

# Doing Math: Mathematics Accessibility Issues

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## ABSTRACT

Limited mathematics accessibility support has been always a barrier for students with impaired vision to learn that fundamental subject. In response to that persistent need, enhancing mathematics accessibility has been deeply thought of with more attention given towards facilitating “Doing the math” and not only working on the rendering level. In specific, for the challenges they face in algebra, the efforts are being made to enable students to do and learn algebraic skills; i.e., arithmetic manipulation on the level of basic building blocks of entire expressions, working on complex expressions simplifications and evaluation, and solving algebraic equations. As a non-visual framework, manipulation is made through an accessible hierarchy of recorded, navigatable, and recoverable steps. With different layers each of which supports distinct needs of learners; the framework is to facilitate doing the math according to the student level of subject mastery and disability severity in minimal possible efforts; i.e., avoiding rewriting the same sub-expressions when they are not manipulated at certain point in the hierarchy from one step to the next.

## Categories and Subject Descriptors

H.5.4 [Information Systems]: Information Interfaces and Presentation—*User Issues*.

## General Terms

Design, Human Factors.

## Keywords

Mathematics Accessibility, Visually Impaired Students, Learning, Interactivity, Assistive Technology.

## 1. INTRODUCTION

Within information era where computers vitally play a significant role, web resources became inseparable from our daily life; they are extensively used by diverse users who vary in interests, age, background, domain, and needs.

The reliance on accessing web resources in education is increasingly spreading; e-learning, online courses, distant education, and course content management systems (e.g., Blackboard) have become a cornerstone of education at most levels of the educational pipeline. These flexible trends are

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moving forward to replace older approaches, and they are facilitating more opportunities for individuals. However, when it comes to students with disabilities, we find that web accessibility especially in education is still an issue that needs be supported and ensured in most resources available on the web.

Speaking of education, mathematics is a cornerstone of any scientific discipline; mastering the subject is essential in order to pursue STEM (Science, Technology, Engineering, Mathematics) disciplines, and hence gain competitive position in jobs market. There is an extensive literature showing that students who have visual impairments select not to continue learning mathematics after middle school level for the challenges mathematics poses on them due to the following reasons:

- Complexity of mathematics that relies on abstract notations [11]
- Disability impact on a relatively visual science which depends on bi-dimensional representations
- Limited capabilities of traditional tools for a subject composed of dense topics
- Lack of technologies that fully support math accessibility.

These challenges have become of larger impact especially within the technology revolution in education that necessitates students - regardless their needs- to deal with more online resources; curriculum, assignments, assessments, and discussions.

Students who have visual disabilities must not be deprived of valuable opportunities mathematics education gives them. For that reason, I chose to work in the field of mathematics accessibility and to effectively add to previous contributions discussed in [1]. The problem of rendering mathematics as static images is solved through LaTeX and MathML standards; that helped students with visual impairments to access mathematical content on the web. However, the topic is broader than just rendering mathematics and reading it, moreover; requirements are increasingly demanding “Doing math”; (e.g., writing math, manipulate math, solve equations, simplify expressions, and carry out calculations).

Facilitating “Doing math” in the context of web-based systems is not supported yet although more demand is put on students to deal with. In Math accessibility I am working on “Doing math” particularly to find ways through which students who are visually impaired can use computers to manipulate mathematics in minimal effort from their side through an accessible interactive web based framework. Learning process is also emphasized supporting different levels of vision disability and mathematics mastery.

This originated from the challenges students who are visually impaired still encounter in handling mathematics manipulation for the previously discussed reasons.

In working on that, I aim into developing efficient ways of interaction for educational purposes, and to enable students who are visually impaired get motivated to study mathematics which is critical in determining their career future.

## **2. W4A 2012: UNIQUE OPPORTUNITY**

In attending W4A 2012, I find a great opportunity to learn from the state of the art and the ongoing research being presented in the conference. In my opinion, W4A 2012 gives me a unique chance to present my work done so far to get feedback and discuss research related issues: challenges, contributions, studies, findings, and more with specialists and scholars in the field of

web accessibility from which I would greatly benefit and guide my research to the right directions and potentials. In addition, I am looking for building bridges with other researchers in the same topic and other related topics that have strong potential to interoperate for integrated solutions to web accessibility.

## **3. REFERENCES**

- [1] A. Karshmer, G. Gupta and E. Pontelli, "Mathematics and Accessibility: a Survey", in *Proc. 9th International Conference on Computers Helping People with Special Needs*, Vol. 3118, Paris, France, 2004, pp.664-669.