



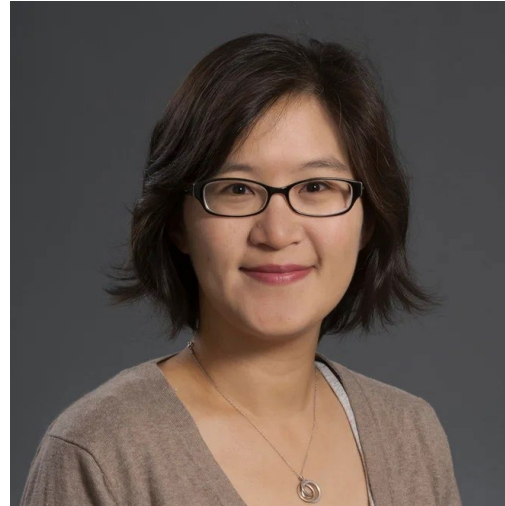
Teachers' Experiences and Perceptions of Virtual Manipulatives following the COVID-19 Pandemic

Presenters



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Introduction

- ① Background information on math manipulatives
- ① Emergence of virtual manipulatives
- ① Research gap on teacher perspectives of virtual manipulatives
- ① Purpose of the study

Research Questions

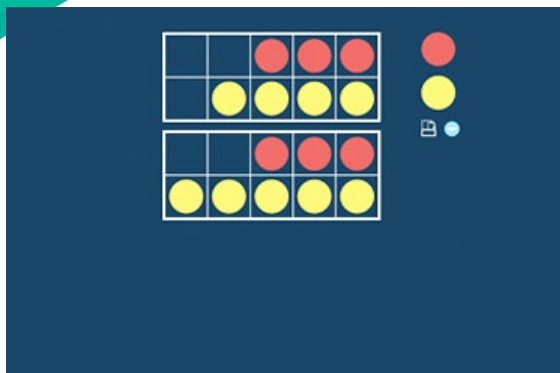
- ◎ **RQ 1: To what extent do teachers feel the use of virtual manipulatives are a valid and feasible support for mathematics instruction as defined by the Technology Acceptance Model following the COVID-19 pandemic?**
 - ◎ **RQ 1.1: What patterns of usage do teachers report regarding virtual manipulatives following ERT?**
- ◎ **RQ 2: How do teachers describe their experiences using virtual manipulatives during and after emergency remote teaching (ERT)?**

Research on Physical Manipulatives

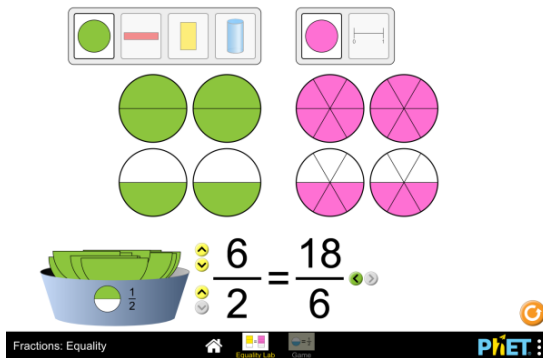
- Used by educators to increase active participation in mathematics learning
- Shown to have a positive effect on learning compared to abstract only mathematics
- May be affected by learning preferences or mathematics ability



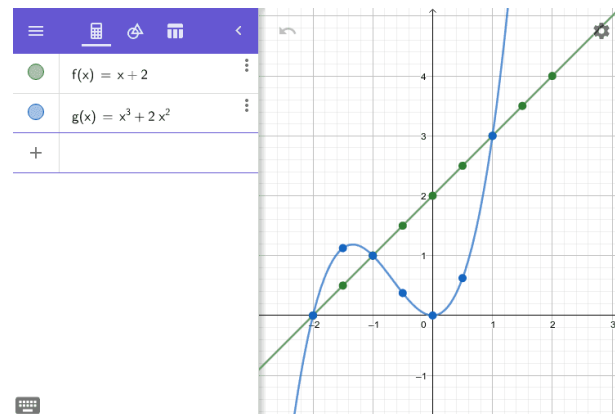
Examples of Virtual Manipulatives



Didax - Elementary



PhET Simulations - Upper Elementary/ Middle School



Geogebra - High School

Research on Virtual Manipulatives

- Defined as “an inter-active, Web-based visual representation of a dynamic object that presents opportunities for constructing mathematical knowledge” (Moyer et al., 2002)
- Have been demonstrated to improve student outcomes
- Provide support for students with disabilities
- Can provide more feedback to students

Student Perceptions of Virtual Manipulatives

- Students like using virtual manipulatives and want to continue
- Virtual manipulatives make math more fun and engaging



Teacher Perceptions of Virtual Manipulatives

- Lack of research after long term use
- Teachers choose to use VM partially due to the immediate feedback they provide students
- VM provide students with opportunities to connect multiple representations, providing students with differentiated instruction, increasing engagement and exploration, providing opportunities for students to use and develop mathematical models, reduce cognitive load, providing additional practice opportunities, and aiding students in visualizing mathematical concepts (Reiten, 2020)

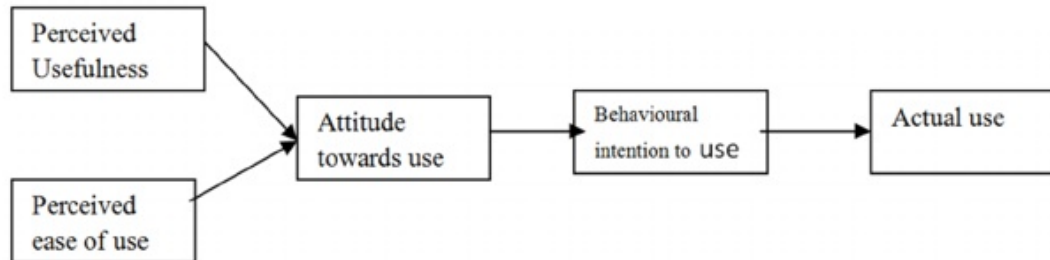
Emergency Remote Teaching in COVID-19 Pandemic

- ⦿ Response to a crisis rather than best practice distance learning or online education
- ⦿ ERT increased and diversified instructional technology usage in mathematics teachers



Technology Acceptance Model

- ① The more complex a technology the more likely it is to be overlooked in favor of technology that is easier to use (Davis, 1989).
- ① Perceived usefulness
- ① Perceived ease of use



Methods

Participants

Gender	Male	Female	Non-binary	Decline to state
Percent	14.6%	80.6%	1%	2.9%

Age Range	21-29	30-39	40-49	50-59	60+
Percent	8.7%	24.3%	31.1%	26.2%	8.7%

Participants

Experience (years)	0-3	4-6	7-9	10+
Percent	8.7%	11.7%	11.7%	67%

Grades	Kindergarten	Elementary	Middle School	High School
Percent	8.7%	49.5%	14.6%	26.2%

Instrument

- ① Survey conducted on Google Forms
- ① 19 items that included questions about participant demographics and their teaching environment (5 questions), perceptions of VM based on the TAM (6 questions), and questions related to their usage of VM (4 questions).

Data Analysis

- Descriptive statistics for frequency to describe participants, Likert-scale questions, and questions regarding usage
- Latent content analysis was used for the open-ended responses

Results



RQ1: To what extent do teachers feel the use of virtual manipulatives are a valid and feasible support for mathematics instruction as defined by the Technology Acceptance Model following the COVID-19 pandemic?

- ① Average Perceived Ease of Use (PEOU) score was 3.7 (SD = 0.97)
- ① Average Perceived Usefulness score was 3.3 (SD = 0.96)
- ① Average Preference for Virtual Manipulatives score was 3.3 (SD = 0.89)

RQ1.1. What virtual manipulatives do teachers report using most frequently?

- Majority of teachers used VM at least once a week

Manipulative Type	Recommended Age Range	Frequency
Applets within textbook/curriculum	K-12	29
ABCya	PreK-6	24
Math Playground	K-6	23
Desmos	6-8	23
Geogebra	6-12	19
Math Learning Center	K-5	19
NLVM	K-12	16
Didax	K-12	14
Toy Theater	K-3	14

Math Content Standards most frequently taught with VM

Common core mathematics content standards	Frequency (%)
Counting & Cardinality	29 (28.2%)
Operations & Algebraic Thinking	46 (44.7%)
Number & Operations	54 (52.4%)
Measurements & Data	47 (45.6%)
Geometry	59 (57.3%)
Ratios & Proportional Relationships	16 (15.5%)
The Number System	20 (19.4%)
Expressions & Equations	23 (22.3%)
Statistics & Probability	15 (14.6%)
Number and Quantity (High School)	8 (7.8%)
Algebra (High School)	22 (21.4%)
Functions (High School)	19 (18.4%)
Modeling (High School)	12 (11.7%)
Statistics & Probability (High School)	12 (11.7%)
My school does not follow common core standards.	5 (4.9%)
I have not used virtual manipulatives.	19 (18.4%)

Math Practice Standards most frequently taught with VM

Common Core Mathematical Practice Standards	Frequency (%)
Make sense of problems and persevere in solving them.	53 (51.5%)
Reason abstractly and quantitatively.	38 (36.9%)
Construct viable arguments and critique the reasoning of others.	20 (19.4%)
Model with mathematics.	70 (68%)
Use appropriate tools strategically.	53 (51.5%)
Attend to precision.	28 (27.2%)
Look for and make use of structure.	33 (32%)
Look for and express regularity in repeated reasoning.	26 (25.2%)
My school does not follow common core standards.	5 (4.9%)
I have not used virtual manipulatives.	20 (20%)
Did not respond	3(2.9%)

Intention to use VM following the pandemic

	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	M	SD
After the pandemic I am more likely to use virtual manipulatives.	7 (6.8%)	15 (14.6%)	31 (30.1%)	39 (37.9%)	11 (10.7%)	3.3	0.96

RQ 2: How do teachers describe their experiences using virtual manipulatives during and after emergency remote teaching (ERT)?

Key Themes

- ① Teacher Usage
- ① Content Taught
- ① Manipulative Type Used
- ① Perceived Ease of Use
- ① Perceived Usefulness
- ① Barriers/Cons to Use
- ① Teacher Perceptions of Student Experience

Teacher Usage

- Some educators began using VM due to ERT, but some were experience users pre-pandemic
- Some educators continued to use VM after return to in-person learning while others abandoned VM when schools reopened
- Some educators indicated that they had a preference for using VM in face-to-face instruction rather than trying to teach students to use these tools remotely
- VM were a good substitute for physical manipulatives only when physical manipulatives were unavailable
- Teachers also described their usage of VM including using them for modeling for students, or linking them to a class website for students to access independently

Content Taught

- ⦿ Most frequently mentioned content
 - ⦿ algebra and equations ($n = 7$)
 - ⦿ fractions ($n=4$)
 - ⦿ place value/base-10 ($n+3$)

Manipulative Type Used

- ① Most popular manipulative types mentioned
 - ① Desmos (n = 16)
 - ① Geogebra (n = 5)
 - ① Applets within the textbook or curriculum (n = 4)
 - ① Self-created (n = 3).

Perceived Ease of Use

- The majority of participants that referenced ease of use in their response indicated that VM were difficult to use for both the teacher and the student (n=9).
- Large range of VM required a lot of time for teachers to determine which VM were of high quality and worth taking the time to train students to use
- It can be difficult to introduce VM to students who are unfamiliar with them in a remote learning environment like ERT
- However, some teachers did feel that VM were easy to use (n=3)

Perceived Usefulness

- Participants stated that VM were useful as a replacement for unavailable or impractical physical manipulatives
- Many participants shared that VM were useful for providing models or visual aides to students, particularly for special education students or English language learners
- Other participants appreciated that VM allowed them to provide as close to an in-person experience as possible, increase student engagement, collect data for assessments, see student work, and give feedback.

Barriers/Cons of Using

- The use of VM requires a lot of time for the teacher to select a VM, set them up for student use, or create them from scratch
- Students struggled to access remote learning
- Some teachers desired to reduce student screen time and felt VM lacked the kinesthetic aspect of physical manipulatives
- Some teachers believed young students could not use VM, and other teachers believed that VM were not relevant to older students
- Some teachers shared that their students have a hard time staying on task or making connections to abstract mathematical concepts when using VM compared to physical manipulatives

Teacher Perceptions of Student Experience

- Teachers describe their students as more successful after gaining experience with or having explicit instruction in using VM.
- Many responses indicated that VMs work better for some students than for others, based on mathematics ability level, learning needs, or student behavior.
- Some teachers reported that VM helped build conceptual understanding in students and that they enjoyed using them.
- Some teachers also stated that many students did not participate in remote learning or use VM when provided with access.

Discussion

- ① The quantitative data demonstrated that teachers have a slight acceptance of VM
- ① The qualitative data indicated that teachers perceived VM as being useful, particularly in conditions when physical manipulatives were impractical or unavailable
- ① The qualitative data seemed to reveal that teachers found VM more difficult to use than the quantitative data indicated.

Limitations

- ① Participants recruited from both urban and rural districts but this was not asked about in survey data, this may impact usage
- ① Some educators are unfamiliar with VM
- ① Survey had a low response rate - possibly connected to teacher burnout or lack of familiarity with VM

Future Directions

- ① Most of the current literature focuses on using VMs to teach fractions, but most teachers report using VMs for geometry
- ① Further research could focus on the differences between teachers using VMs to model concepts compared to students using VM to actively participate in lessons
- ① Future studies could include student perspectives
- ① Future research could use TAM to predict intention to use VM

Questions?



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