Teaching Data Visualization to Kids

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Fig. 1. Kids playing the Match It! data visualization card game.

Abstract—One of the first steps to expanding data visualization literacy is to recognize and name different charts, graphs, and diagrams. In a set of activities used with different sets of elementary school-aged children, I show one way to help expand children's data visualization literacy. This activity is a set of three activities when teamed together show kids the variety of graphic types available to them and then provide hands-on sketching and gaming opportunities to further learn the material. The activities have yet to undergo an evaluation but qualitative feedback suggests these activities are promising to promote excitement and learning.

Index Terms— sketching templates; activity procedures; dataviz games; examples

1 Introduction

Think of all the things you learned in elementary school: How to read. How to write. How to count. How to do add, subtract, multiply, and divide. These are all learned skills, things that we are not innately born knowing how to do.

Just like these, reading graphs is a skill. We are taught how to read line, bar, and pie charts in elementary school because they have been around longer than others and are used the most. But there is a wide array of graph types outside of these standard types that we can use to visualize data. In the right context—with the right content—some of these graphs are inherently better than standard graphs while other times they enable us see patterns and relationships that might not be as apparent in standard forms.

This data visualization activity is actually a set of three activities taught within a 1- to 1.5-hour session and targeted primarily to elementary school-aged children (approximately 8 to 13 years old), though it could easily be adapted for older audiences. The session has been conducted in person three times at an elementary school in northern Virginia and a shorter version was conducted in two one-hour virtual workshops in April and May 2020.

There are three primary goals for this activity. First, to expose participants to different graphs outside the standard graphs like lines, pies, and bars. Second, to have participants *do* something physical and active. Third, and especially important for kids, to have fun.

The activity has three parts:

1. First, a short lecture, around 20 minutes. The lecture exposes the students to different graph types, using examples that are light-hearted, engaging, and fun. The lecture primarily focuses on maps because they are easily recognizable and can take various formats, such as choropleth maps, dot density maps [1], tile grid maps [2], and animated maps [3]. Other graphs, like Sankey diagrams and dot plots, can also be shown. For children, the presentation focuses on data and visualizations that are engaging and easy to understand (see Appendix Figure 1).
2. Second, a drawing exercise. Here, students draw a map of one floor in their home. Then, using tracing paper, they add data on top of the map—for example, differently-sized bubbles to their favorite rooms, lines showing their paths through the house, or smiley faces for the most fun room. Students can be shown examples to help get them started, but doing so has shown to prime the students along those paths and perhaps to discourage initial creativity. A posted list of topics after the activity helps demonstrate the array of data available (see Appendix Figure 2).
3. Finally, a *Match It!* data visualization card game tournament [4]. In the *Match It!* data visualization card game, each player gets a card and places it on the table

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face up. The rest of the deck (each deck contains 31 cards in total) is placed in the center face up, with the top card face down. That top card is then flipped over and the first player to identify the matching card calls out the graph and takes the card, revealing another card below. The game continues until there are no cards left and the person with the most cards wins. Each student receives a deck and a "Tournament of Champions" is posted to the wall. Students are given five minutes to study the *Symbol Guide* card, which is the glossary for the game, and the games then begin (see Figure 1 and Appendix Figure 3).

2 Materials and Preparation List

The following lists materials and considerations for this activity:

1. **Materials:** presentation slides; paper; tracing paper; colored pencils; and *Match It!* game cards.
2. **Time to run activity:** 1.5 hours (in-person); 1 hour (virtual session does not include the *Match It!* card game)
3. **Number of participants:** 25 (in-person); 60 (virtual)
4. **Number of facilitators:** 1, though an additional facilitator would be advantageous
5. **Ease for facilitator:** Moderate (3)
6. **Ease for participants:** Easy to very easy (1-2)
7. **Cost:** Approximately $400 for Match It! game cards and other supplies (in-person)
8. **Approximate time to prepare the activity:** Slide preparation time plus arranging paper and opening card packages (15-60 minutes, depending on the amount of time needed for presentation slide preparation)
9. **Approximate time after the activity:** 10-15 minutes

3 Assessment

Students have responded well each time I have conducted this activity. Especially in the in-person session, the card game generates real excitement. The card game is not part of the virtual session but attendees responded well to the lecture and drawing activities. More than 80 people attended the first virtual session in April 2020 [5].

These activities have not yet been assessed in a formal evaluation framework. The purpose of the evaluation is to determine which visualizations children can correctly identify.

I have been in discussions with several elementary schools in northern Virginia to conduct such an evaluation, but the COVID-19 pandemic halted those efforts. The draft evaluation plan consisted of working with three different classes of students. The evaluation would consist of five different elements split across the classes:

1. *Lecture*. A 20- to 30-minute lecture where the instructor will teach students (using presentation slides) about 15 different graphs using real-world examples. The drawing exercise could be included in this section of the lesson with the primary purpose as an engagement strategy.
2. *A column-matching group exercise*. Working in pairs, students in two of the three classes will work together on an exercise. Instructors will provide paper to the students on which one column will contain a list of actual graphs (different from those in the lecture). On the other column will be a list of names of those graphs. Students will need to draw a line connecting the correct graph with its name.
3. *Individual writing exercise*. Students will receive a second piece of paper with a list of actual graphs (different from those in lecture and in the first exercise) and write the names of each from memory.
4. *Memory game tournament (Game condition)*. There are two options for this part of the evaluation. One would use the existing *Match It!* card game. In another, students will receive a set of cards, each with a different graph and appearing in pairs. Each card will have a picture of a graph on one side (same set of graphs as in the individual writing exercise) and the school logo on the other. Students will be asked to play the standard memory matching game. Winners will proceed through a standard tournament to ultimately crown a class champion.
5. *Follow-up multiple choice quiz*. The next day, the instructor will return to administer a 10- to 15-minute multiple choice quiz that will use an entirely new set of graphs and ask students to identify each one. Ideally, the instructor would return a month later and administer the same quiz again to the students to text longer-term retention.

The table below summarizes the different activities for each of the three class.

	Lecture	Column-matching exercise	Individual writing exercise	Card game	Multiple choice quiz
Class #1	✓				✓
Class #2	✓	✓	✓		✓
Class #3	✓	✓		✓	✓

4 Reflection and Conclusion

The activities presented here are just one way in which people—kids in particular—can learn how to expand their data visualization literacy. The proposed lessons are just a first step towards developing more sophisticated data visualization literacy. These exercises focus simply on *naming* different data visualizations and not formal instruction on how to read or understand the data visualizations [6]. But this first step is as important and developing data visualization literacy at early ages is "vital for combating misinformation, and for progressing towards a more informed society" [7].

The next time they open their newspaper or open their favorite tool to create a graph, they will hopefully not feel bound by the graph types in the default menus. In this set of activities, a standard lecture format is paired with two hands-on exercises: A drawing exercise helps kids explore their own personal data and a card game exposes them to new graph types and encourages competition and play. Additional avenues to explore are alternative games and a formal evaluation of the effectiveness of the activities.

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