Chinese Online School for the Blind (COSB): A Platform Integrating AI and Student Volunteers to Enhance Educational Resources and Expand Opportunities for Visually Impaired Children in China

Huici Yu, Kaichen Zhang, Peijiao Zhang, Dongzheng Han, Ruiming Zheng

Abstract

Visually impaired people in China, with a population over 17 million, are currently experiencing marginalization in society, as reflected by adverse education and employment circumstances. Limited educational resources confine the learning efficiencies of visually impaired students, restricting their opportunities to pursue higher-level education, limiting their employment prospects and contributing to the marginalization of this population in society.

Our innovative design, an educational platform named “The Chinese Online School for the Blind (COSB)”, aims to help resolve educational resource shortages, which is the fundamental cause of the adverse social circumstances faced by the visually impaired. By interviewing multiple visually impaired middle and high school students as well as their parents, we realized that students mainly have trouble understanding concepts involving diagrams. Therefore, our educational model targets this by providing lessons that merge pre-recorded video lessons with assistive teaching tools that can be easily recreated to help the students better understand such concepts. Our model also utilizes AI tutors to provide personalized and interactive learning experiences. This outlines a framework for accessible education that supports independent learning, empowering visually impaired students to take initiative of their own education.

We have tested the effectiveness of COSB by asking 2 visually impaired students to learn unfamiliar concepts using COSB resources only. According to their feedback, COSB supports independent learning of new concepts in various subjects. Thus, our solution has been proven to enhance the accessibility of educational resources to visually impaired students.

Keywords: visually impaired, education, volunteers & AI tutors

1. Introduction

China has approximately 85.91 million people with disabilities—accounting for 6.34% of the population—of whom 17 million suffer from visual impairments (*Chen*). There is an urgent need for addressing the challenges faced by this community, as statistics reveal significant disparities in education and employment opportunities between sighted and visually impaired populations.

By conducting interviews with 3 visually impaired college students and the families of 3 visually impaired children (aged between 12 and 15), we developed a comprehensive understanding of the difficulties faced by this underappreciated population. Therefore, our team has resolved to empower education for visually impaired children by creating a platform that connects visually impaired children with high school students, offering recorded video lessons paired with easily-recreated assistive models to enhance their educational resources and opportunities.

2. Essential Research

Visually impaired individuals experience difficulty in performing everyday tasks such as reading, recognizing faces, or navigating an environment (*World Health Organization*). The term "visual impairment" refers to the condition where a person has partial or complete loss of vision that cannot be corrected to a normal level with standard glasses or contact lenses. This population, therefore, consists of individuals experiencing partial or full blindness due to congenital or non-natural diseases or injuries, thereby encompassing a wide range of visual disabilities.

2.1 Literature review

Education prospects for the visually impaired population are bleak. Less than 10% of visually impaired students attend high school in China, demonstrating how very few visually impaired students pursue higher levels of education beyond compulsory education up to Grade 9 or equivalent (*Sohu News*). Limitations in the education received in turn inhibit the employment outcomes of the visually impaired, contributing to stigmatization and furthering the marginalization of the visually impaired population.

Resulting from inadequate education, employment opportunities offered to the visually impaired are mainly low-paying jobs. Among the nearly 4,000 jobs offered on China's Disabled Employment and Entrepreneurship Networks Service Platform, only a minimal range of occupations are offered to the visually impaired population. As a result, only 5 million out of 17 million visually impaired individuals are employed. While much of this employed population clusters in massage, an occupation stereotypical to the visually impaired, less than 1,000 such individuals engage in other occupations such as tuning, anchoring, customer service, programming, or teaching (*Yunnan News*). The conformity of employment prospects for the visually impaired stems from educational limitations, bringing forth a long chain of cause-and-effect relationships:

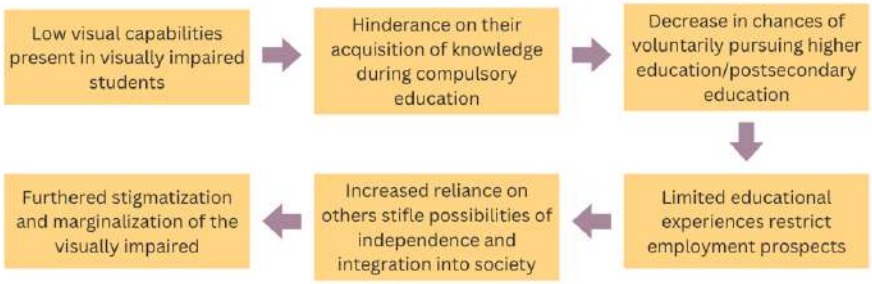

Fig. 1 Difficulties faced by the visually impaired and the long-term effects

There is an essential gap in educational resources between sighted and visually impaired populations: that is, limitations on their ability to access and read materials that are readily available to the sighted population – and used as the major source of knowledge transmission for traditional schooling – contribute to the unsatisfactory education and employment outcomes of the visually impaired. Globally, less than 10% of all publications are accessible to the visually impaired (*Klosek*). The lack of educational materials, or the gap in educational resources available to the unsighted and their sighted peers, limits the accessibility to education of the visually impaired population, reducing future employment opportunities, negatively impacting their future economic and social positions (*Loh et al.*). Evidently, to increase employment prospects, foster societal integration, and reduce stigmatization of the visually impaired population, their special needs in education must be accommodated with the utmost priority.

2.2 Existing Solutions and Inspirations

There are currently some existing solutions aiming to support the visually impaired community. One such solution is the accessibility features in smartphones, such as Apple's "VoiceOver" (*Apple*) and Android's "TalkBack" (*Roth*). The accessibility features provide their visually impaired users with audio guidance to use certain functions on their phones, increasing the visually impaired population's capability to work and live independently. Yet, while accessibility functions focus on supporting the visually impaired community in daily livelihood, these approaches lack the effectiveness to foster a comprehensive learning experience for the user. Consequently, a more comprehensive solution for accessible education was analyzed. Another solution is existing online websites that incorporate auditory and tactile haptics to increase the motivation for studying among visually impaired children. Meanwhile, visual representations are also provided on the websites to help their sighted peers understand the content that the visually impaired student is looking at. This facilitates a collaborative learning environment, allowing visually impaired students and their sighted peers to work together towards understanding common content, thereby increasing the interest and motivation of visually impaired students towards learning (*Zhu and Yang*).
This solution is advantageous since it successfully increases interest among visually impaired students towards learning and education through utilizing sensory haptics tangible to both visually impaired and sighted populations, such as auditory and tactile approaches, inspiring our educational model to preserve the interactivity and maintain the collaborative nature of learning. Meanwhile, the solution is also very comprehensive, as it is accompanied by visual representations to help sighted individuals, especially the parents of visually impaired children, to understand the content, allowing them to assist in the studying of visually impaired students. This provides some ideas as to what our solution could ultimately be. For instance, visual, auditory, and tactile approaches are all needed to accommodate the needs of the clients we are targeting, including the visually impaired students and their parents.

However, this solution is also disadvantaged to an extent, as it overgeneralizes the needs of visually impaired students, and cannot tailor a specific experience for any individual. Therefore, our solution must be able to accommodate both the needs of specific individuals as well as the general needs of the visually impaired student population.

The recent advancement of generative AI has shown its strong potential as a tool to assist education for visually impaired students. In addition to the AI models already in use in fields such as object recognition and image alternative text generation, generative AI models can also be utilized as digital tutors to visually impaired students. AI models can output messages and receive responses through speech, bypassing barriers of sight and rendering accessible content to accommodate for the needs of visually impaired students (*Aikaterini Tsouktakou et al.*). AI models can also foster one-to-one interactivity, considering how they can check student understanding by coming up with practice questions, listening to the students' response, and generating specified audio feedback. In doing so, AI models integrate all three senses, creating personalized and customizable learning experiences. Admittedly, AI cannot be the only "tutors" in our educational model, as they cannot replace human interactions. To this end, in our educational model, AI will be used mainly during stages of independent learning (e.g., when the student desires to test their understanding with guided practice sessions), while other tasks, such as teaching, are carried out by either volunteers or via video lectures recorded by

volunteers. The huge potential of generative AI inspires our education model to make use of their strengths and provide an inclusive and flexible learning experience.

Teaching STEM courses to visually impaired students can be particularly challenging. However, tactile representations, auditory representations, as well as specially made assistance technology for STEM classrooms are among some adaptations to help visually impaired students understand STEM content. For instance, tactile representations of experiments such as conductivity of materials, fermentation, and magneticity can help students understand STEM content through hands-on experiences. Auditory representation can help students understand images and diagrams. Special technologies such as accessible voiceovers for labs can also be used to enhance student understanding (*Wandy*). Tactile models will be used in the content exploration and concept understanding stage of our educational model. Explanation videos, coupled with authentically designed tactile models to aid student understanding will be included in our educational model. These models will consolidate abstract concepts and theories into tangible representations, fostering student interest and enhancing student understanding.

2.3 Field Research

To test the validity of our approaches, we worked with Jia Nuo, a visually impaired 8th grade student attending a Chinese public school. The testing process began with attempts to explain existing practice questions, especially algebra or physics questions that include graphical representations, to Jia Nuo. After more than a combined total of 10 hours of working with Jia Nuo, we developed sufficient understanding to draw conclusions on the learning challenges faced by visually impaired students.

For one, inefficiencies in notetaking with braille results in the inadequate reception of knowledge in classrooms. Hence, visually impaired students require constant reiteration of taught concepts to absorb essential knowledge. To this end, our solution is to record and catalog a series of video lectures on common concepts. This video series can be referenced by visually impaired students frequently and allows them to pause and restart the explanation as needed to accommodate slower note taking habits.

For another, the lack of visual abilities in these students accounts for difficulties in understanding concepts requiring graphical or physical representation. To resolve this, our solution will incorporate simplistic physical models made from common household objects (e.g., rubber bands, pens, or playdough). The physical model and the video lecture work complementarily, allowing visually impaired students to understand and actively engage with knowledge.

3. Innovative Design

Examining the existing solutions and drawing inspirations as previously mentioned, we have gained innovative ideas on making learning more efficient for visually impaired students. Specifically, our solution stimulates multiple senses, involving audio and tactile approaches. In addition, we have realized the importance of taking everyone's personal needs into account and have come up with an innovative design that makes all visually impaired students' learning experiences unique.

Our solution is a "Khan Academy – like" teaching model, namely, a "Chinese Online School for the Blind (COSB)", targeted specifically for visually impaired students. COSB is an educational

platform in which volunteers design lessons that allow students to follow through self-paced learning, while stimulating multiple senses to enhance their understanding. To make the teaching process more effective, we plan to incorporate additional learning resources, namely, AI tutors.

At its core, the mechanism of COSB boils down to the following steps:

a. *Communication with client & initial testing with the AI tutor model Baidu QianFan*

Volunteers will initially communicate with visually impaired students to acquire information on the knowledge in various subjects that each individual needs support in. Then, we will test the extent that Baidu QianFan can help with demands of these students by asking the AI tutor to explain the concept. If responses from AI tutors are considered comprehensive and can be easily understood, we will suggest that students communicate with AI tutors directly.

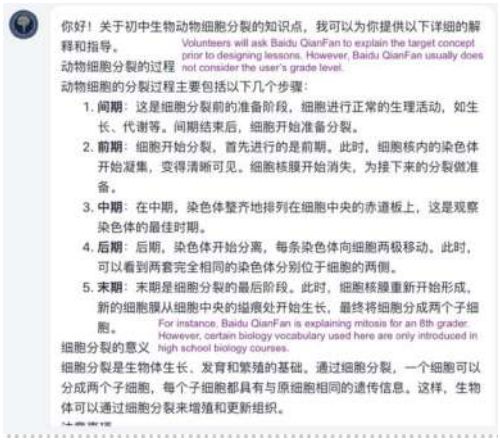

Fig. 2 Results from Baidu QianFan when asked to explain mitosis to an 8th grade student

b. *Volunteers record video lessons that clearly explain the target concept to students*

If Baidu QianFan shows limitations in its ability to explain certain concepts comprehensively, volunteers will record additional video lessons providing more information and teaching knowledge beyond the capability of AI to help students further their understanding. These videos will be cataloged in a cloud folder to be retrieved at any time and place.

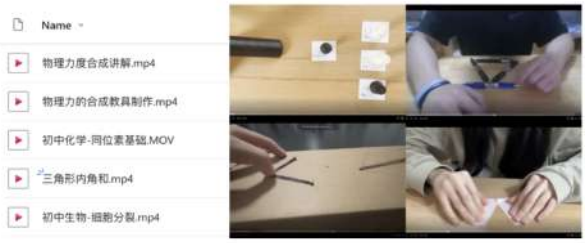

Fig. 3 Our currently catalogued video lessons (full links in the Appendix section)

c. *Development of assistive teaching tools and physical models with documented instructions on how to recreate them with common household objects*

Fig. 4 Authentic designs of assistive teaching tools for math (left) and physics (right)

d. *Facilitated student interaction with Baidu QianFan to test their understanding*

After every lesson, we will ask Baidu QianFan to design homework questions targeted at specific concepts taught in the lesson for students to complete. AI technology will also be incorporated to help students with their homework. This allows students to self-assess their understanding. Voice inputting and outputting features on Baidu QianFan increases the accessibility and interactivity of the learning process for visually impaired students.

e. *Additional volunteer assistance as needed*

If the students have any further questions after lessons or in their homework, additional tutoring sessions can be scheduled between the student and volunteers to resolve them.

Our model outlines a sustainable educational framework for visually impaired students. Currently, the lessons and assistive tools designed by our 5 student volunteers have been shared to 3 families with visually impaired children, and our digital lessons have received 11+ hours of streaming combined.

In the future, we will recruit more volunteers with different academic professions and interests to create a larger quantity of lessons spanning a wider range of subject areas, helping more visually impaired students with personalized needs, and expanding on the impact of our model.

Our solution establishes, arguably, the first fully comprehensive educational model targeted specifically for the visually impaired population. The lessons we create in the model are designed with holistic considerations of the observed learning processes and issues of visually impaired students in mind, incorporating assistive teaching tools to enhance their understanding through stimulating auditory and tactile senses. Our solution further utilizes advanced modern technology, incorporating AI tutors like Baidu QianFan to provide educational support. This idea of combining AI and human teaching is highly original and in close association with current trends of accelerated technological development.

4. Verification of Results

To ensure that our educational model is effective, we have tested the two most essential parts of our solution:

1. The significance of AI tutors such as Baidu QianFan in our model
2. The effectiveness of our teaching model in helping visually impaired students learn.

Although AI technology can already help our academic studies in various ways, an AI tutor designed specifically for visually impaired students has yet to be designed. Therefore, without the ability to create our own AI model, we must test the existing AI tutoring models in their capability to help visually impaired students. We have tested an AI tutor model from Baidu QianFan, for it is able read aloud its content, demonstrating high accessibility for visually impaired students. We asked the model to explain several concepts that visually impaired students often have trouble understanding. Based on our tested results, the AI tutor shows limitations in its ability to teach visually impaired students such concepts most of the time. That is, it either conveys information at rates that are too fast for these students to understand, or it provides vague details and is unable to give clear explanations. We have also tested its ability to design simple practice problems targeted at those concepts, as well as how well it can explain those problems. Based on our testing evaluations, the AI tutor has shown high capabilities in this process, presenting qualitied problems with clear explanations. Thus, we have proven that AI tutors are essential in our model, serving its function mainly in the step of designing and explaining homework problems to help students review content.

The next step is to evaluate the efficiency of our educational model. We designed three lessons that involved teaching with assistive teaching tools, encompassing the subjects of math, physics, and biology. The concepts we chose to teach were all designed for grade 8 students in public schools in China. Nevertheless, we taught the lessons to a visually impaired student, Wang Ru, who is currently in grade 6. In this way, we guaranteed that the student's understanding of these concepts was completely the result of our lessons because the knowledge was beyond his level of education. We evaluated his understanding based on his personal feedback (more information provided in the Appendix section) and his ability to solve simple problems generated by the AI tutor. Based on our evaluation, he demonstrated comprehensive understanding, as he "understood a great proportion of the lessons" and was able to answer almost all the problems correctly. After all lessons were taught, he acknowledged that the lessons were highly understandable, and that teaching through the approach of providing assistive teaching tools had made it easier for him to understand the concepts. In addition, he claimed that providing problems generated by AI after teaching the concepts was an effective way in consolidating his understanding. We have proven that our educational model is beneficial to visually impaired students' learning process through interacting with Wang Ru, giving us confidence to continue to work on this educational model in the future.

5. Discussion and Conclusion

In recent years, visually impaired people's adverse social circumstances have raised awareness and attracted efforts to help. Current solutions have their advantages, but few realize that supporting visually impaired students' education is the key to resolving disparities between the visually impaired and sighted populations. We came up with the educational model, the "Chinese Online School for the Blind (COSB)", after acquiring insights on the most effective way of teaching from evaluating former solutions. Differing from currently existing educational models, our educational model offers online courses designed specifically for visually impaired students, taking their learning progress into consideration. Our innovation excels in the efficiency of teaching, for nearly all lessons include simple assistive teaching tools that parents or visually impaired students can make with everyday materials. In this way, the courses are taught through visual, audio, and tactile senses, making it significantly easier for students to

understand. In addition, our solution innovates by involving AI tutors to provide and explain homework questions after every lesson. This reduces the workload of the teaching volunteers, as well as consolidates the understanding of concepts through homework practices for visually impaired students.

Though the model is currently in a very rudimentary phase, our innovation has been proven to be effective after testing with visually impaired students. The foundation of our educational model is extremely solid, for we have considered the most effective way of teaching specifically for visually impaired students and followed the trend of adopting highly advanced technology. We have faith that the educational model will be enhanced in the future, attracting more student volunteers to teach and more visually impaired students to learn. Our educational model will soon grow in influence and magnitude because the lack of educational resources is a common problem in China, and the online courses provided in our model can be easily accessed anywhere. Our solution may enhance the educational circumstances of visually impaired students, allowing them to receive higher levels of education and thus granting them more opportunities to make contributions to society. We believe that our innovative design can significantly resolve disparities between visually impaired people and normally sighted people in China and may even have an impact on the global visually impaired population.

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Appendix

Links to video lessons recorded by student volunteers and uploaded to COSB: COSB Videos

Recording of our trial lesson with Wang Ru: https://meeting.tencent.com/crm/N8jbQ6QXb0

In our project, one of our team members conducted research in Marburg, Germany to help us better understand the issues faced by the visually impaired. This also allows us to compare the circumstances of visually impaired individuals in Marburg and in China, helping us pinpoint the issue we want to solve with our project. This is the link to the research report at Marburg: CTB Marburg - Notes & Progresses.docx

In the initial stage of our project, we conducted interviews with 3 visually impaired college students and 3 families of visually impaired children. This is the link to our interview notes: Interview Questions & Notes.docx