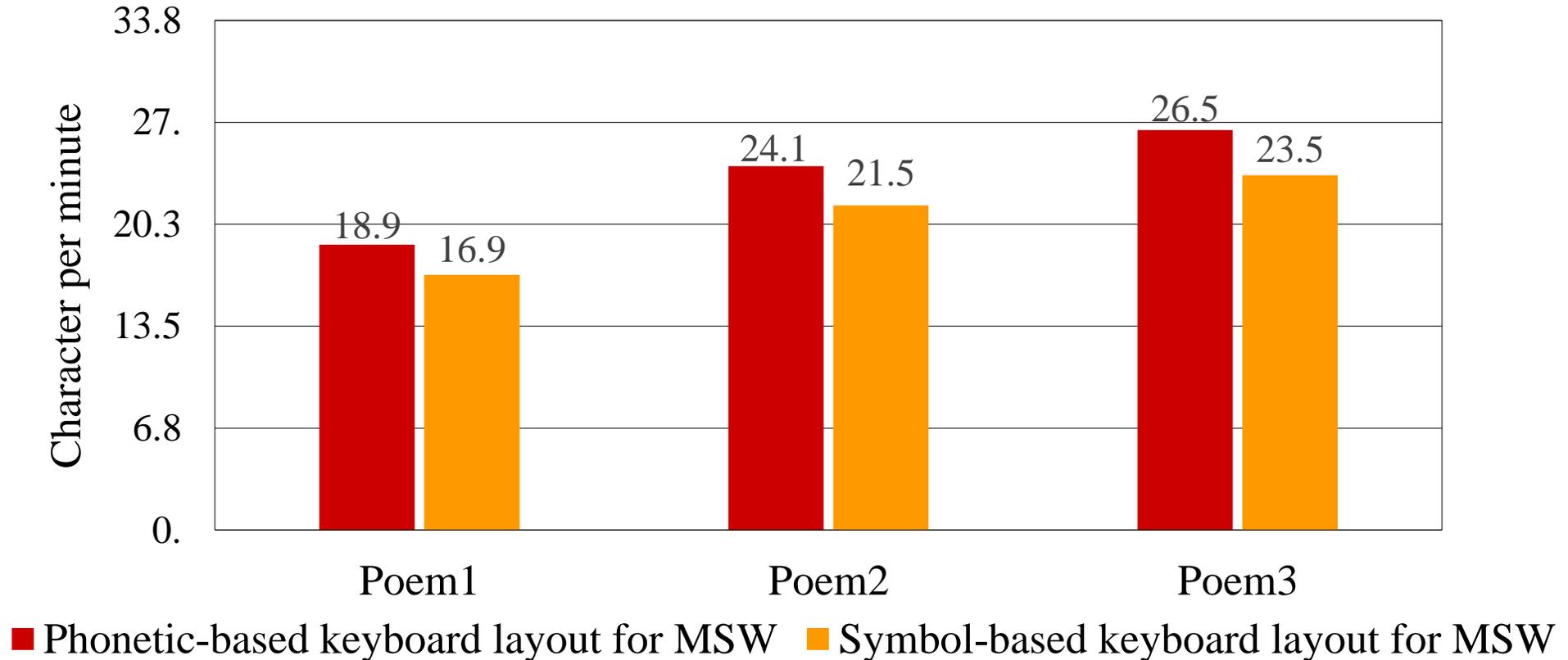


Figure 7. Average CPM of hearing participants' typing for three poems with both two fingerspelling keyboard layouts for MSW

# Comparison of CPM Values of Two Users

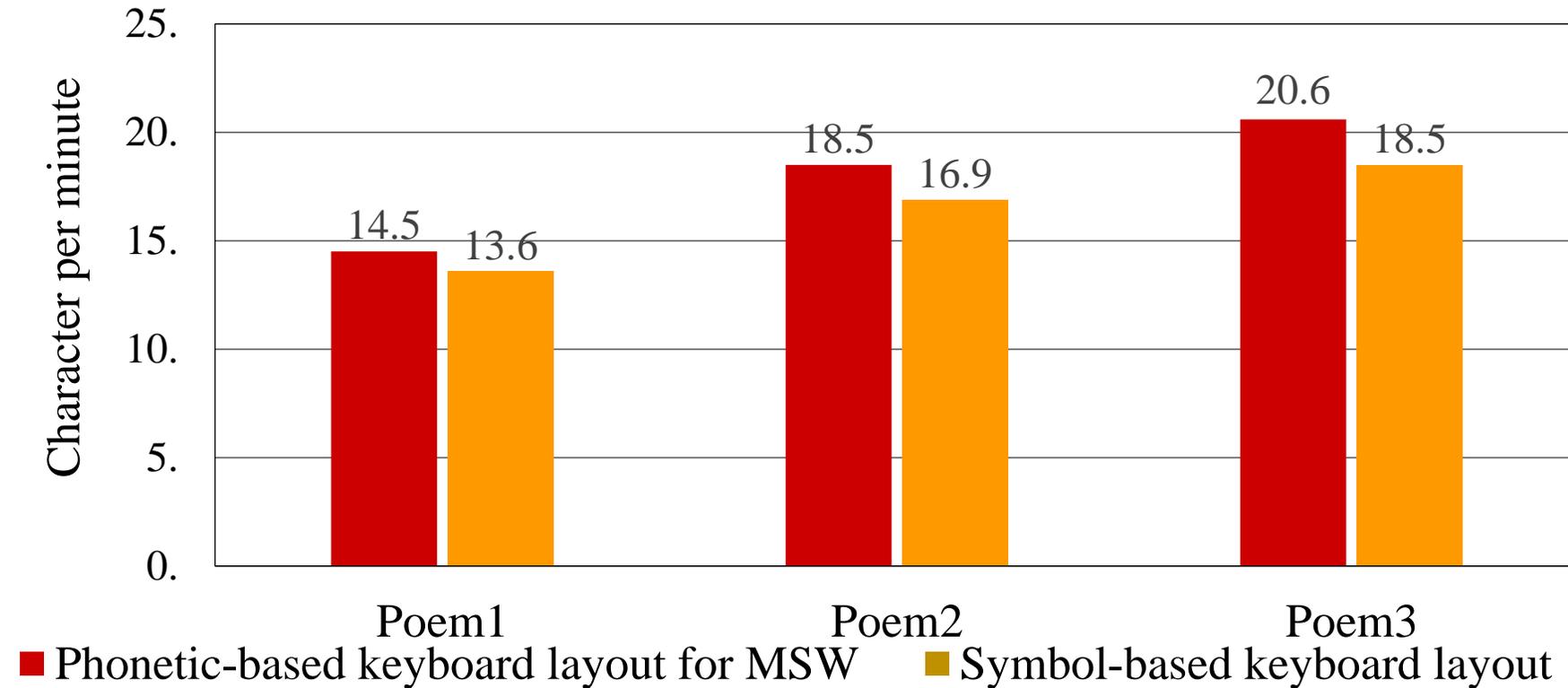


Figure 8. Average CPM typing speed of two types of participants: hearing-impaired and hearing participants for three poems with both two fingerspelling keyboard layouts

# Likert Scale Evaluation

- Questionnaires were taken to the participants in order to get their comments and suggestions on that keyboard layout.
- The questions are:
  1. Do you have any experience of using personal computer?
  2. Are you familiar with one of the existing Myanmar PC keyboard layout?
  3. Can be skillfully used QWERTY keyboard layout?
  4. Which keyboard layout is the best suitable to use in real time?
  5. Do you have any comments or suggestions?

# Likert Scale Evaluation (Cont'd)

- Four Likert scales (1 to 5) are made to rate the user-friendliness of two fingerspelling keyboard layouts for Myanmar Sign Writing.
- The scales are:
  1. Difficult-easy
  2. Slow-fast
  3. Dislike-like
  4. Impossible-possible
- Likert scales value 1 is the most negative, 3 is neutral and 5 is the most positive.

# Likert Scale Evaluations Results

- The average or arithmetic mean results of Likert scale questions to hearing-impaired users and hearing users can be seen as follows:

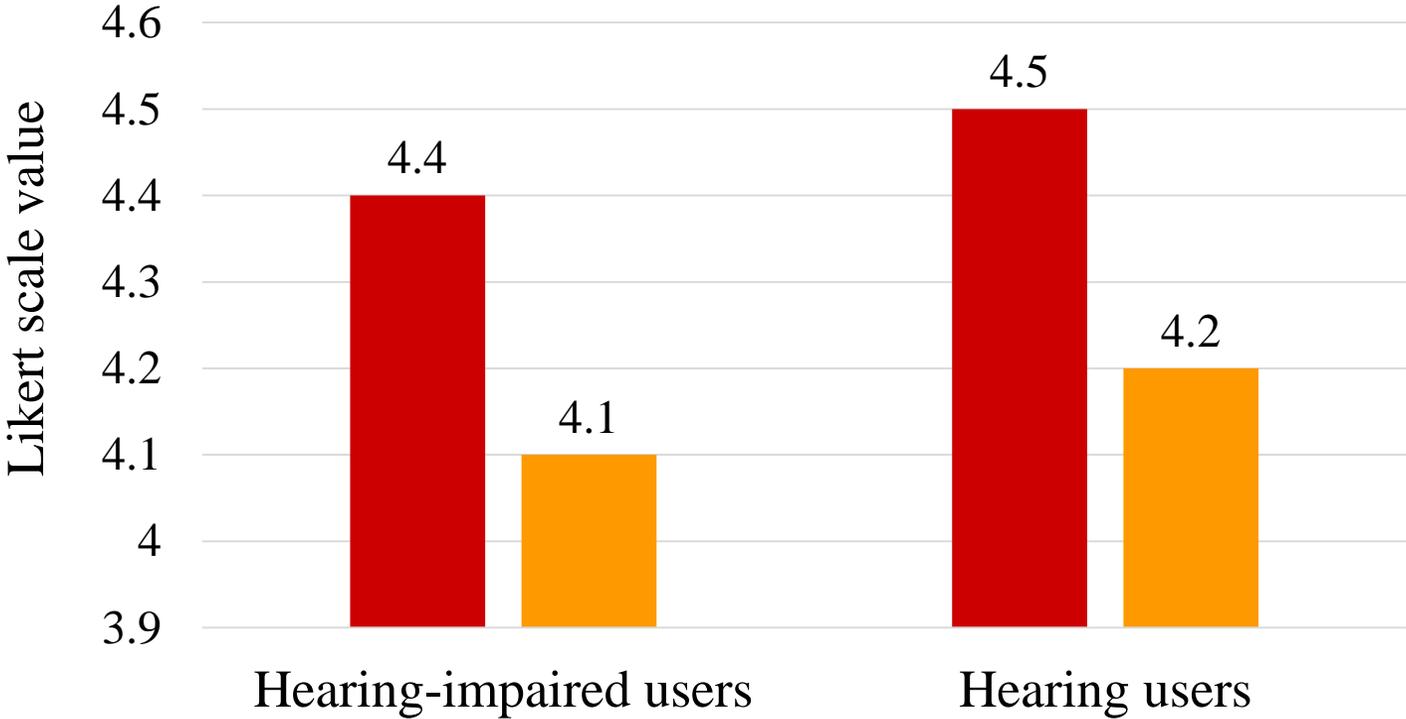
Likert scales	Phonetic-based keyboard layout for MSW	Symbol-based keyboard layout for MSW
Difficult-Easy	4.3	4.1
Slow-Fast	4.3	3.9
Dislike-Like	4.5	4.3
Impossible-Possible	4.4	4

Table 3. Evaluation by hearing-impaired users

Likert scales	Phonetic-based keyboard layout for MSW	Symbol-based keyboard layout for MSW
Difficult-Easy	4.5	3.7
Slow-Fast	4.1	4.1
Dislike-Like	4.4	4.5
Impossible-Possible	4.8	4.6

Table 4. Evaluation by hearing users

# Comparison of Likert scale Evaluation Results



■ Phonetic-based keyboard layout for MSW ■ Symbol-based keyboard layout for MSW

Figure 9. Comparison of Likert scale evaluation results for both two fingerspelling keyboard layouts for MSW

# Discussion

- Experiment was made with 8 hearing-impaired users and 11 hearing users.
- Hearing users achieved maximum typing speed 26.5 CPM with phonetic-based keyboard and 23.5 CPM with symbol-based keyboard.
- Hearing-impaired users achieved 12.6 CPM with phonetic-based keyboard and 11.5 CPM with symbol-based keyboard.
- The results of two users are very different because of hearing-impaired users are not familiar with computer keyboard but the results of two keyboard layouts are not significantly different.

## Discussion (Cont'd)

- From the evaluations in terms of both CPM and Likert scale, both of the keyboard layouts are applicable for typing Myanmar fingerspelling SignWriting.
- Based on users' comments, suggestions and Likert scale values, phonetic-based keyboard layout is more flexible to use for both users.

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# Conclusion

- This research introduced the first study of Myanmar SignWriting and the Myanmar SignWriting text input interface system of Myanmar sign language for Myanmar deaf society.
- Reading and writing Myanmar sign languages with SignWriting are effective in Deaf Education and communicating with each other.
- In our paper, two fingerspelling keyboard layouts for Myanmar SignWriting: **phonetic-based and symbol-based keyboard layouts** have been proposed.

## Conclusion (Cont'd)

- Among two fingerspelling keyboard layouts, the **phonetic-based keyboard layout** is more flexible to use for both hearing-impaired users and hearing users based on the results of experiments.
- Two-fingerspelling keyboard layouts were shared with the public via GitHub, and can be downloaded and used on your Ubuntu desktop computer.  
(<https://github.com/ye-kyawthu/MyanmarSignWriting-Fingerspelling-Keyboards>)
- The future work is the implementation of SignWriting Text Input Interface for Myanmar Deaf people to write Myanmar sign language.

# Reference

1. “Myanmar Sign Language Dictionary (Vol:1)”, Mandalay School for the Deaf, 2007
2. “Text book of Speaking and Myanmar Sign Communication”, Mary Chapman School for the Deaf, 1988
3. “Text book of Primary Myanmar”, Mandalay School for the Deaf
4. MacKenzie, I. S. and Aleks Oniszczyk, “A Comparison of Two Input Methods for Keypads on Mobile Devices”
5. Valerie Sutton and Adam Frost: Manual book about SignWriting Hand Symbols in the International SignWriting Alphabet 2010
6. Ye Kyaw Thu†, Sai Aung Win Maung‡ and Yoshiyori Urano†: Direct Keyboard Mapping (DKM) Layout for Myanmar Fingerspelling Text Input
7. Sutton SignWriting, Unicode Standard, 10.0
8. <https://en.wikipedia.org/wiki/SignWriting>
9. <https://en.wikipedia.org/wiki/SignLanguage>
10. <https://github.com/ye-kyaw-thu/kKg-Myanmar-keyboard/>

# List of Publications

- Swe Zin Moe, **Hlaing Myat Nwe**, Hnin Wai Wai Hlaing, Ye Kyaw Thu, Hnin Aye Thant, Nandar Win Min, “Myanmar Sign Language (MSL) Corpus for Emergency Domain”, PACLING2017 conference, Yangon, Myanmar. (Demo and Poster)
- Swe Zin Moe, Ye Kyaw Thu, **Hlaing Myat Nwe**, Hnin Wai Wai Hlaing, Ni Htwe Aung, Hnin Aye Thant, Nandar Win Min, “Corpus Building for Machine Translation between Myanmar Sign Language and Myanmar Written Text”, World Deaf Day 2017, 14<sup>th</sup> Sept. 2017, Mandalay Community Center, Chan Aye Tharzan Township, Mandalay, Myanmar. (Poster)
- Swe Zin Moe, Hnin Wai Wai Hlaing, Ye Kyaw Thu, **Hlaing Myat Nwe**, Ni Htwe Aung, Hnin Aye Thant, Nandar Win Min, “မြန်မာ လက်သင်္ကေတပြဘာသာစကားမှ မြန်မာစကားပြောစာကြောင်းသို့ ကွန်ပျူတာသုံး ဘာသာပြန် သုတေသန”, International Day of Persons with Disabilities 2017, 3<sup>rd</sup> Dec. 2017, Wilson Hotel, No.31(E), Yangon-Mandalay Main Road, Maha Aung Myay Township, Mandalay, Myanmar. (Demo and Poster)
- **Hlaing Myat Nwe**, Ye Kyaw Thu, Hnin Wai Wai Hlaing, Swe Zin Moe, Ni Htwe Aung, Hnin Aye Thant, Nandar Win Min, "Two Fingerspelling Keyboard layouts for Myanmar SignWriting", International Day of Persons with Disabilities 2017, 3<sup>rd</sup> Dec. 2017, Wilson Hotel, No.31(E), Yangon-Mandalay Main Road, Maha Aung Myay Township, Mandalay, Myanmar. (Demo and Poster)

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- **Hlaing Myat Nwe**, Ye Kyaw Thu, Hnin Wai Wai Hlaing, Swe Zin Moe, Ni Htwe Aung, Hnin Aye Thant, Nanda Win Min, "Two Fingerspelling Keyboard Layouts for Myanmar SignWriting", In Proceedings of ICCA2018, February 22-23, 2018, Yangon, Myanmar, pp. 290-298. (Paper)
- Swe Zin Moe, Ye Kyaw Thu, Hnin Wai Wai Hlaing, **Hlaing Myat Nwe**, Ni Htwe Aung, Hnin Aye Thant, Nandar Win Min, "Statistical Machine Translation between Myanmar Sign Language and Myanmar Written Text", In Proceedings of ICCA2018, February 22-23, 2018, Yangon, Myanmar, pp. 217-227. (Paper)
- Hnin Wai Wai Hlaing, Ye Kyaw Thu, Swe Zin Moe, **Hlaing Myat Nwe**, Ni Htwe Aung, Nandar Win Min, Hnin Aye Thant, "Statistical Machine Translation between Myanmar Sign Language and Myanmar SignWriting", at the First International Symposium on Artificial Intelligence for ASEAN Development, ASEAN-AI2018, Phuket, Thailand, 26<sup>th</sup> March 2018. (Paper)

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# Thank You

