

AI as Collaborative Tool for Teachers for Effective Integration of Dynamic Geometry Tools

S. Asli Özgün-Koca¹, Michael Meagher², & Todd Edwards³

¹Wayne State University, ²Brooklyn College, ³Miami University

Abstract

In this paper, we discuss our collaboration with ChatGPT in the creation of a fraction bar applet in GeoGebra. As we document our successes and challenges as we use AI to develop the applet, we illustrate how AI's role as a collaborator that helps teachers augment and extend their instructional capabilities.

Keywords: artificial intelligence, ChatGPT, GeoGebra, teacher collaboration, fractions

1 Introduction: A Teacher's Challenge

You are a fourth-grade teacher, and many of your students are struggling to understand basic fraction concepts. Some can identify simple fractions like $\frac{1}{2}$ and $\frac{1}{4}$, but they struggle to grasp what the numerator and denominator represent in more complex cases. They mix up which number indicates the number of parts versus the number of shaded parts, and they find it difficult to compare fractions visually.

Your textbook suggests using fraction strips (see Figure 1) to help students visualize fractions and compare their sizes. However, the activity requires cutting out and distributing paper strips, which is time-consuming and messy. You want to find a digital alternative that allows students to interact with fraction strips dynamically and explore concepts at their own pace. Ideally, students could use this tool both in class and at home, reinforcing their understanding beyond the classroom.

You visit GeoGebra.org, a website that offers thousands of free interactive math resources. However, none of the available fraction tools match the way your textbook presents fractions. You want to build your own custom GeoGebra sketch, but you have never created one before. Unfortunately, you don't have a tech-savvy colleague to assist you, and you need the tool within the next two days for your lesson.

What do you do?

With limited time and no prior GeoGebra experience, you turn to AI as a collaborator. You open ChatGPT and type: "I need to create a GeoGebra applet that dynamically displays fraction bars. How do I start?"

This paper explores how **AI can serve as a critical partner in developing technology-integrated materials**, focusing on the iterative process of human-AI collaboration. Using the case of fraction bar sketch development, we examine:

- How teachers can interact with AI to overcome technical barriers in digital tool creation.
- The strengths and limitations of AI in supporting GeoGebra applet design.
- The role of the teacher in refining AI-generated outputs for classroom use.

In this paper, we discuss our collaboration with ChatGPT in the creation of a fraction bar applet in Geogebra. As we document our successes and challenges as we use AI to develop the applet, we illustrate how AI's role as a collaborator that helps teachers augment and extend their instructional capabilities.

This challenge of creating interactive sketches is not unique to one teacher—many educators struggle to integrate technology effectively into their classrooms due to barriers in technical knowledge, time constraints, and lack of professional support. Research on teacher technology integration highlights these difficulties, particularly in using Dynamic Geometry Environments (DGEs) like GeoGebra. The following section explores these challenges through the lens of the Technological Pedagogical Content Knowledge (TPACK) framework, which helps explain the types of knowledge teachers need to implement digital tools in mathematics instruction successfully. This framework provides a foundation for understanding how AI might address some of these barriers and support teachers in developing effective instructional materials.

2 Literature Review: TPACK and Teacher Knowledge for Technology Integration

Integrating technology requires many components of teacher knowledge in a complex and dynamic way. The Technological Pedagogical Content Knowledge (TPACK) model emphasizes the need for teachers to blend their understanding of content, pedagogy, and technology in order to effectively integrate technology into their teaching (Mishra & Koehler, 2006). Whether creating one's own sketches or using the work of others, integrating Dynamic Geometry Environments (DGEs) like GeoGebra into mathematics instruction requires teachers to have specific technical knowledge. As an action technology defined by Dick and Hollebrands (2011), DGEs provide a platform for students to interact with mathematical objects and act on them. While the default for DGEs is a blank canvas for students to create their own objects, many teachers prefer using pre-created sketches to allow students to focus on concepts (as evidenced by the “over 1 million free classroom resources” created by its multilingual community (GeoGebra, 2025). However, making those pre-created dynamic and interactive sketches can be challenging for teachers, particularly those without extensive experience in programming or the software's advanced features. This article investigates the role of artificial intelligence (AI) as a support tool for teachers in creating sketches that can be used for teaching with conceptual understanding. We present the collaborative development with GeoGebra and AI of sketch to visualize fractions. The aim is to explore how AI can support teachers to integrate technology seamlessly into their instruction while mitigating common technical obstacles.

2.1 Teacher's Technological Needs

Building on Shulman's' Pedagogical Content Knowledge, TPACK model highlights the complex teacher knowledge required to create effective sketches and the many interacting components of that knowledge. Listiawan et al. (2024) detailed some of those knowledge types, for instance, teachers use knowledge to create and select appropriate DGE representations (TCK) and need to understand DGE functions and troubleshooting (TK)). In this paper, we will focus specifically on teacher's technological

knowledge and how AI might leverage teachers' work in creating DGE environments by providing technical support. Boiling and Beatty (2012) address the technical challenges K-12 teachers face when integrating technology into their classrooms and offers suggestions to help them overcome these issues. "There is a level of technological proficiency they must have in order to successfully use these technologies...educators who encounter technology so complex that it is confusing or difficult to use such that they need to rely on others to implement it are less likely to effectively use that technology with their students" (pp. 141-144).

Technical proficiency with dynamic geometry software is essential for successful technology integration as well. To support teachers, professional development and training are crucial for ensuring they stay updated with technological advancements and technical skills. Jones et al. (2009) discussed the establishment of a professional development network to support teachers using DGE software like GeoGebra, emphasizing the value of collaborative learning. They underlined the value of professional learning communities in supporting teachers as they adopt GeoGebra, facilitating the exchange of best practices. Mavani et al. (2018) also highlighted the importance of collaborative engagement between teachers as they integrate technology into their teaching. As they closely studied two teachers as they integrated DGEs into their teaching, one of the main challenges that teachers faced was their computer skills in the technical sense. Hohenwarter et al. (2009) echoed this by stating "it has been suggested that adequate training and collegial support have the potential to boost teachers' willingness to integrate technology into their teaching" (p. 137). Studies show that merely supplying technology does not ensure its effective integration for mathematics learning; carefully designed comprehensive training and collaborative learning with colleagues are essential (Lavicza et al., 2010).

Hohenwarter et al. (2009) argued that "while many teachers are willing to experiment with new technologies they often are hindered by initial difficulties such as the lack of access to technology, basic skills for using the new technologies, and knowledge about effective integration of new tools into their teaching practices" (p. 136). In their study with 44 secondary school teachers in a professional development to identify challenges that they face with a specific DGE tool they found a "strong correlation between difficulty ratings of tools and activities... complex tasks negatively influenced tool ratings" (p. 142). Moreover, specific difficulties were "constructing geometric figures, properly using dynamic geometry tools, and inputting appropriate algebraic syntax" (pp. 143-144). These findings underscore the importance of targeted professional development to enhance teachers' effective use of technology in the classroom. Many teachers use DGE without formal training, driven by personal interest or peer encouragement. Research shows that access to technology alone isn't enough; proper training and collegial collaboration are crucial.

AI has the potential to address several challenges identified in the literature. Teachers often struggle with learning new digital tools independently, require professional communities for support, and face significant time constraints when integrating technology into their instruction. AI can serve as a bridge in these areas by providing real-time feedback, troubleshooting technical issues, and guiding teachers through the iterative process of constructing digital resources. Unlike static professional development workshops, AI can act as an on-demand collaborator, offering personalized assistance tailored to a teacher's specific needs.

This paper explores AI's role in supporting teachers as they develop GeoGebra applets, focusing on how AI-assisted iterations help teachers refine and evaluate technology-based instructional materials. The following section provides a case study illustrating this dynamic interaction, demonstrating AI's potential as a partner in digital tool creation while underscoring the importance of teacher expertise in guiding and refining AI-generated outputs.

3 AI-Supported GeoGebra Sketch Development

The collaboration between the user and AI was an iterative process including the following steps:

Initiating Requests: The user sought AI support for developing GeoGebra sketches, asking for guidance on structuring code, implementing interactive features, and overcoming technical challenges. Requests evolved from general inquiries about feasible approaches to specific troubleshooting and refinement of AI-generated suggestions.

AI's Responses: AI responded by offering structured explanations, suggesting GeoGebra commands, and proposing different implementation methods. It adapted its responses based on user feedback, refining its suggestions when previous solutions did not fully meet expectations.

Iteration and Refinement: The user tested AI-generated solutions in GeoGebra, identifying errors, limitations, or unexpected behaviors. AI responded to the troubleshoot issues, suggesting modifications to correct errors or improve efficiency. The process was cyclical, with the user refining AI-generated code and AI adjusting recommendations based on feedback.

We began by asking ChatGPT how to construct a fraction bar visualization in GeoGebra. Our goal was to create an interactive sketch where students could adjust the number of equal partitions (denominator) and the number of shaded sections (numerator) using sliders. Below, we provide prompts that we used with AI to construct our GeoGebra sketch. These prompts are intentionally detailed to give the AI more context and constraints, which we've found leads to more accurate and useful responses. Note that we provided ChatGPT with specifics regarding the format of its responses, including our desire to work one step at a time and to be provided with construction choices.

As you read the steps that we took with ChatGPT to construct our sketch, it's important to consider the ever-evolving nature of technology. The results our prompts gave in May are different from those obtained in August. Because AI tools change over time, our aim here is not to provide a note-for-note script for reproducing the same sketch. Instead, we want to share our experience as an example of how collaborating with AI can guide and enhance the process of creating dynamic sketches in GeoGebra. As Figure 1 illustrates, the chatbot responded with three options for creating a sketch.

Figure 1

An initial request posed to ChatGPT.

I want to create a fraction bar visualization in GeoGebra, but I need your help in a structured, step-by-step manner. For instance, don't give me an entire set of instructions at once. Instead, please provide 2 or 3 broad options for how we might approach the task. I'll choose an approach, and then you can give me just one step at a time. Also, don't assume any method will work—let's test each step before moving forward. Keep responses concise, focusing on one clear instruction at a time so I don't get overwhelmed.

Got it! Here are three broad approaches we could take to create a **fraction bar visualization** in GeoGebra:

- 1. Rectangle + Segments Approach**
 - Draw a rectangle for the whole fraction bar.
 - Use segments to divide it into equal parts.
 - Shade a portion to represent the fraction.
- 2. Dynamic Sliders Approach**
 - Create a rectangle that adjusts based on slider values for numerator and denominator.
 - Automatically divide and color the fraction bar dynamically.
- 3. Grid-Based Approach**
 - Use a pre-defined grid.
 - Color cells to represent fractions rather than using a single bar.

Which approach do you want to try first?

Note: This screenshot shows the beginning of the collaborative process where the teacher asks ChatGPT for help creating a fraction bar applet in GeoGebra.

While we focused on the “Rectangles + Segments” approach for this case study, ChatGPT also suggested alternatives such as a dynamic sliders method and a grid-based approach. We already incorporated dynamic sliders into our chosen design (Editor’s Note: the maximum of 10 for the slider was chosen for readability, but the reader is encouraged to try other values), but we never explored how either of these alternatives might have changed the look, functionality, or classroom use of the sketch. At the time, we simply needed to start somewhere, and this approach allowed us to move forward quickly while still meeting our instructional goals. There is no end to the options and variations one could follow, but knowing the potential options helped, and our priority was to select a workable starting point and see it through. Starting with “Rectangles + Segments,” we entered the suggested command into GeoGebra (Figure 2), which successfully created a rectangular region representing the unit (Figure 3). At this stage, the sketch lacked a representation for the numerators.

Figure 2

Indicating our preference for the “Rectangles + Segments” approach.

Let's go with the Rectangle + Segments Approach.
What's the first step?

Great choice! The first step is to draw a rectangle to represent the whole fraction bar.

Step 1: Create the Whole Fraction Bar

1. Open GeoGebra and ensure you are in the **Graphics** view.
2. Use the **Polygon tool** (or type the following command in the Input bar):

scss

Copy
Edit

```
Polygon((0,0), (10,0), (10,2), (0,2))
```

This creates a rectangle with a width of **10 units** and a height of **2 units**.

3. Press **Enter** to execute the command.

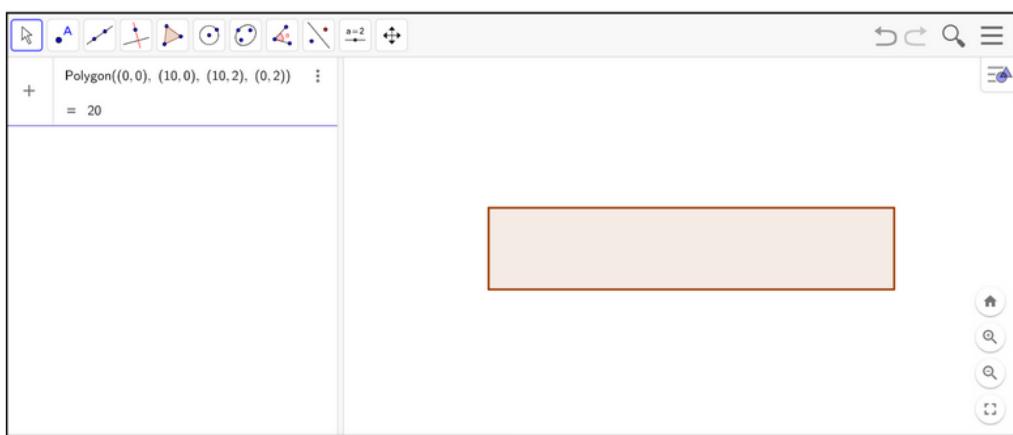
Let me know once this works, and we'll move to Step 2!

Note: The user communicates their choice to proceed with the Rectangles + Segments method.

The results of the command `Polygon((0,0),(10,0),(10,2),(0,2))` is shown in Figure 3.

Figure 3

Resulting GeoGebra sketch.



Note: A basic rectangular region has been created, but it does not yet show fractional divisions.

Next, as illustrated in Figure 4, ChatGPT recommended using the Sequence command to generate vertical segment dividers.

Figure 4

ChatGPT recommended the Sequence command to mark divisions of the unit.

Done

Nice! Now, let's **divide the rectangle into equal parts** to represent fraction denominators.

Step 2: Add Vertical Segments to Divide the Bar

1. Decide how many parts you want to divide the bar into (e.g., **4 for fourths, 5 for fifths, etc.**).
2. Use the following command to create vertical segments at equal intervals:

For 4 equal parts:

Sequence(Segment((i*2.5,0), (i*2.5,2)), i, 1, 3)

- This creates vertical lines at **x = 2.5, 5, and 7.5**, dividing the bar into **four equal sections**.
- If you want a different denominator, replace **2.5** with **10/n**, where **n** is **your denominator**.

3. Press **Enter** to execute.

Let me know if this works, and we'll move to shading part of the fraction!

Note: The AI suggests a structured approach to create the fractional divisions.

Entering the Sequence command resulted in a divided fraction bar; however, the divisions were fixed. The resulting sketch didn't provide a way to select (or change) the numerator or denominator. This is shown in Figure 5.

Figure 5

Static representation of fraction in GeoGebra.

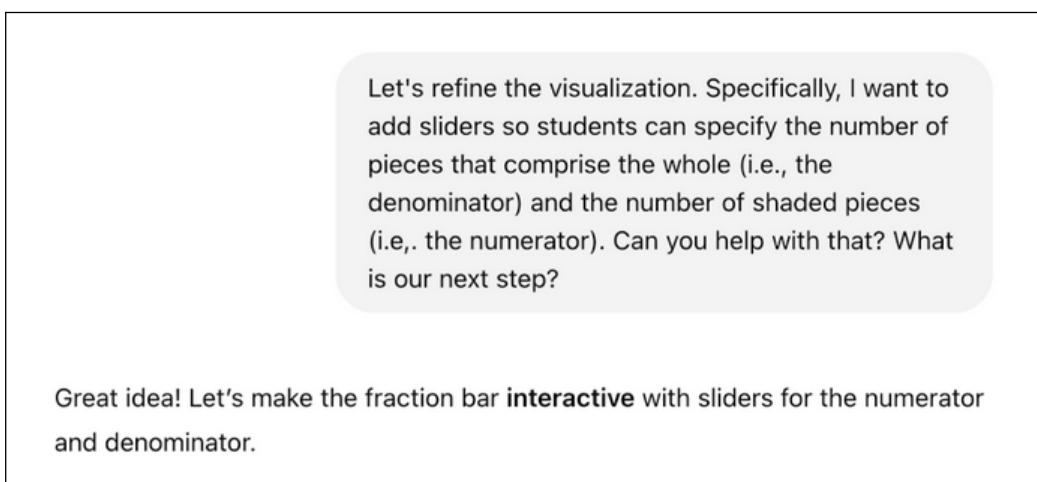


Note: The fraction bar is divided, but lacks interactive controls (sliders).

To make the sketch dynamic (so that students can interact with it), we asked ChatGPT how to introduce interactivity using sliders. This request is illustrated in Figure 6.

Figure 6

Asking ChatGPT to add interactivity with sliders.

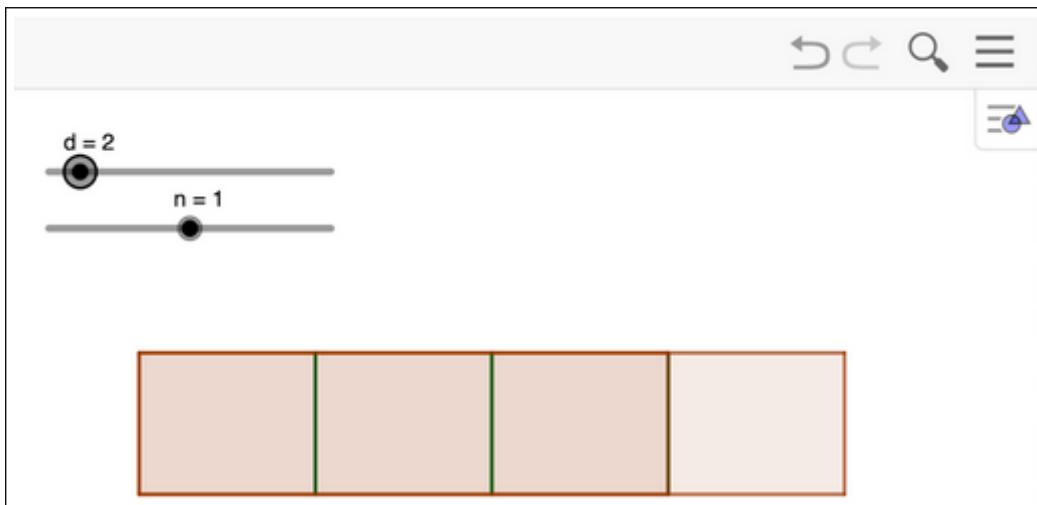


Note: The user requests dynamic features to allow student manipulation of fractions.

ChatGPT suggested defining a denominator slider (`d = Slider(1, 10, 1)`) and numerator slider (`n = Slider(0, d, 1)`). This adjustment added sliders but unfortunately they were not linked to the shaded rectangles (Figure 7).

Figure 7

Sliders added but not yet linked to the visualization.



Note: The numerator and denominator are shaded but don't reflect the values depicted by the sliders.

We indicated this problem to ChatGPT, as illustrated in Figure 8.

Figure 8*Suggested steps for linking the denominator slider to the fraction bar.*

The sliders exist, but they aren't linked to the fraction bar. How can I make the segment divisions and shading update dynamically when I adjust the sliders?

Now, let's link the sliders to the fraction bar so the number of divisions and shading update dynamically.

Step 5: Dynamically Divide the Bar Using the Denominator Slider

1. Modify the vertical segments to update based on `d` (denominator slider)
 - Delete any existing segment dividers.
 - Enter the following command in the Input Bar:

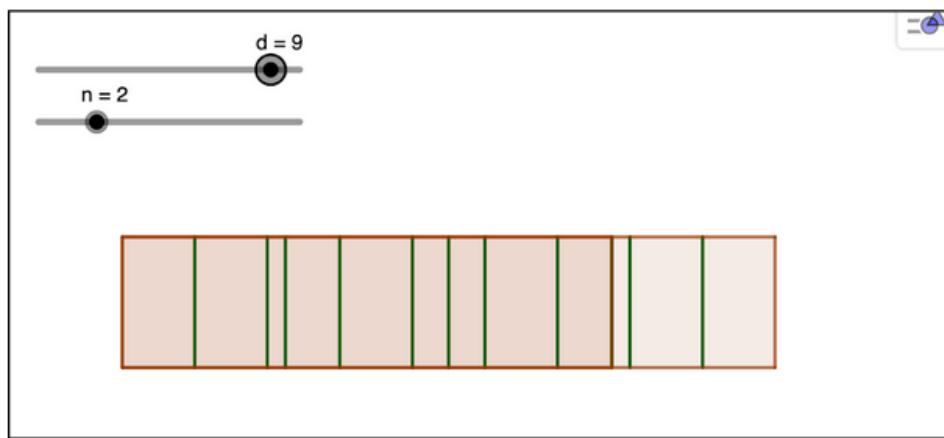
```
CSS Copy Edit
Sequence(Segment((i * (10/d), 0), (i * (10/d), 2)), i, 1, d - 1)
```

 - This dynamically places vertical lines at $x = (10/d), 2(10/d), 3(10/d), \dots$, ensuring equal divisions.
2. Test: Move the `d` slider—does the number of divisions adjust accordingly?

If this works, we'll move to shading dynamically based on `n`!

Note: ChatGPT provides instructions for connecting the slider to the visual representation.

Although this step linked the numerator slider to the fractional region, an unexpected issue emerged—old fraction divisions remained visible alongside the updated ones.

Figure 9*Old fraction divisions displayed alongside updated ones.***Note:** Multiple fraction divisions appear due to static objects remaining in the sketch.

We asked how to remove the static shading and segments. The chatbot recommended deleting each item separately; however, we determined that hiding or deleting outdated segments (i.e., 11) and shadings (i.e., q2) would resolve the problem more efficiently (and less destructively), so we opted to ignore the chatbot's suggestion.

Figure 10*ChatGPT's suggestion for removing unnecessary objects.*

I think that worked, but the old shading and old denominator appears to still be there.

Sounds like the old shading and segmentation elements are still visible. Let's clean up and ensure only the **current** fraction representation is displayed.

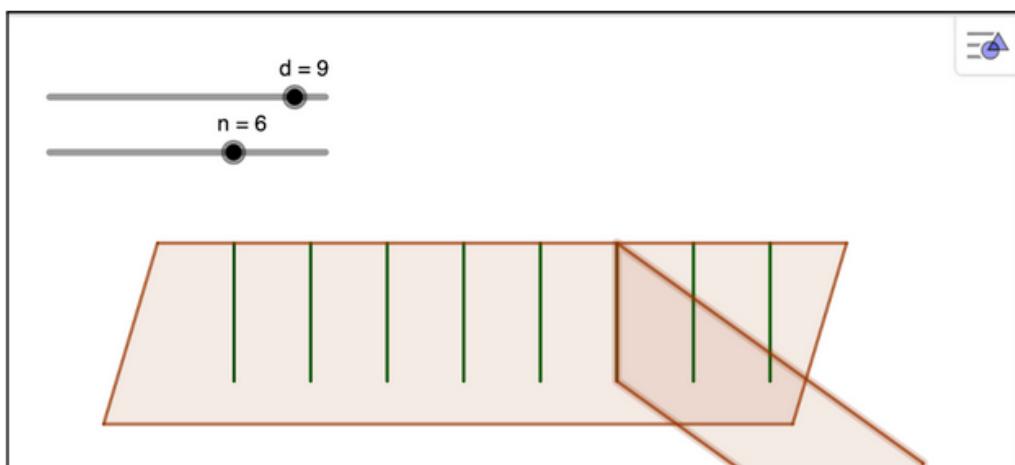
Step 7: Remove Old Elements & Ensure Dynamic Updates

1. Delete any static shading and segment objects
 - In the **Algebra View**, look for manually created **Polygon** and **Segment** objects.
 - Right-click and **Delete** them.
2. Ensure the fraction visualization updates dynamically
 - If duplicate elements persist, they might be leftover from previous steps.
 - Click on the **Sequence** command in Algebra View and ensure it's linked to **d**, **not a fixed number**.
3. Manually adjust **n** and **d** sliders to confirm everything updates in real-time.
 - If the old fraction bars still appear, try resetting the view (**View** → **Refresh** or **Ctrl + R**).

Does this clear things up? If you still see ghost elements, we can refine further!

Note: ChatGPT recommends deleting objects individually.

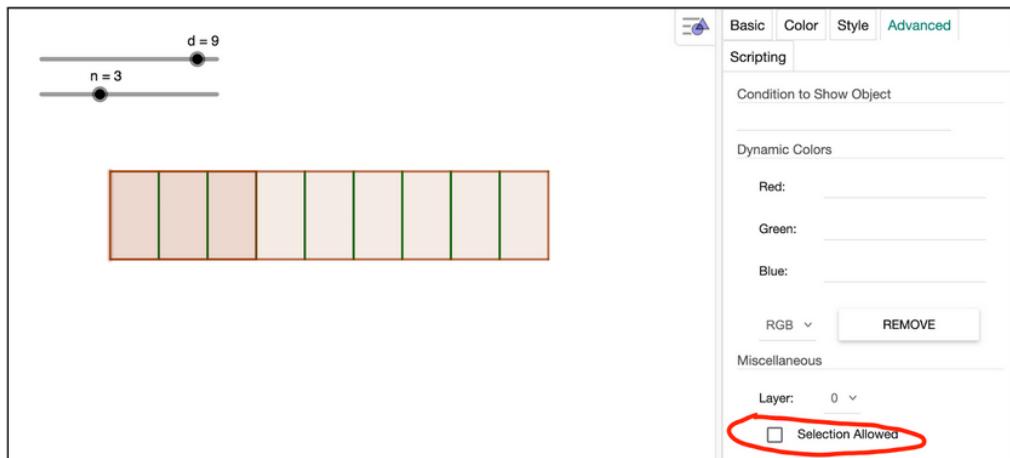
After resolving this issue another problem became evident: the shaded region was draggable. This is illustrated in Figure 11.

Figure 11*Draggable shaded regions in GeoGebra.***Note:** Students can inadvertently move the shaded regions, disrupting the intended visualization.

To prevent unintended manipulation, we had to manually disable selection for the quadrilaterals in GeoGebra's object properties as shown by the circled region in Figure 12.

Figure 12

Disabling selection in *GeoGebra* object properties.

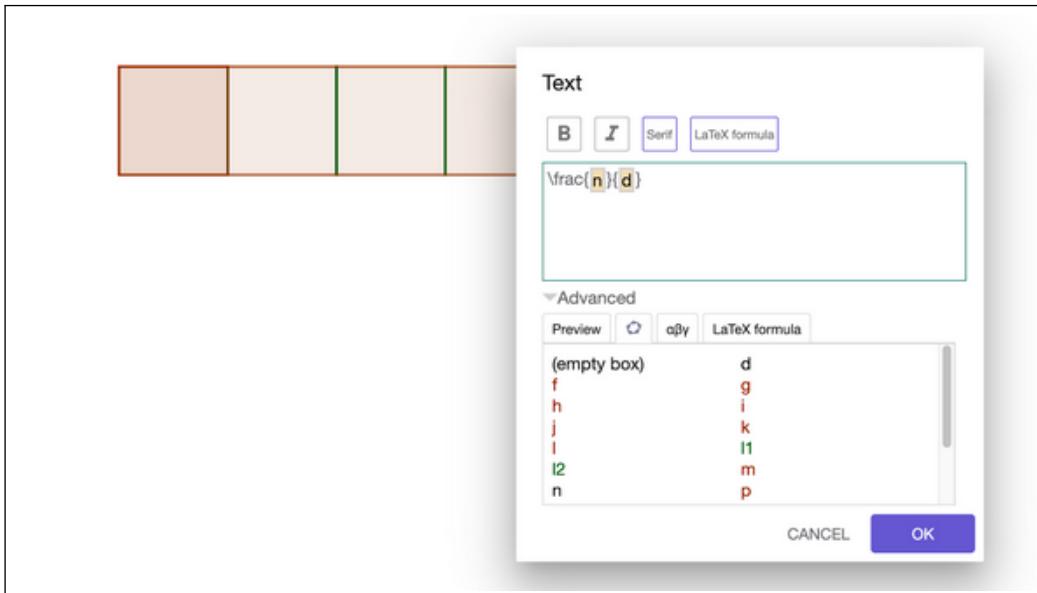


Note: The circled region shows where to disable object selection.

With the fraction bar now functioning correctly, we shifted focus to the symbolic fraction display. ChatGPT's first suggestion used simple text formatting (n/d), which did not match the stacked fraction notation students expect in textbooks. We requested a proper fraction format, and the AI proposed using LaTeX (`\frac{n}{d}`) as shown in Figure 13.

Figure 13

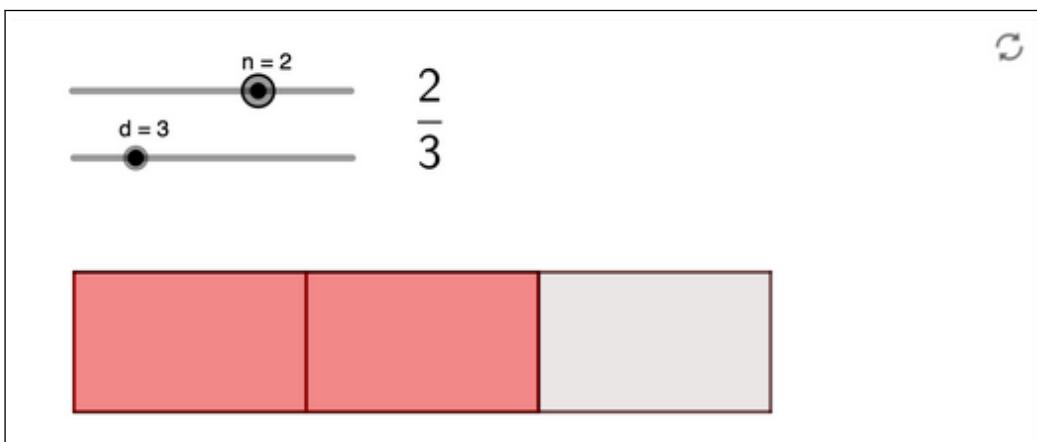
Using LaTeX formatting for proper fraction display



Note: ChatGPT suggests LaTeX syntax for displaying fractions in standard mathematical notation.

With that step completed, we had a fully functioning sketch that students could use to represent various fractions by specifying various numerators and denominators via the sliders in the sketch. A final version of the sketch is available at the following url: <https://www.geogebra.org/m/q8ajjkqh>.

Figure 14
Completed fraction bar sketch.



Note: Final interactive sketch with working sliders and proper fraction display.

4 Debriefing the Collaboration with AI

This collaboration highlights the potential of AI as an assistive tool for educators integrating dynamic technology into instruction. AI provided structured support, alternative methods, and troubleshooting insights, while the user played a critical role in testing, refining, and aligning the outputs with educational objectives. The process demonstrated that AI can be a valuable co-developer in instructional design, but human expertise remains essential for guiding and evaluating its outputs. AI functioned as a support tool, complementing but not replacing the user's expertise in pedagogy and technological integration.

AI's help was sought after for the development of the fraction sketch. Table 1 summarizes the development of the sketch for their focus, techniques used, scalability, complexity, challenges and debugging. These features will be discussed more in detail in the following sections.

Table 1. Creating Fraction Bars in GeoGebra

Conceptual Focus	Aims to represent fractions, percentages, or part-whole relationships using bar-like segments.
GeoGebra Techniques Used	Utilizes Sequence and Segment commands to generate dynamic bar segments.
Scalability & Adaptability	Could easily be adapted to different fraction, ratio, or percent problems.
Challenges	Ensuring bar segments dynamically adjust with correct proportional relationships. AI-supported coding provided efficient sequence-based solutions. Some manual tweaking was needed to refine layout consistency.
Complexity	Moderate: Linear division and simple shading.
Debugging Difficulty	Low: Sequence and Segment are straightforward. Debugging was relatively easy due to structured sequences. Some refinements were needed for accurate visual proportions.

The sketch construction involved the creation of a visualization to dynamically partition and highlight fractions. The user was guided by AI to design a GeoGebra sketch that included adjustable sliders for the total number of parts and the fraction highlighted. The AI suggested using combined Sequence and Segment commands to create dividing lines and dynamically shaded regions. These recommendations

enabled a highly interactive sketch where users could manipulate parameters to explore fractional areas visually. The AI's ability to simplify GeoGebra syntax and automate complex constructions allowed the user to come up with a dynamic scalable DGE sketch (see Figure 14). Some of the initial AI suggestions, such as the use of movable rectangles and fraction representations, were incompatible with GeoGebra's behavior or with best teaching practices. This required iterative refinement by the user to arrive at a workable solution, highlighting the need for user's expertise and content and pedagogical knowledge to make informed decisions. The final DGE sketch is designed for early grades students to represent fractions by specifying a numerator and denominator. Although we were aware of the Sequence and Segment commands, we had never used them before when authoring sketches. Collaboration with the AI not only helped user to come up with a GeoGebra sketch very quickly but also leveraged user's technical skills for the next designs.

5 Implications and Future Directions

The comparative analysis of these case studies highlights AI's dual role as a guide and collaborator in the sketch development process while highlighting the importance for teachers to critically review the AI suggestions. While AI simplifies the technical aspects of GeoGebra, it also prompts teachers to engage in problem-solving and iterative design, fostering professional growth in technology integration. However, the limitations observed—such as the need for user refinement and occasional mismatches between AI suggestions and software constraints—underscore the importance of developing AI systems that are context-aware and better aligned with educational tools, especially with DGEs.

Targeted professional development and collegial collaboration were mentioned as main suggestions from the literature above but in this paper, we shared our collaboration with AI as we tried to create different sketches. Formal training programs equip teachers with the necessary (basic) technical skills and pedagogical strategies to integrate tools like DGEs. That kind of training or knowledge background was assumed before one can starts with collaborating with AI to create advanced sketches.

In addition to formal training, the literature highlights a culture of collegial collaboration. Peer support and shared experiences and resources play a significant role in supporting teachers as they try to integrate technology into their teaching effectively and smoothly. When teachers collaborate, they can share best practices, troubleshoot challenges together, and inspire each other to explore new technological tools and methods. This collaborative environment encourages continuous professional growth and innovation. In this study, however, AI was the sole collaborator as the user was trying to debug commands and so on. While we saw that AI could leverage one's knowledge and skills in designing sketches for DGEs, we also believe that if there were other users collaborating together with AI, those design process could be more beneficial.

This paper highlights another crucial aspect of the design process: the significance of critical and iterative engagement with AI tools during professional development. While AI can simplify technical tasks and act as a collaborator, it is important for teachers to critically review AI suggestions. This critical engagement ensures that AI tools are used effectively and appropriately, fostering a deeper understanding of the technology and its potential applications in education. Moreover, teachers would gain more information about how to use AI effectively for their profession.

Looking ahead, the integration of AI into classrooms has the potential to lower the barriers for teachers to adopt dynamic tools like GeoGebra and foster creativity and experimentation for teachers in lesson design. AI-supported sketch development in GeoGebra is a promising (provided if teachers having a critical lens) avenue for enhancing mathematics education, provided the tools are iteratively improved to align more closely with teacher needs and software capabilities.

5.1 A Note on Reproducibility

As we mentioned above, the specific responses from ChatGPT evolved from May to August and will continue to evolve. However, the fundamental collaborative process we describe remains the same. The toggling between AI chat window and GeoGebra open in another, alternating between generating code and testing, represents a durable approach to sketch development. The idea of AI as a collaborator, rather than an answer generator, is key to productive sketch building with AI.

As AI capabilities mature, we may see improvements in the sophistication of initial suggestions or more accurate code, but the core pattern of human-AI collaboration—namely, requesting modifications, debugging outputs, and critically evaluating suggestions against pedagogical goals—will persist regardless of which AI tool or version a teacher employs. Teachers following our approach should expect their specific commands and code to differ from ours, but the problem-solving cycle of prompt, test, refine, and repeat remains the essential process.

References

Boling, E. C., & Beatty, J. (2012). Overcoming the tensions and challenges of technology integration: how can we best support our teachers? In R. N. Ronau, C. R. Rakes, & M. L. Niess (Eds.), *Educational technology, teacher knowledge, and classroom impact: A research handbook on frameworks and approaches* (pp. 136-156). IGI Global.

Dick, T. P., & Hollebrands, K. F. (2011). *Focus in high school mathematics: Technology to support reasoning and sense making*. National Council of Teachers of Mathematics.

Hohenwarter, J., Hohenwarter, M., & Lavicza, Z. (2009). Introducing dynamic mathematics software to secondary school teachers: The case of GeoGebra. *Journal of Computers in Mathematics and Science Teaching*, 28(2), 135-146.

Jones, K., Lavicza, Z., Hohenwarter, M., Lu, A., Dawes, M., Parish, A., & Borcherds, M. (2009). Establishing a professional development network to support teachers using dynamic mathematics software GeoGebra. *Proceedings of the British Society for Research into Learning Mathematics*, 29(1), 97-102.

Lavicza, Z., Hohenwarter, M., Jones, K., Lu, A., & Dawes, M. (2010). Establishing a professional development network around dynamic mathematics software in England. *International Journal for Technology in Mathematics Education*, 17(4), 177-182.

Listiawan, T., Darmawan, P., Rofiki, I., & Hayuningrat, S. (2024, February). Mathematics teachers' knowledge in using dynamic geometry software (DGS) based on the TPACK framework. In *AIP Conference Proceedings* (Vol. 3049, pp. 030011-1–03001110). AIP Publishing.

Mavani, D., Mavani, B., & Schäfer, M. (2018). A case study of two selected teachers as they integrated dynamic geometry software as a visualisation tool in teaching geometry. *African Journal of Research in Mathematics, Science and Technology Education*, 22(3), 297–307.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, 108(6), 1017–1054.



S. Asli Özugün-Koca, Ph.D., is a Professor and Program Coordinator of Mathematics Education at Wayne State University in Detroit, Michigan. Her research interests include the use of technology in mathematics education and mathematics teacher education.



Michael Meagher, Ph.D., is a Professor and Department Chairperson at Brooklyn College in Brooklyn, New York. His research interests include the use of technology in mathematics education and teacher education.



Todd Edwards, Ph.D., is a Professor of Mathematics Education at Miami University in Oxford, Ohio. His professional interests include the use of writing as a tool to promote mathematical thinking at all levels of instruction.