USING VIRTUAL MANIPULATIVES TO TEACH FRACTION IN MATH

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Inquiry Questions:

- **How do virtual manipulatives support elementary students' conceptual understanding of fractions?**
- **What are the benefits and limitations of using virtual manipulatives compared to physical manipulatives?**
- **How do teachers implement virtual manipulatives effectively to enhance fraction instruction**

Introduction to the Research

Understanding fractions is a foundational yet challenging concept for many elementary students. As mathematics education continues to evolve with the integration of technology, virtual manipulatives (VMs) have emerged as a promising tool to support conceptual understanding. Unlike physical manipulatives, which require hands-on interaction with tangible objects, virtual manipulatives are digital tools that allow students to manipulate visual representations of mathematical concepts on a screen. This research explores the use of VMs such as virtual fraction bars, number lines, and interactive models to support student learning.

The growing body of scholarship indicates that virtual manipulatives can enhance students' ability to visualize and reason about fractions. They provide immediate feedback, opportunities for repeated practice, and the flexibility to adjust representations easily. Studies also suggest that VMs can be particularly beneficial for students with learning difficulties, offering accessible and differentiated pathways to learning. However, the research also highlights challenges such as the need for intentional teacher guidance, the importance of aligning virtual tools with learning goals, and potential equity gaps in access to technology. By synthesizing empirical studies and practitioner insights, this research aims to understand how VMs can be effectively integrated into fraction instruction to support all learners.

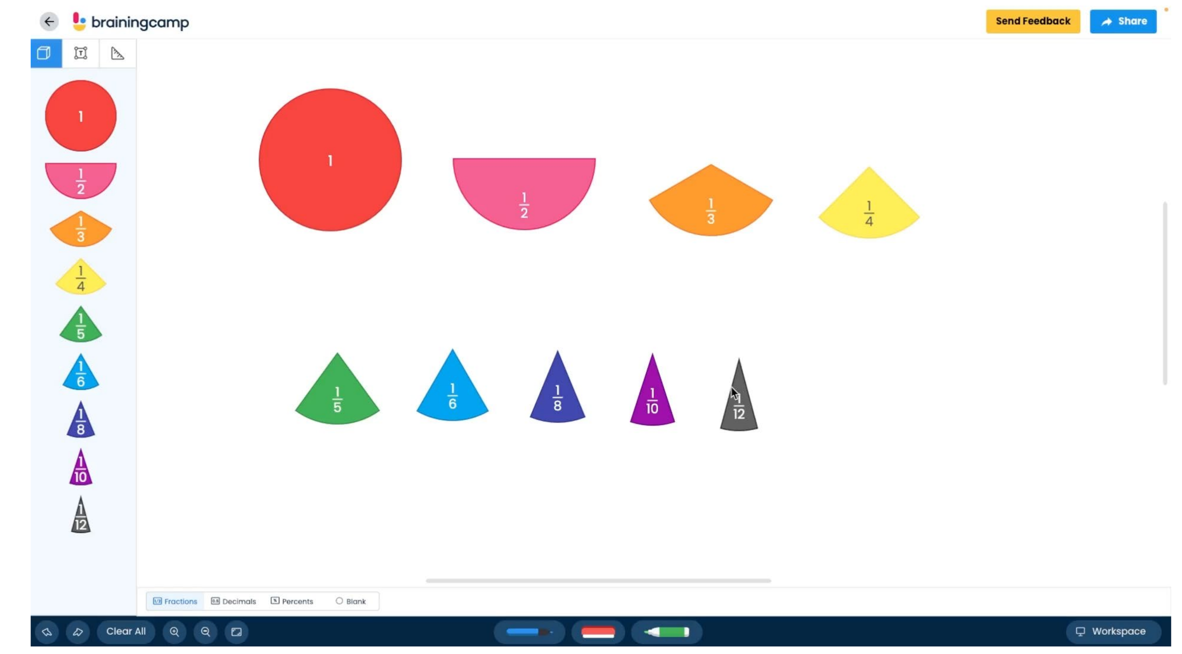
Comparing Tangible and Virtual Manipulatives in Teaching Fractions

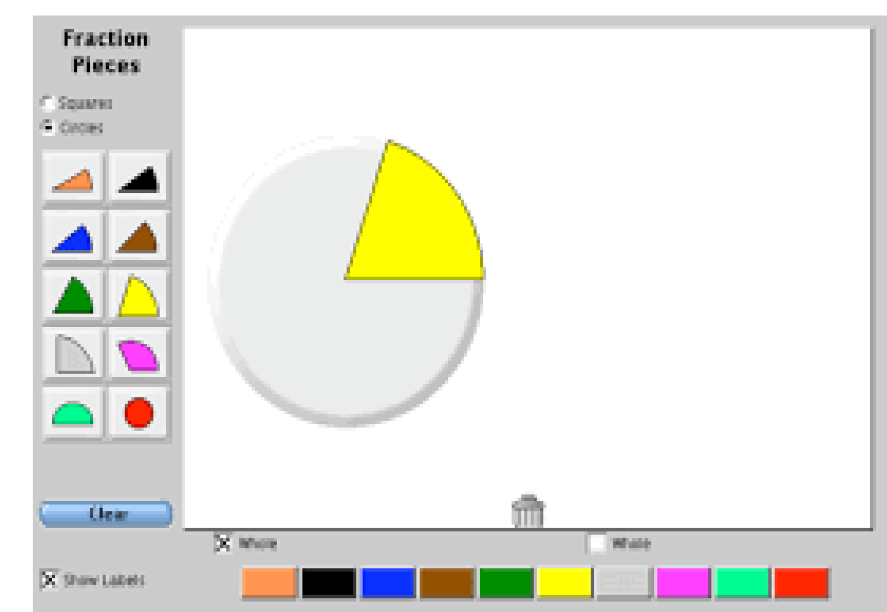
Both tangible and virtual manipulatives are widely used in mathematics instruction, especially in helping elementary students grasp the often challenging concept of fractions. Each type offers unique benefits and potential drawbacks, and the decision to use one over the other—or a thoughtful combination of both—can significantly impact student understanding.

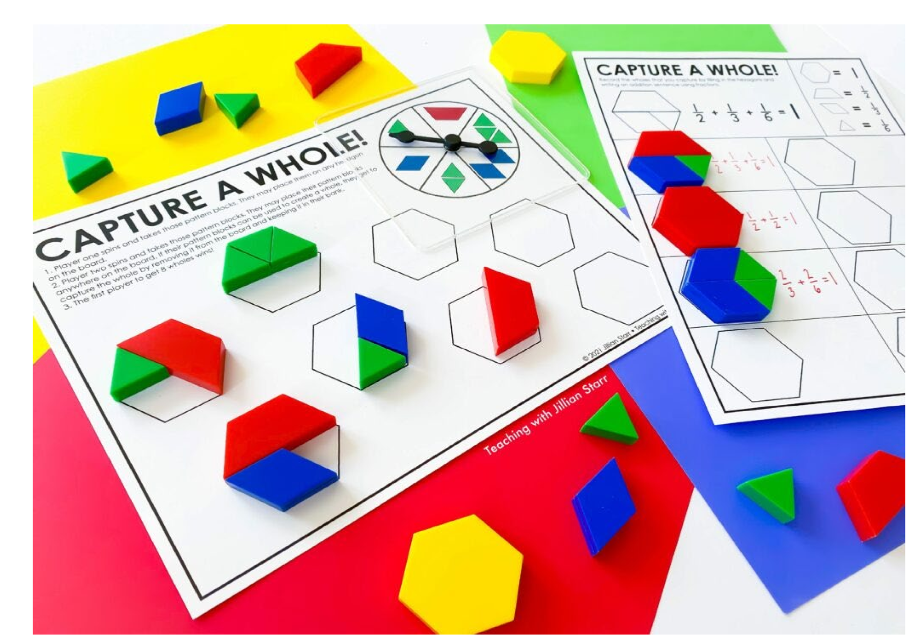
Tangible manipulatives, such as fraction tiles, paper models, or physical number lines, provide students with a concrete, hands-on experience. These tools are particularly beneficial for young learners and those who thrive through kinesthetic learning. Manipulating real objects allows students to physically build, divide, and compare fractions, fostering a sense of number sense and spatial awareness. Research from Gaetano (2010) and Getenet (2023) highlights that some students, especially those with strong tactile learning preferences, express a preference for physical tools over digital ones, as they find them more intuitive and less distracting.

On the other hand, virtual manipulatives offer interactive, flexible, and often visually engaging environments for exploring mathematical concepts. Tools like online fraction bars, dynamic number lines, or interactive pie charts enable students to receive immediate feedback, repeat tasks easily, and visualize abstract concepts in new ways (Rich, 2022; Yuan, 2024). Virtual manipulatives also support accessibility features such as audio prompts, color contrast, and language supports, making them more inclusive for diverse learners, including those with learning difficulties (Satsangi & Raines, 2022).

Empirical studies, including work by Moyer-Packenham et al. (2014) and Mendiburo (2010), have shown that students using virtual manipulatives often perform equally well or better than those using traditional tools when instruction is guided and intentional. However, challenges include the need for consistent device access, digital literacy, and ensuring students stay engaged with the conceptual goals rather than just the novelty of the interface.







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10 key facts

- **Virtual manipulatives (VMs)** are interactive, web-based or app-based tools that visually represent mathematical concepts and allow students to manipulate numbers and shapes digitally.
- **VMs improve conceptual understanding** of fractions by allowing students to explore relationships (like part-whole or equivalence) in a visual and dynamic way (Moyer-Packenham et al., 2008).
- **Students with math difficulties benefit** from VMs due to their multimodal support—combining visual, symbolic, and interactive elements (Satsangi & Raines, 2022).
- **VMs can offer real-time feedback**, enabling students to self-correct and reflect on their reasoning during tasks (Rich, 2022).
- **Research shows students often outperform peers** when using virtual manipulatives versus traditional instruction alone (Yuan, 2024; Mendiburo, 2010).
- **Physical manipulatives still have value**, and some learners may prefer or benefit more from hands-on tools depending on learning style and cognitive needs (Getenet, 2023).
- **Teacher guidance is critical**—students benefit most when VMs are embedded in well-structured lessons with clear goals and discussion prompts (Moyer-Packenham et al., 2014).
- **The design of virtual tools matters**—tools must maintain mathematical fidelity and align with cognitive development stages (Moyer-Packenham, Salkind, & Bolyard, 2008).
- **VMs support differentiation** by allowing students to work at their own pace and revisit concepts as needed, supporting inclusion and equity (Wilkie & Roche, 2023).
- **Challenges include access to devices** and ensuring students use the manipulatives for thinking, not just clicking—pedagogical intention must guide tech use (Durmuş & Karakırık, 2006).