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# The Effects of Integrating Lego Robotics Into a Mathematics Curriculum to Promote the Development of Proportional Reasoning

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# The Effects of Integrating LEGO Robotics Into a Mathematics Curriculum to Promote the Development of Proportional Reasoning



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# Existing Research

- Development of proportional reasoning is necessary for students to progress through higher-levels of mathematics (Langrall and Swafford, 2000; Jitendra, Star, Dupuis, & Rodriguez, 2013; Larson, 2013)
- Use of robotics in mathematics has shown positive effects with problem-solving and critical thinking skills (Ardito, Mosley, & Scollins, 2014)
- An extra-curricular one-week intervention provided evidence of improved proportional reasoning skills among 5<sup>th</sup> grade students (Martinez Ortiz, 2015)

# Purpose of the Study

To investigate how the carefully designed incorporation of LEGO Robotics can influence the development of proportional reasoning among seventh grade students.

# Research Questions

1. How does the incorporation of LEGO robotics into a unit on ratios and proportions influence proportional reasoning?
2. In what ways do students reason about distance, rate, and time?

# Theoretical Framework

- Vygotsky's Social Constructivist Theory
  - ~learning through social interactions
- Carbonaro, Rex, and Chambers Five Stages of Technology Integration
  - ~engagement, exploration, investigation, creation, and evaluation



(Vygotsky, 1978; Carbonaro, Rex, and Chambers, 2004)

# Methodology

- Action research
- Mixed Methods
- Case Study with Embedded Cases



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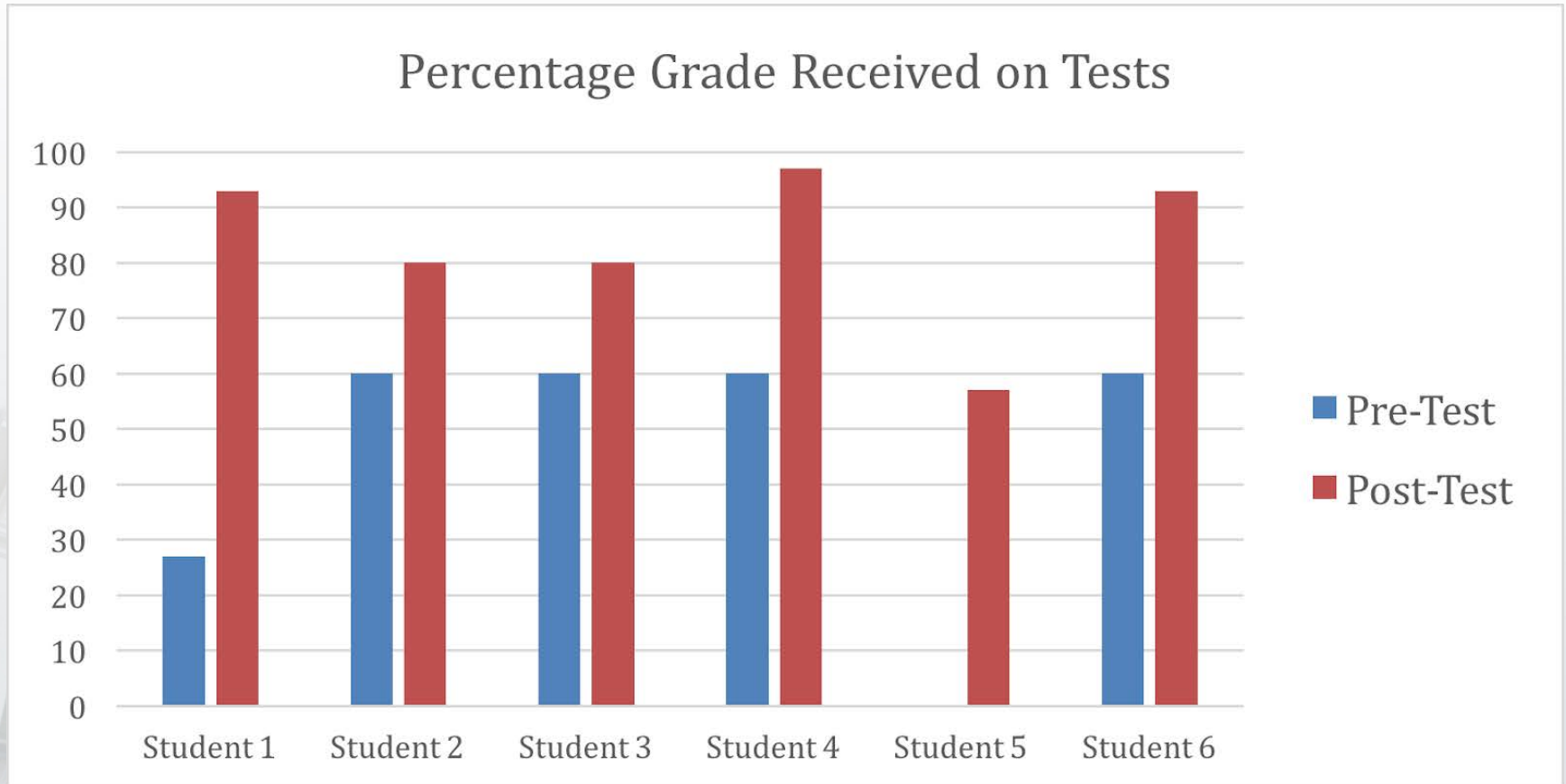
# Data Collection

- regular unit of study
- purposely designed students pairs
- robots required to complete investigations
- discussion before and after each investigation
- activity at end of Investigation 4
- Pre- and post-tests
- Classroom video recordings
- Student interviews
- Field notes
- Student journals and artifacts



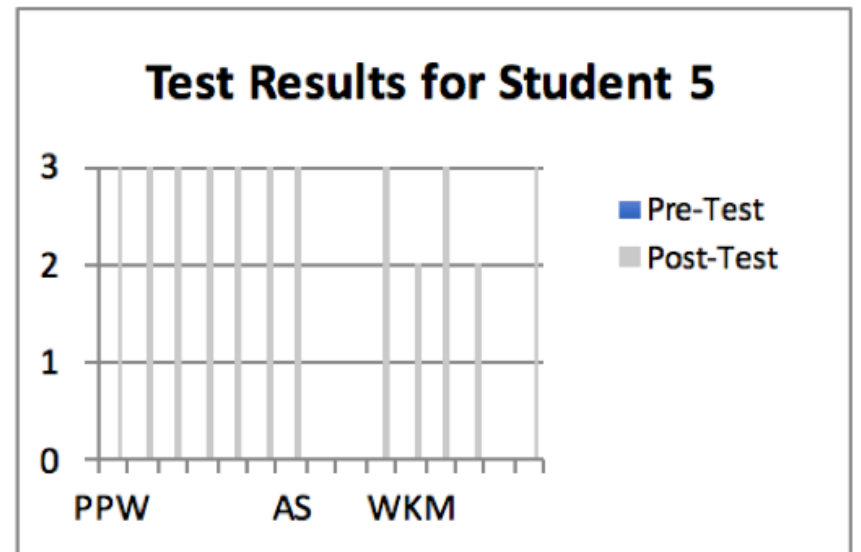
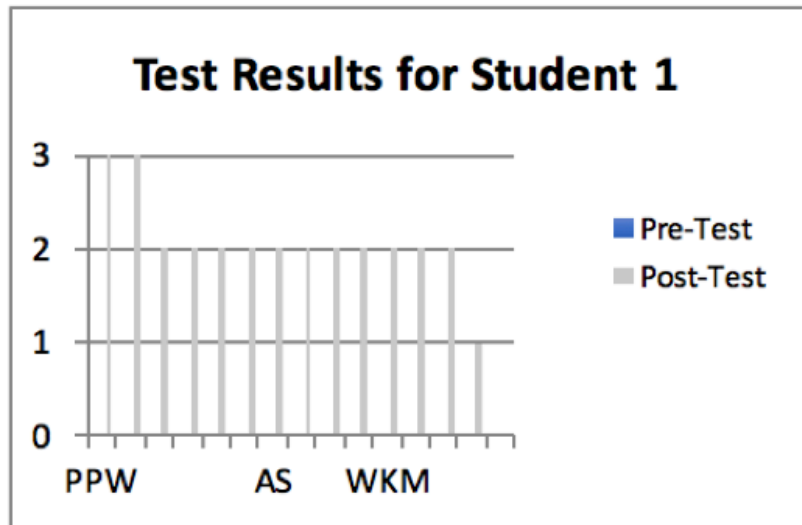


# Research Findings



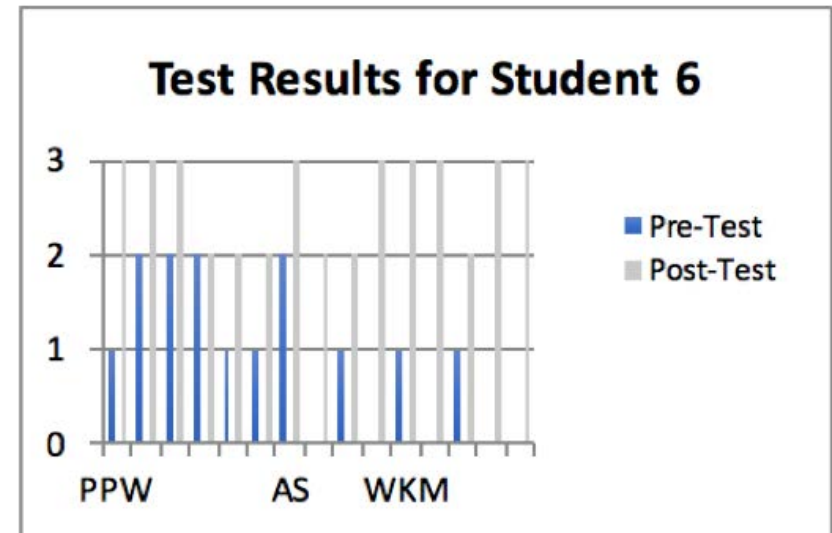
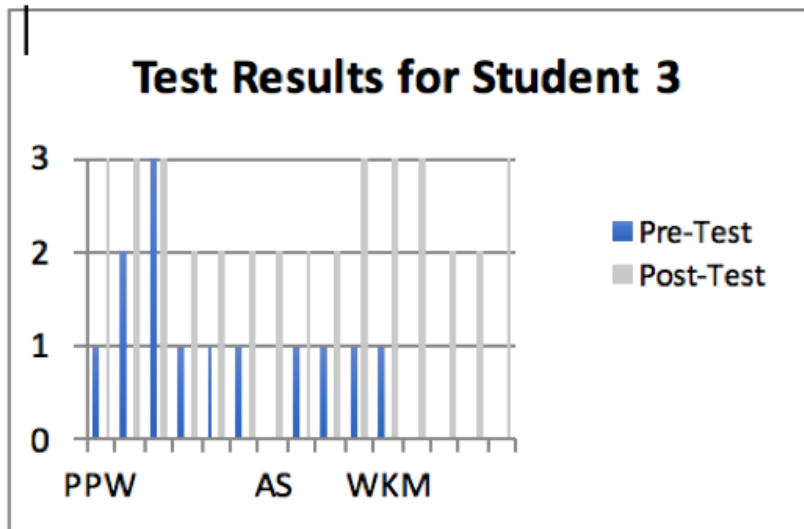
# Research Findings

## Low-Performing Students



# Research Findings

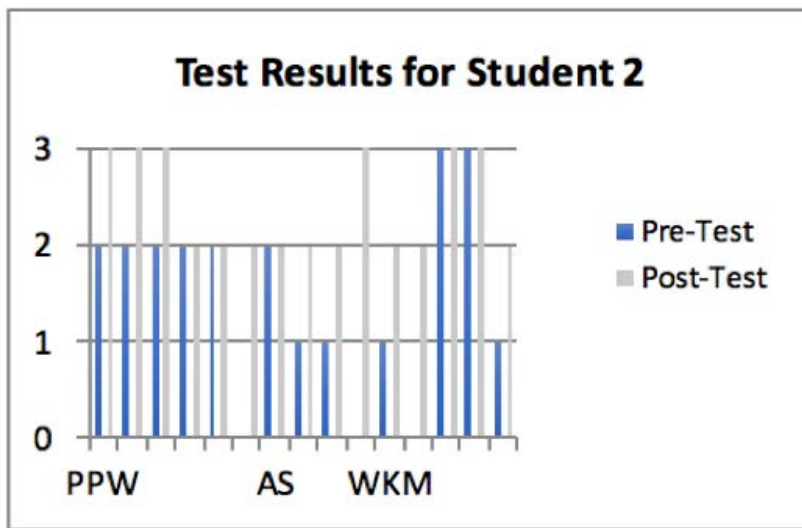
## Average-Performing Students



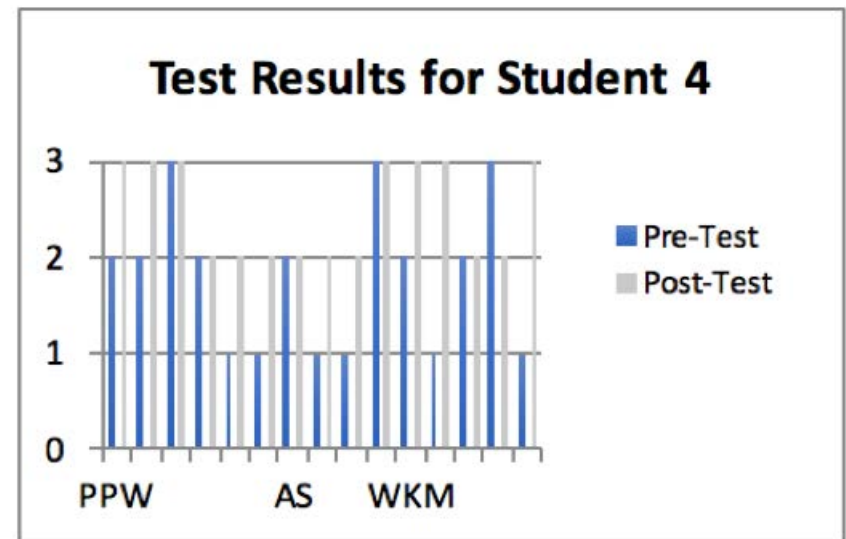
# Research Findings

## High-Performing Students

### Test Results for Student 2



### Test Results for Student 4



# RQ#1 - How does the incorporation of LEGO Robotics into a unit on ratios and proportions influence proportional reasoning?

- Robots create opportunities for discussion via problem-solving
- Discussions (small group and whole class) were analyzed using the four levels of Langrall and Swafford's Proportional Reasoning Rubric (2000)
  - Non-proportional reasoning, Informal reasoning about proportional situations, quantitative reasoning, formal proportional reasoning
- The inclusion of the robots allowed students to see and experience proportionality

# RQ#2 - In what ways do students reason about distance, rate, and time?

- Application of Carbonaro, Rex, and Chambers (2004) Five Stages of Technology Integration (engagement, investigation, exploration, creation, and evaluation)
- Verbal communication - both in, and among, groups - as they progress among the stages

# Embedded Cases

- Two high-performers and two low-performers
- Importance of mathematics
- Enjoyed learning with LEGO robots
- Developed improved proportional reasoning skills
  - High performers - able to verbalize their understanding
  - Low-performers - had difficulty verbalizing their understanding

# Implications

- Provides example of how technology integration can support learning of mathematics
- Learning with robotics allows students to see what they learning (e.g., seeing proportionality)
- Sense of play when working with robotics improves perseverance – creates a “can-do” attitude



# Limitations

- Primarily qualitative, thus not generalizable to all 7th grade classrooms
- Small class size does not allow for the quantitative findings to be reliable
- Small class size limits the breadth, and depth, of the analysis
- Completed in a school environment where hands-on learning is the norm

# References

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# Thank you!

## Questions?

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