Adapting an organic chemistry course for the visually impaired

Joseph Cramer Schneider* and Brandon G. VanNess (Mentor)

Department of Biology and Chemistry, College of Science

ABSTRACT

Incorporating visually impaired students into classes that rely heavily upon visual communication can be highly challenging. Organic chemistry presents special challenges and safety issues that need to be addressed in order to fully incorporate visually impaired students. This project relates different strategies and techniques that were utilized to adapt CHEM 201, the Survey of Organic Chemistry course, for the visually impaired. New technology allowed access to finely detailed tactile images that were previously inaccessible in the classroom. Strategies that provided audible relay of visual outputs permitted greater student independence in the laboratory setting. Overall, these strategies improved the relay mastery of course content and techniques while fully involving visually impaired students in the course. Financial support for the materials necessary to create these adaptations was provided by the Office of Disability Services and the Department of Biology and Chemistry.

INTRODUCTION

Organic chemistry is a course that relies heavily upon 2-dimension representations to communicate molecular structure and chemical reactions to the audience. In lectures, many teachers use chalkboard drawings and overhead projections to communicate this information to students. Testing procedures typically rely upon traditional 2-dimensional drawings and text on paper to garner a student's comprehension of the subject matter.

In the laboratory, organic chemistry is a very visually dominate subject. Students use instruments such as balances with digital outputs to record material mass, graduated cylinders with demarcations on the sides to record volumes of liquids by the location of their meniscus, and thermometers to determine the temperature of collected fractions during distillations. Some reactions even require that students follow the progression of the experiment by color changes or formation of precipitates, and some reactions require the separation of layers of immiscible liquids based on their differences in density.

For students with blindness or low vision (BLV), the inability to process visual inputs can hinder a student's success in the classroom if material is not presented in a manner that is accessible and comprehendible to the BLV student. As more BLV students undertake traditional, mainstream post-secondary education at major universities, faculty and staff must adapt their courses to incorporate this vastly different learner-type into their courses. This project highlights the different technologies and techniques that were employed to improve the inclusiveness and academic success of BLV students in organic chemistry.

METHODS

Lecture: One way to provide notes to BLV students is via an electronic format that can be accessed with an audio translation software, such as J.A.W.S.® or Window-Eyes™ screen reader software. While this works for many different lecture types, organic chemistry utilizes 2-dimensional drawings to communicate chemical structure (Figure 1), which screen reader software does not interpret.

Another way to provide notes is to use a Braille embosser, such as the Tiger embosser at the Office of Disability Services (ODS), which can convert text and simple images to tactile Braille format for BLV students. While the use of a Braille embosser provides reasonable text notes, the software is unable to translate simple images into highly detailed tactile format.

Creating highly detailed tactile images can be easily accomplished using swell touch technology, which causes images printed in black ink onto specially produced paper to swell into a tactile image when heated. This method, originally pioneered for organic chemistry by Supalo et al.,[1] was incorporated with notes produced on a Braille embosser to provide thorough, in-depth notes for the course. The American ThermoForm™ Swell-Form Graphics Machine (Figure 2) purchased by ODS made production of the tactile graphics easy. The swell-touch images were then bonded into the Braille printed notes by using double-sided tape (Figure 3).

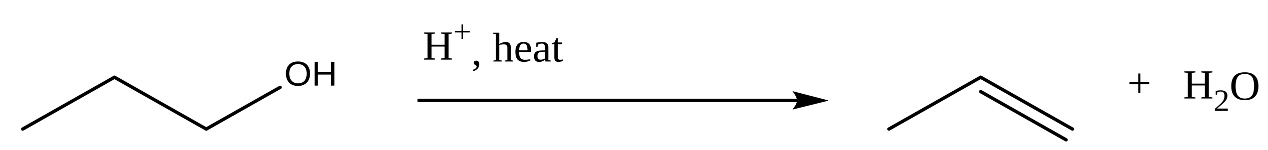

Figure 1. Example of organic chemistry diagrams that must be converted to tactile format.

Figure 2. American ThermoForm™ Swell-Form Graphics Machine

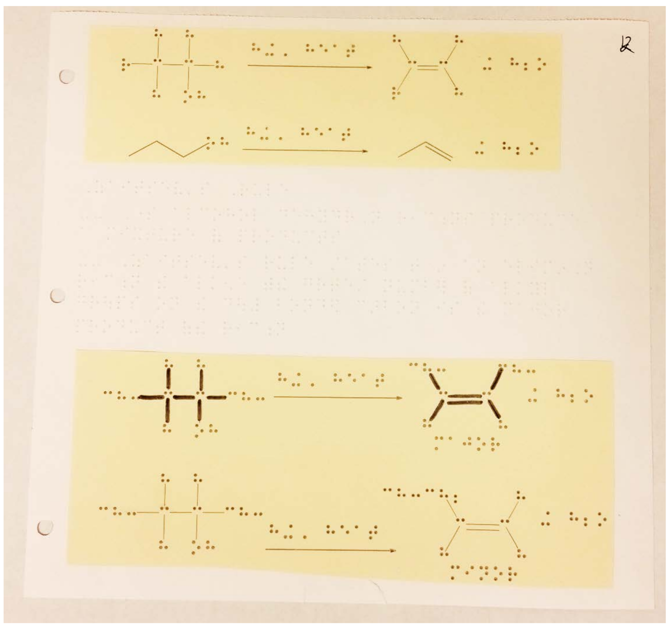

Figure 3. Examples of course notes prepared using Braille and tactile graphics

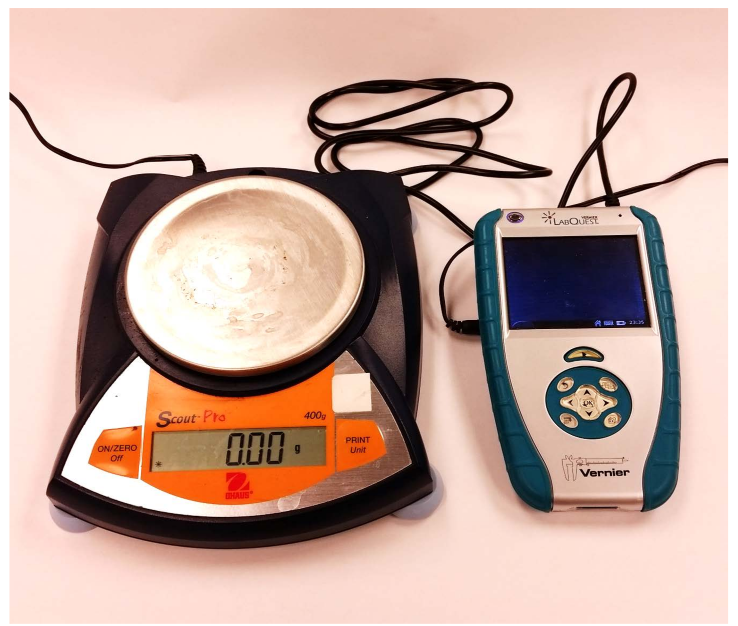

Figure 4. Talking Labquest and balance for determining mass audibly.

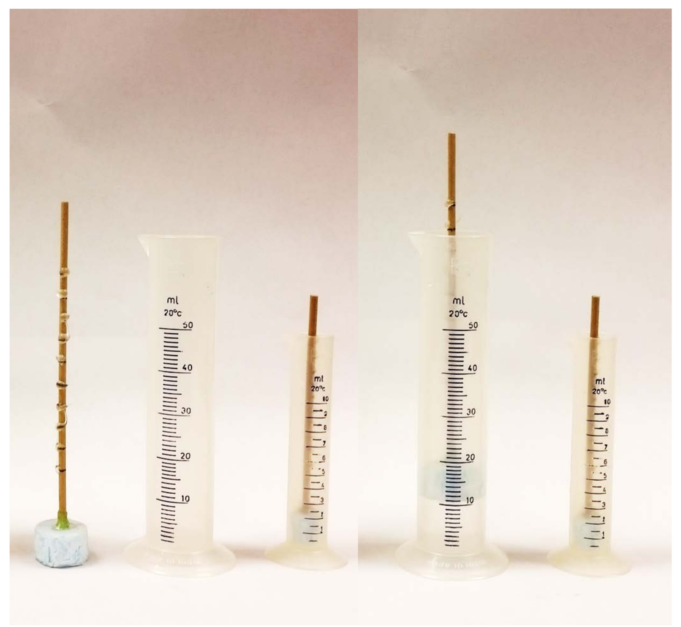

Figure 5. Graduated cylinders with floats for determining volumes of non-volatile solvents.

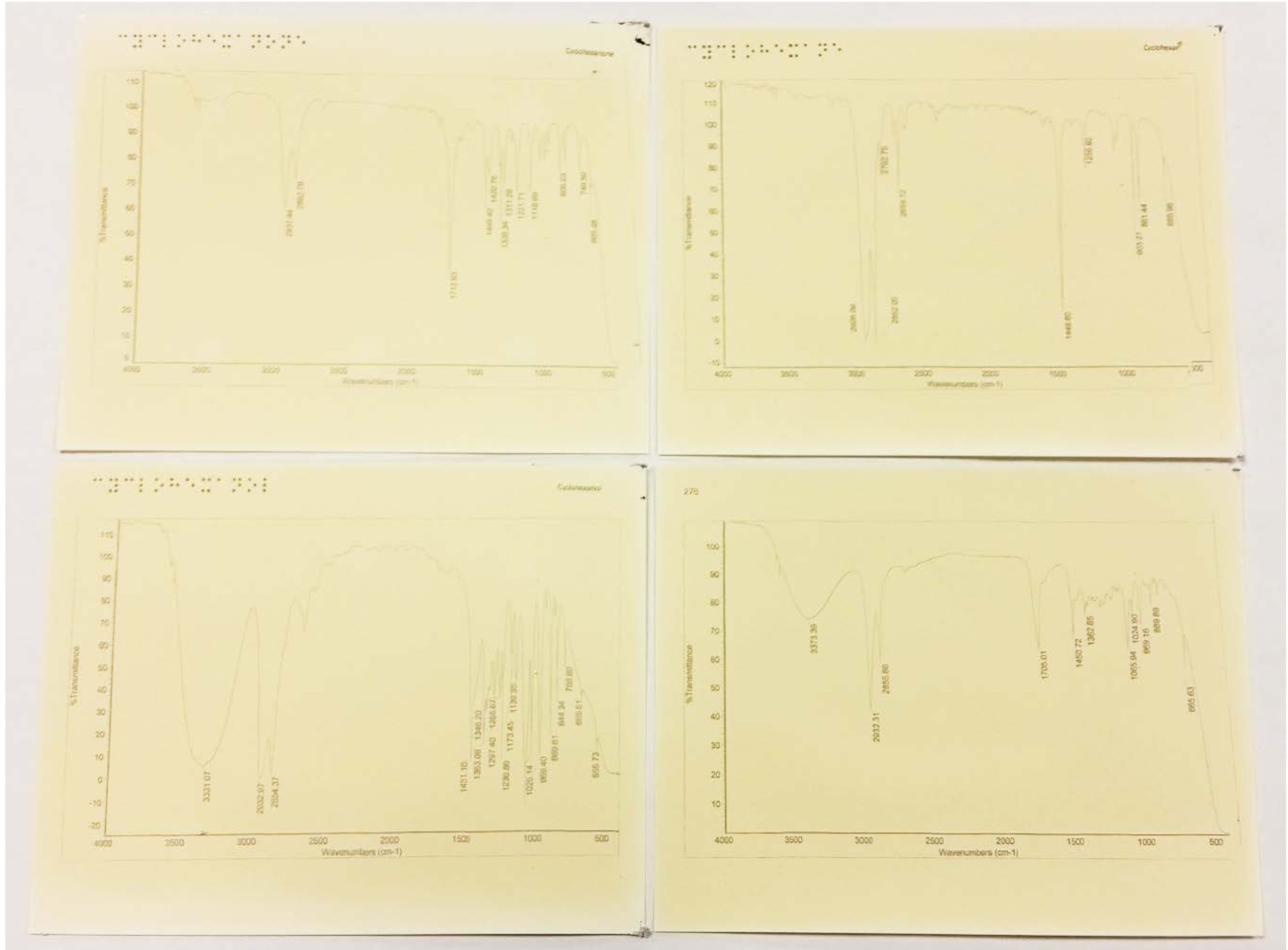

Figure 6. Infrared spectra printed in a tactile format for unknown identification.

METHODS

Laboratory: The most important portion of any laboratory experiment is safety. BLV students are still required to wear appropriate safety attire and must wear safety glasses throughout the experiment. The experiments were typically completed with the assistance of a lab partner, which helped improve the safety of the BLV student.

To improve independence of the BLV student, the mass of materials was measured using an Omaha Scout Plus balanced attached to a Vernier Talking LabQuest, a product owned by ODS (Figure 4). This technique provided an audible report of balance masses for the student. An external speaker was used to overcome the ambient noise of the safety hoods in the laboratory. The audible balance was used in many lab sections to determine the mass of starting reagents for reactions and the mass of the products formed.

A graduated cylinder with a demarcated flotation device (Figure 5) was employed for measuring non-volatile liquids, as described by Supalo et al. This method was useful in providing rough volume measurements of liquids such as water and vegetable oil, but the Styrofoam float would dissolve in organic solvents. Thus, volatile organic solvents were measured by mass difference and density calculation.

The infrared spectroscopy lab experiment was made accessible by printing the student's unknown compound spectrum on the swell-touch tactile diagram paper and developing the paper in lab with the American ThermoForm™ machine. Comparison of the unknown compound's spectrum to previously prepared tactile spectra of the known compounds was performed by the student using tactile comparison (Figure 6). These tactile comparisons allowed the student to interpret the infrared spectrum of the compound in a method similar to the rest of the class.

CONCLUSIONS

As more BLV students take mainstream courses, there is a growing need to prepare course materials to incorporate this learner type into mainstream courses. Preparing materials to adapt a traditional lecture to successfully educate a visually impaired student may be time consuming and may appear to be counterproductive to many educators, but all educators must strive to fully involve all learner types in their classes.

The techniques and technology highlighted above showcase different strategies to overcome the challenges presented in the visually rich organic chemistry course. Translating the 2-dimensional world of organic chemistry into both tactile and audible formats permits visually impaired students to partake and succeed in an organic chemistry course.

REFERENCES

1. Supalo, C.A.; Kennedy, S.H. *J. Chem. Ed.* **2014**, *91*, 1745-1747.
2. Supalo, C.A.; Mallouk, T.E.; Rankel, L.; Amorosi, C.; Graybill, C. *J. Chem. Ed.* **2008**, *85*, 243-247.

ACKNOWLEDGEMENTS

Financial support for the materials necessary to create these adaptations was provided by the Office of Disability Services and the Department of Biology and Chemistry at Morehead State University.