# Teaching Students in Grades 2-5 How to Access, Interpret, and Create Tactile Line Plots, Pictographs, and Bar Graphs

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## Introduction

Students who are braille readers must learn to be efficient in locating and interpreting information in tactile graphics, including line plots, pictographs, and bar graphs. Two instructional units were developed and field tested with 28 U.S. students in grades 2-5 to evaluate if use of the instructional materials increased their accuracy and efficiency with line plots, pictographs, and bar graphs. A secondary purpose of the study was to

collect impressions from teachers of students with visual impairments (TSVIs) about the readability of computer generated and fuser generated tactile graphics used by their students during the study.

## Methods

In summer and fall 2022, two instructional units were designed by the author and Dr. L. Penny Rosenblum, a researcher and teacher of students with visual impairments, with input from Susan Osterhaus and Sara Larkin, both of whom are nationally recognized consultants in math education for students with visual impairments. Each unit contained a teacher guide, a tactile graphic of the endangered species featured in the unit, four content graphics, an audio file of the unit content, fun facts about the animal, and extension activities that provided students the opportunity to create their own graphics. Throughout the units, students were encouraged to develop a consistent approach when exploring tactile graphics (e.g., top to bottom). They were taught specific strategies for approaching different types of graphics. Students received embossed (computer generated) graphics for one unit and fuser generated graphics for the other unit.

Participants were recruited through multiple social media posts and email lists. Informed consent was obtained from all study participants, and then instructional materials were sent to participating TSVIs. Prior to beginning the first unit, families provided student demographic data. TSVIs provided demographic data for themselves, completed a detailed teacher form for each unit, and were provided an opportunity to complete an optional follow-up survey.

## Results

In spring 2023, 28 dyads comprised of a student with visual impairments and their TSVIs participated in the study. Participants were from 16 geographically diverse states. All of the dyads completed the first unit, and 24 dyads completed the second unit. In addition, 16 TSVI completed the optional follow-up survey. Most TSVIs reported that their students were not familiar with or only somewhat familiar with locating and interpreting information in bar graphs, line plots, and pictographs before beginning the intervention.

After completing each unit, TSVIs rated how valuable the units were in helping their students to learn how to systematically explore as well as locate and interpret information in tactile graphics. A 5-point Likert scale with values from strongly disagree (1) to strongly agree (5) was used. The overall mean rating for the line plot and pictograph unit was 4.69, and the overall mean rating for the bar graph unit was 4.82, indicating that the TSVIs found the units very valuable. Several comments by TSVIs on the teacher forms and follow-up survey also suggested that the units were very valuable. For example, a TSVI shared her appreciation, “Thank you for this opportunity to improve my skill as a teacher to assist my students who read braille become stronger at reading charts and graphs. I will continue to use the wording of ‘verify’ to check what their fingers just did.”

The TSVIs reported that their students were motivated to learn about the endangered species featured in the instructional units. The audio files for each unit included the sound the animal made, and students enjoyed hearing the sound of a lemur and blue whale. Several students appreciated having fun facts about lemurs and blue whales to share with family members and classmates. The fun facts also provided students with foundational information about each animal. One TSVI reported that their “student LOVED the fun fact sheets and, in fact, did much better on the unit when that was done first. It gave her somewhat of a basis to understand something she has never seen or heard of before.” TSVIs were also provided expansion activities to complete with their students. Written directions and bags of materials (e.g., different textured materials and embossed graph paper to use in creating a bar graph) were provided. Both the students and TSVIs found these opportunities beneficial to solidify the skills the students learned during instruction.

On the follow-up survey, TSVIs were asked if their students were equally efficient with the computer generated and fuser generated tactile graphics or more efficient with one type of tactile graphics or the other. Five TSVIs reported that their students were equally efficient. Two TSVIs reported their student was more efficient with computer generated (embossed) tactile graphics, and six TSVIs reported their student was more efficient with fuser generated tactile graphics. Of these, two students had usable vision, and the visual contrast of the fuser generated tactile graphics was reported to be helpful.

On the follow-up survey, the TSVIs also provided feedback about the quality of the tactile graphics. Twelve TSVIs reported that the quality of the tactile graphics was sufficient, good, or great. One TSVI reported that it was difficult for their student to follow the horizontal gridlines, and another TSVI shared that the bar graphs were a little difficult to read “when the beginning bars were higher than the later bars.” A different TSVI noted that her student had difficulty “when reading the computer generated tactile graphic (specifically the bar graph) when she had to read the bars that were located farther away from the y-axis because she had to track through other bars to get to the y-axis. She also had difficulty reading bars that did not fall exactly on a gridline. But I don't believe these are due to the graphics itself.” In addition, one TSVIs stated that their “students loved the pictographs, but found reading the other charts challenging, especially when the top of the bar graphs were between two numbers.”

Students and TSVIs were invited to share suggestions for improvements and/or next steps. One student suggested a unit about monkeys. He also asked “if there was a next ‘level’ of this project that he could participate in.” His TSVI reported, “He is eager for more graphics like these, especially if there were graphics with increasing levels of difficulty.” Another TSVI thought that their “student would benefit from more questions drawing conclusions or comparing components.” In addition, one TSVI recommended “additional activities or even create a unit that teaches students to create various tactile graphs using their braillewriter or Desmos.” (Desmos is an accessible, online graphing calculator that can be used with screen reading software.)

## Take Aways

* Young students who read braille benefit from explicit instruction in systematic search patterns and strategies for locating, interpreting, and verifying key information in tactile graphics.
* When meaningful and engaging instructional materials are used, students are more responsive to learning new strategies that they can employ when locating and interpreting information presented in tactile graphics.
* Students who read braille benefit from opportunities to use tactile graphics created in a variety of ways (e.g., embossed, fuser-generated, collage).
* Students benefit from creating their own tactile graphics. Engaging in the creation process allows students to demonstrate their learning and offers TSVIs opportunities to provide feedback and reteach as needed.
* TSVIs can video their students periodically as the students are using tactile graphics to document student progress as well as identify areas for future instruction.
* TSVIs should work closely with general education teachers so that they can pre-teach necessary skills and ensure students will be able to focus on STEM learning during class.

## Limitations

This study has limitations. The sample size was small, with 28 students completing one instructional unit and 24 of these students completing a second instructional unit. Also, we did not develop the follow-up survey until the end of the study. Therefore, not all TSVIs were motivated to complete the follow-up survey as some students had already finished the units.

## Conclusion

This study is a beginning step in developing engaging instructional materials to support young braille readers in learning how to systematically locate and interpret information presented in tactile graphics. It is clear from these pilot data that students benefit when they are engaged in learning and have scaffolded instruction. TSVIs reported that the units provided them with an efficient and cohesive method for introducing and/or reviewing skills students must use when working with bar graphs, line plots, and pictographs.

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