An accessible STEM editor customizable for various local languages

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Abstract

Purpose – *The purpose of this paper is to facilitate the spread of accessible e-books, especially ones of STEM much more in developing countries, an efficient/systematic scheme to localize tools for producing/reading them should be established. Furthermore, even in many advanced countries, Print-disabled people still do not have a good tool to write a content including technical notations such as mathematical formulas in their own local language. This work is aimed at giving a practical solution for those problems.*

Design/methodology/approach – *Here, multilingual support in a tool to produce accessible STEM contents and its new localization scheme are discussed.*

Findings – *It is shown that the accessible STEM-document editor can be customized easily for print-disabled people so that they can read and author a material including complicated technical notations in their own local language. The localization for Vietnamese and other various languages actually has been worked on.*

Originality/value – *The Vietnamese version was completed, and some prototype versions for the other languages were also given. It is expected that the software can contribute to improve STEM accessibility much more in many countries.*

Keywords *DAISY, Localization, Accessible editor, Multilingual support, Print disability, STEM accessibility*

Paper type *Research paper*

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1. Introduction

As is well known, in advanced countries, "Digital Accessible Information System (DAISY)" (or accessible EPUB3 that is essentially DAISY4) has already held the position of the international standard for accessible e-books (DAISY Consortium, n.d.; Schwarz *et al*., 2018). Many excellent tools to produce and to read DAISY/accessible EPUB3 books are available. On the other hand, it is said that 90 percent of visually disabled people live in the developing countries. Recently, accessible e-books are becoming gradually available even in those countries. For instance, "the Accessible Books Consortium" has provided training and technical assistance in developing countries such as India, Bangladesh, Nepal and Sri Lanka since 2015 in the production and distribution of books in accessible formats (Accessible Books Consortium, n.d.). In 2015, within the framework of its support to digital inclusion in Africa, UNESCO organized a series of programs in partnership with the DAISY Consortium (DAISY Consortium, n.d.). Training sessions on accessible publishing and digital inclusion were conducted at the 6th Africa Forum in Uganda. Definitely, DAISY is a key technology in such activities.

However, to facilitate the spread of accessible e-books much more in developing countries, even now, they have many problems. For instance, a text-to-speech (TTS) engine for their local language is usually not available or of low quality. Ordinary tools for producing DAISY books or DAISY players often cannot treat their own (local) characters/symbols. Thus, accessible books for developing countries are usually in old-fashioned audio DAISY using recorded human voice (i.e. DAISY2); it is rather hard to produce accessible books in text DAISY or multimedia DAISY (DAISY3 or accessible EPUB3) with the TTS technology. In addition, the society of developing countries often does not realize well the concept of accessibility and the necessity of

accessible books, themselves. We cannot necessarily expect to receive broad social support. In those countries, it is particularly difficult for print-disabled people to obtain accessible e-books for STEM (science, technology, engineering and mathematics).

As will be discussed in Section 2, recently, STEM accessibility has been improved remarkably in advanced countries. However, you must confess that there also remain some problems to deserve greater attention even in those countries. For instance, print-disabled people still do not have a good tool to write a technical e-content in their own local language. They often tend to be regarded just as a reader, not a person who authors the content that includes technical notations such as mathematical formulas. A disabled student can neither draw up a technical report in DAISY nor write a solution directly into a DAISY work sheet.

For about 20 years, NPO: "Science Accessibility Net (sAccessNet)" and research group, "Infty Project" (sAccessNet, n.d.; Infty Project, n.d.) have been developing assistive tools for print-disabled people to access STEM information, and they have recently worked out and applied a solution to the problem by improving one of their assistive tools. In this paper, at first, the history and the current situation of STEM accessibility are briefly reviewed. Next, multilingual support in the assistive tool to produce/read multimedia-DAISY STEM books and its new localization scheme are discussed. Using the scheme, users can customize easily the accessible STEM editor so that they can author a material including complicated technical notations in their own local language. Finally, some model cases of customizing the accessible STEM editor for local languages are shown.

2. STEM accessibility

For the past more-than-20 years, various computerized approaches have been tried to improve STEM accessibility, mathematics accessibility in particular. In 1994, T.V. Raman gave his doctoral thesis on "Audio System for Technical Readings" which could read out mathematical documents in LaTeX format with DEC Talk synthesizer. It might be the very first trial in this field (Raman, 1994, 1998). Since that time, STEM accessibility for visually disabled people has been steadily improved. For instance, in 2000s, speech-output utilities for mathematical contents (Gillan *et al*., 2004; Soiffer, 2005), automatic LaTeX-to-Braille converters (Archambault *et al*., 2005; Duxbury Systems, n.d.) and mathematical editors for blind people (Edwards *et al*., 2006; Yamaguchi *et al*., 2008) were studied, and in several cases, they were put to practical use. Sophisticated software and hardware that could produce tactile graphics (ViewPlus Technologies, n.d.) and other useful interfaces to make graphics accessible (Gardner and Bulatov, 2006) have also been developed. Such works have greatly contributed to the production of accessible STEM materials for print-disabled people. "The International Conference on Computers Helping People with Special Needs (ICCHP)" has held regularly a special thematic session (STS) on STEM accessibility since 2002, which has also made great contributions in this field. This STS is now entitled "Art Karshmer Lectures in Access to Mathematics, Science and Engineering," and recently, more-various new topics such as accessibility in chemistry or other STEM fields (Sorge, 2016; Godfrey *et al*., 2018) and a tool for the blind to solve mathematical problems (Soiffer, 2018) were discussed in there.

In many of the early approaches such as Raman's work (Raman, 1994, 1998), LaTeX played an important role in STEM accessibility. While it is important even now, recently, MathML has become a key technology in assistive tools for print-disabled people to access STEM. For instance, DAISY has adopted MathML to represent mathematical formulas (DAISY Consortium, n.d.), and some DAISY/accessible EPUB3 players could read out such mathematical formulas with a TTS voice even if alternative texts for them were not available. In terms of web accessibility, recently, MathJax is widely used to represent MathML formulas on the web. The current version of JAWS, the most popular screen reader in Windows OS, can read out such mathematical contents to a certain extent (MathJax, n.d.; Freedom Scientific, n.d.).

As was mentioned, sAccessNet and Infty Project have been also developing assistive tools for print-disabled people to access STEM contents, most of which were given at the ICCHP STS. For instance, ChattyInfty (sAccessNet, n.d.; Infty Project, n.d.) is an accessible

STEM-document editor with a TTS voice, which was first given in ICCHP 2006 (Komada *et al*., 2006). It is self-voicing software that uses Microsoft Speech API, Ver.5 (SAPI5) as a TTS engine, and it can help print-disabled people with both accessing and doing mathematics with speech output. Using it, they not only can read but also author a STEM document easily for themselves in an intuitive manner. Furthermore, the current version, "ChattyInfty3" can be used as an authoring tool for accessible STEM books since the edited result can be saved as a multimedia DAISY/accessible EPUB3 book, in which literal sentences and mathematical expressions are synchronized with audio generated by the SAPI5 voice. All the mathematical expressions are represented in MathML or SVG (scalable vector graphics) on a display.

Optical character recognition software for STEM documents, "InftyReader" (sAccessNet, n.d.; Infty Project, n.d.) can properly recognize scientific documents in print or PDF, including complicated mathematical expressions, tables, graphs and other technical notations. Its prototype was first given in 2003 (Suzuki *et al*., 2003) and also introduced in the ICCHP 2004 (Suzuki *et al*., 2004). In the current version, combined with a PDF parser, it becomes much more powerful in recognizing e-born PDF (originally produced from an electronic file such as Microsoft Word, LaTeX, etc.) (Suzuki and Yamaguchi, 2016). Combining InftyReader and ChattyInfty3, users can convert e-born PDF quite efficiently into multimedia DAISY/accessible EPUB3.

3. Multilingual support in Chattyinfty

3.1 Multilingual support in the previous version

Mathematics is the most universal language for sighted people in the world to describe technical statements. You could understand mathematical expressions in a STEM document even if it were written in an unknown language. However, as for print-disabled people, mathematical expressions are not necessarily universal. For instance, there exist many different Braille notations for mathematics in the world (Archambault *et al*., 2005), and you do need to convert mathematical expressions into an appropriate Braille notation for each local language. Concerning audio rendering of mathematics, you must translate a mathematical formula into a word description in each local language, and the word description is certainly different from one in the other languages. As it was discussed in the previous section, mathematics accessibility is remarkably improved especially in English-speaking countries. However, it is not so easy to use those technologies in the other countries as they stand (Riga *et al*., 2016).

In ChattyInfty, the Japanese and the English versions have been released simultaneously since the very beginning of it. To realize the audio rendering of mathematical formulas, the Infty team had to begin by tackling some problems peculiar to Japanese. In English-speaking countries, "how to read out mathematical expressions" is well established in mathematics education. However, in Japanese, mathematical symbols/formulas are not commonly regarded as objects that should be read out. Many mathematical symbols such as "the partial-derivative symbol (rounded d)" do not have officially assigned names for reading in Japanese. Furthermore, it is rather difficult to read down a mathematical expression in the original (character/symbol) order due to the difference of grammatical structure. English has the almost-same structure as mathematics; however, Japanese does not. For instance, a mathematical expression, $x = 0$, has the same grammatical order as its word description in English, "x equals zero." However, in Japanese, a predicate verb is usually located at the end of a sentence such that x, zero, equals. The denominator of a fraction is read prior to the numerator, etc.

The Infty members organized a committee to consider how mathematical symbols/formulas should be read out in Japanese. The committee gave a standard manner before developing the software, and the result was incorporated in ChattyInfty. To represent math contents properly in both languages (English and Japanese), the software has been designed so that double-byte characters (Hiragana, Katakana and Chinese characters) in Japanese, ordinary alphanumeric characters and various technical symbols in STEM can be displayed in its main window. A reading order in mathematical expressions can be customized flexibly to meet the difference of grammatical structure.

To release both the English and the Japanese versions efficiently/systematically, in ChattyInfty3, not only tables to assign aloud reading mathematical symbols/formulas but also captions in menu items and dialogs are all stored in files independent on a main program. Thus, in principle, one could customize ChattyInfty3 for another local language without modifying its main program.

3.2 Some other features and evaluation in Japan

As is well known, while mathematical expressions in print have no ambiguity, there are some ambiguities in reading out them. For instance, A(–*x*) can be read as "(a function) A of (an argument) –x" or "(a coefficient) A times (a quantity) –x." In popular DAISY browsers, users usually cannot change a manner of aloud reading locally/manually, and it is difficult to treat such ambiguities properly. To solve this problem, ChattyInfty3 provides a new way to control how to read out each symbol, technical term or math formula locally according to their context. We refer to this new concept of assigning a pronunciation as "Yomi" (a Japanese word that means "a manner of reading aloud"). Furthermore, in Japanese, four different character sets are used simultaneously in print: Chinese characters, Hiragana, Katakana and alphanumeric letters. While Hiragana and Katakana are essentially kinds of phonetic symbols, a single Chinese character or a compound of the characters usually has several ways of pronouncing, according to its context. In STEM, they are often read in a different manner from the usual. In ChattyInfty3, you can give a correct Yomi to them as well if necessary (Suzuki *et al*., 2014).

However, even if a correct Yomi for a math formula or a Chinese character(s) were given, a TTS engine would make errors frequently concerning breaks and intonations. Each TTS voice makes errors in their own manner. Even though a voice can read a math expression or a literal sentence correctly, the other voices cannot necessarily do the same. The speech control seems to be TTS-engine-dependent job. Hence, as far as the Japanese version is concerned, a specific TTS (Japanese) engine of high quality for DAISY production is chosen, and a special version of ChattyInfty3 is developed, in which an interface is implemented to control speech output (breaks and intonations), based on that specific engine (Yamaguchi *et al*., 2013). It can export an edited document as a multimedia-DAISY/accessible EPUB3 book. In its contents, audio files of aloud reading corresponding to each of literal sentences and mathematical expressions generated with the TTS voice are embedded as well as text-based information. This file can be produced after correcting all errors in the speech output, and any DAISY browser/player can play back that book in a proper manner with the embedded voice.

In Japan, the Japanese Society for Rehabilitation of Persons with Disabilities started providing print-disabled students with e-textbooks in multimedia DAISY in 2008 (Japanese Society for Rehabilitation of Persons with Disabilities, n.d.). It now organized 23 volunteer groups/organizations and produced 291 titles of multimedia-DAISY textbooks for elementary and junior-high school in 2018. Those textbooks were provided to more-than-10,000 print-disabled students (mostly ones with developmental reading disorder). Those 23 groups/organizations use mainly three applications to make multimedia-DAISY textbooks, and the Japanese version of ChattyInfty is one of them. In total, 34 percent of 291 titles (99/291) were made with ChattyInfty, and as far as textbooks for mathematics and science are concerned (99 titles in total), ChattyInfty3 was used for 80 percent of them (79/99). It shows that ChattyInfty has already held the position of the standard software for producing accessible e-books in multimedia DAISY, especially, accessible e-books for STEM in Japan.

Incidentally, sAccessNet, itself is also a member of the 23 groups/organizations and has been working on producing many e-textbooks in multimedia DAISY until now, by making use of the Infty software (sAccessNet, n.d.). The total number of textbook titles produced by them until 2018 is as follows:

1. Mathematics:
    - Elementary school: 37, Junior-High School: 31, High School: 9.
    - Total: 77 titles.
2. Science:
    - Elementary school: 2, Junior-High School: 9, High School: 11.

- Physics: 1, Total: 23 titles.

3. Others: 31 titles; Full total: 131 titles.

sAccessNet has also held instructional courses to train persons for producing multimedia-DAISY textbooks with ChattyInfty3 several times every year in various parts of Japan.

4. Localization of ChattyInfty for other languages

In 2016, a research group at Indian Institute of Technology, Delhi inquired of the Infty team if a Hindi version of ChattyInfty3 could be developed. They said, "Millions of children with visual disabilities exist even now in India or other developing countries due to inadequate medical treatment. Accessible books should be exactly necessary for those countries." It strongly impressed the Infty members, and they thoroughly examined its possibility. Through this process, it was concluded that a much better localization scheme for ChattyInfty3 should be given.

As the first step to realize that, the following new features have been implemented in ChattyInfty3:

1. Unicode can be used on its main Window so that users can input a text in their local language other than English and Japanese if characters are included in Unicode.
2. The definition file for reading aloud mathematical symbols and formulas, "ReadSetting.txt," is also represented in Unicode so that users can prepare its local-language version.
3. STEM terminology in menu items can be also replaced with local names. Ordinary menu items such as "File" might be OK even if they were represented in English. In developing countries, users are usually familiar with the menu items in English; however, names of technical symbols and mathematical formulas such as "Regular Triangle" and "Square Root," which also appear as the menu items, should be represented in their local manner.
4. Any SAPI5 voices can be selected for speech output.
5. In the case that a TTS voice is too bad, audio files generated with the TTS engine can be replaced with recorded human voice.
6. Users can register Short sentences and math expressions that are frequently used; they can be called with user-defined shortcuts.

As the first model case of the localization, in cooperation with "Assistive Technology Developing Organization (ATDO)" (ATDO, n.d.), the Infty team worked on developing the Vietnamese version in 2017 (Yamaguchi *et al*., 2018). Historically, Vietnamese used Chinese characters, but currently, it is represented in alphabet with various (different eight types) accent marks; those characters are all included in Unicode. Using an application named "Unikey," one can input Vietnamese easily with the ordinary keyboard (Unikey, n.d.). Vietnamese SAPI5 TTS engines are not necessarily of high quality but available, anyhow. Certainly, most technical symbols in STEM have their own names in Vietnamese; however, the standard manner of aloud reading for mathematics is well established, and the reading order in mathematical expressions is the same in English. Every student until high school uses the same textbooks approved by the central government, and the number of their titles is not so many.

After due consideration for such situations, it was judged that Vietnamese might be appropriate for the first model case of the localization. This job was completed by the mid October 2017, and workshops were held at the Hanoi School for the Blind in the end October 2017 to demonstrate how the Vietnamese version of ChattyInfty3 worked. The participants confirmed that they could write and read mathematical expressions in an intuitive manner with Vietnamese speech output. A blind high-school student, who participated in the workshop, said that he was so happy that he could write any math expressions freely (Yamaguchi *et al*., 2018). Incidentally, more-than-ten visually disabled students are now using the Vietnamese version of Chattyinfty3 in Hanoi.

However, through this activity, one difficult problem was realized. As was mentioned previously, each TTS voice has its own characteristics, and even if the same definition file for aloud reading

were incorporated, actual speech output would be usually different from each other, depending on a used voice. Unexpected errors in reading could occur due to an inappropriate description in ReadSetting.txt. Thus, in cooperation with ATDO and a local-user community in Hanoi, the Infty team chose an appropriate TTS voice and asked them to check speech output for various sample files with that voice. The local-user community certainly could author the definition files for themselves, but it was difficult for them to incorporate those files into the software at that time. Hence, the Infty team had to exchange data with them over and over to complete the job. It is obviously impossible for the Infty team to do the same jobs for all localization requests in the future. They must give a much more efficient/systematic method to allow end users to do most of necessary jobs just for themselves (without software-developer's help as well as possible).

5. New localization scheme

To achieve the objective, as was reported in the ICCHP 2018 (Yamaguchi and Suzuki, 2018), a new localization scheme has been recently compiled for end-users to incorporate ReadSetting.txt and the other necessary definition files efficiently/systematically into ChattyInfty3 without software-developer's help. It allows users to customize the software simply by putting the definition files in a specified folder and changing some software settings. In addition, the software has been improved for the following points after the conference so that it can treat more various local languages other than English, Japanese and Vietnamese:

1. Its latest version can be customized for languages that are represented in Unicode using Grapheme Cluster such as Hindi and Tamil, in which a single character is often represented with multiple codes. In addition, extended Latin characters that are input with multiple key strokes (characters with an accent mark) can be also used. (However, unfortunately, languages written from right to left such as Arabic are still out of scope).
2. As was pointed out, a SAPI5 voice is often not available or of low quality in a local language. To correspond to such cases, a new application named "SpeechFiveMagic" was developed to allow people to use voices of "Microsoft Speech Platform" or "Windows10 OneCore" as SAPI5 (Speech Five Magic, n.d.).

Based on that, since August 2018, the Infty team has been working on the next project. In cooperation with several local-language groups, they are now developing Czech, German, Greek, Hindi, Italian, Spanish and Turkish versions of ChattyInfty3 by their own efforts (without software-developer's help).

To customize ChattyInfty3 for a new local language, at first, users need prepare a new folder for it such as the "en" folder for English in the lang folder of ChattyInfty3 and put the following two files and a folder in the new folder, which are all included originally in the lang folder:

- resource.xml (file).
- CodeMenu.tbl (file).
- ReadSettings (folder).

Next, they need to author/translate the three definition files: "ReadSetting_SAPI5_EN.txt" in the ReadSettings folder, CodeMenu.tbl and resource.xml, which are all for English originally.

5.1 Authoring ReadSetting.txt

ReadSetting_SAPI5_EN.txt is a text file to define aloud reading for characters/symbols/formulas in the math mode of ChattyInfty3 (in English). ChattyInfty3 is to read out mathematical symbols/formulas in a manner defined in this file.

In ChattyInfty3, three different types of aloud reading for mathematical formulas can be selected (Suzuki *et al.*, 2014). "Plain-Reading mode" is based on one which may be most widely used in English-speaking countries. It is natural, but a spoken mathematical expression is often ambiguous just only with speech. It is assumed that people with low vision and dyslexia use it.

In “Smooth-Reading mode,” minimum-necessary speech guides for blind users to grasp correctly the structure of a mathematical formula are added. “Detailed-Reading mode” is assumed to be used when a blind user wants to know the mathematical-formula structure in the most detail.

The following is the definition of aloud reading for a fraction in English:

•English

[MathReading:frac]

{ // Standard

plain = “%OVER, over, %UNDER, “

detail = “fraction, numerator, %OVER, over, denominator, %UNDER frac end, “

smooth = “frac, %OVER, over, %UNDER, “

}

Here, %OVER and %UNDER are arguments at the numerator and the denominator positions in an original fraction, respectively. For instance, in a fraction “a over 2,” %OVER and %UNDER correspond to a and 2, respectively. Hence, it is read out as “a, over, two,” in the Plain-Reading mode and as “frac, a, over, two,” in the Smooth-Reading mode. Incidentally, commas are inserted to put a certain (speech) interval between words and not pronounced commonly with a TTS voice.

The following samples are other language versions of the same part:

•Vietnamese

[MathReading:frac]

{ // Standard

plain = “%OVER, trên, %UNDER, “

detail = “phân số, tử số, %OVER, trên, mẫu số, %UNDER kết thúc phân số, “

smooth = “phân số, %OVER, trên, %UNDER, “

}

•Czech

[MathReading:frac]

{ // Standard

plain = “%OVER, lomeno, %UNDER, “

detail = “zlomek, čitatel, %OVER, lomeno, jmenovatel, %UNDER konec zlomku, “

smooth = “zlomek, %OVER, lomeno, %UNDER, “

}

•Italian

[MathReading:frac]

{ // Standard

plain = “%OVER, su, %UNDER, “

detail = “frazione, numeratore, %OVER, fratto, denominatore, %UNDER fine frazione, “

smooth = “frazione, %OVER, su, %UNDER, “

}

•Turkish

[MathReading:frac]

{ // Standard

plain = “%OVER, B・ ・ %UNDER, “

detail = “Kesirli Ba・lang・ ・ pay, %OVER, B・ ・ Payda, %UNDER Kesirli Sonu, “

smooth = “Kesirli, %OVER, B・ %UNDER, “

}

●Japanese

[MathReading:frac]

{ // Standard

plain = “%UNDER, bun-no, %OVER, “

detail = “bunsu, bunbo %UNDER, bun-no, bunshi %OVER, bunsu shuryo, “

smooth = “bunsu, %UNDER, bun-no, %OVER, “

}

As was mentioned, only in Japanese, the denominator of a fraction is read prior to the numerator. The above description shows that. Thus, in ChattyInfty3, users can customize a manner of reading out mathematical expressions quite flexibly as they like.

5.2 Authoring CodeMenu.tbl

CodeMenu.tbl defines the structure of symbol/character and formula lists which appear in the context menu. As was pointed out, names of technical symbols and mathematical formulas such as “Regular Triangle” and “Square Root” usually should be represented in a local manner. If users would need to change the names of < group > and < item > in the lists to local ones, it could be done as follows.

To change the name, users should give an attribute: “caption” to it (< group > or < item >) and assign a name as is shown in the following example:

●Original:

< group name = “Character Symbol” >

< group name = “Greek” >

< item code = “Gamma”/ >

●Changed To:

< group name = “Character Symbol” caption = “Math Symbol” >

< group name = “Greek” caption = “Greek Character” >

< item code = “Gamma” caption = “Capital Gamma”/ >

Then, the Greek letter: “Capital gamma” appears in the context menu in the following structure.

Math Symbols > Greek Characters > Capital Gamma, While in the original, Character Symbol > Greek > Gamma.

5.3 Authoring resource.xml

resource.xml gives labels for menu items and dialogs. If the English menu and dialogs were all right, users might not need to modify this file. There are several sectors in this xml file, but in localization purpose, just the following five sectors in this file could be modified:

< captions > , < descriptions > , < strings > , < messages > and < dialogs > .

5.4 How to change a language in ChattyInfty3

To change actually a language in ChattyInfty3, after completing the job described above, users should change three items in the Setting menu as follows:

1. Choosing the (local) language at “LANG” in the Setting menu. At that time, rebooting the software might be required.
2. Selecting a local TTS voice at “Speech Setting” in the menu.
3. Opening “Select Reading Table” in the menu and choosing an appropriate ReadSetting_SAPI5.txt.

Then, ChattyInfty3 works as the new language version. The users not only can read but also author a technical material with speech output in their own local language.

5.5 Preliminary evaluation

As was mentioned, since August 2018, several local-language groups are working on developing Czech, German, Greek, Hindi, Italian, Spanish and Turkish versions of ChattyInfty3 without software-developer’s help. The prototype versions for Czech, Greek, Italian and Turkish were already given. The other versions are not completed yet, but it is confirmed that at least, ChattyInfty3 can treat those local languages properly. It shows that ChattyInfty3 is actually customizable for various local languages by making use of the localization scheme.

6. Conclusion

If the local-language version of ReadSetting.txt and the local names of the menu items are just prepared, by making use of the new localization scheme, users can customize ChattyInfty3 easily for themselves so that it can treat STEM contents in their own local language. In cooperation with several local-language groups, the various language versions of ChattyInfty3 are actually developed. Furthermore, if necessary, end users also could use the localization scheme to meet their own needs. For instance, beginners might need a manner of aloud reading different from the usual in a certain local language. Flexibility in reading mathematical formulas should be helpful for various types of users. It is expected that the software can contribute to improve STEM accessibility much more in many countries.

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