

Addressing Gaps in Conceptual Mathematics Understanding with Innovative Media www.mathsnacks.org

Math Snacks brings mathematics and education faculty together with professional developers with the *Learning Games Lab* at New Mexico State University to develop and evaluate effectiveness of 15 - 20 short computer-mediated animations and games. *Math Snacks* are designed to increase students':

- understanding of problematic concepts of middle grades mathematics;
- mathematics process skills; such as problem-solving and communicating mathematically.

Research Questions

Can a coordinated collection of animations and games help students conceptualize frequently misunderstood core middle grades mathematics ideas?

- What support materials and supplemental activities are necessary to guide teachers in successfully implementing materials in class?
- Can the same tools be used effectively in different learning environments including classrooms, during extended learning time at home, or in other informal educational settings.

Methodological Approaches

Development: The first two years focused on an unusual, but well-defined iterative design process. Researchers reviewed standardized exams to identify frequently missed questions, then used qualitative and additional quantitative measures in assessing student and teacher understanding to identify *why* these questions were missed. Based on these conceptual gaps, math educators, researchers and developers (animators, programmers, instructional designers), worked collaboratively to articulate learning outcomes for developed products (focusing primarily on number sense, ratio and proportion and graphing). The team has continued a multidisciplinary approach where all team members inform design of games and animations, prioritizing conceptual understanding of students. Completed games, animations, supplemental print materials, and extensive teacher support materials have been tested throughout development. Partner teachers and advisory committee members informed lesson development through interviews, observation, student pre- and post-testing, and focus groups.

Student Learning: During structured pilot testing in the 2011-2012 school year, nine teachers in five different schools used Math Snacks animations and supplemental activities with more than 400 students in 6th and 7th grades. Data collection included student pre- and post-tests, surveys of teacher use, and classroom observation to assess learning, student engagement, as well as teacher use and competency with the tools.

Teacher Support: During the pilot study, the teachers were divided into two groups: members in one group were asked to use specific lesson protocols for each of the animations tested, and members of the other group were asked to use the same animations, but were directed to the Math Snacks where more general *Teacher* Guides were available. Teachers were observed at least twice teaching one of the animation lessons and completed personal written reflections on their use of the tools. Finally, the teachers participated in a focus group to discuss their experiences with the resources. Student pre- and post-test data indicated no significant difference in student learning between students whose teachers used specific protocol and those whose teachers were given more general guidelines. However, teachers did express a desire to have access to the protocols for reference.



Types of Data

Learning Games Lab: Middle school "youth consultants" provide input on developed products through observation, focus group discussion, video closet testimonials, interviews and written docs.

Classroom Observations: Throughout development, *Math Snacks* materials at various stages of completion have been tested in classrooms, where observation of teacher and student interaction informs design. As a result, products have been improved, including levels of difficulty, development of supplemental classroom activities, and variety of teacher support materials. For example, each *Snack* will have a *Teaching with Math Snacks* video highlighting best practices, and specific guides for using games in the classroom are in development.

Pre and Post Test: During the 2011-2012 pilot study, an 18-item test included open-ended, multiple choice and short answer questions from released state test items that addressed ratio and number line concepts. Used with more than 400 students, revisions are underway for testing 2012-2012.

Focus groups: Extensive focus groups with teachers and students inform development games and animations and teacher support materials.

Summer Camp: During four separate 16-hour camp experiences, 50 teachers designed *Math Snacks* curriculum activities, testing them with more than 200 students each day, then revising their plans. Researchers observed classrooms and did daily debriefings with teachers, issued student pre and post assessments, conducted end of week surveys.

Challenges Related to Research and Methdology

One challenge we are facing is designing an experimental study which minimizes external influences, particularly related to teacher approach. During the pilot study, teachers in each subgroup were dynamic, possessed excellent questioning skills, demonstrated comfort with the technology and were willing to take the time to extend lessons using the animations. There were also teachers in both groups who wanted to limit the use of the animation lesson to one day and did not want to spend time covering the learner guide appropriately. The team is still discussing ways to control for these effects during the 2012 experimental study, including both quantitative and qualitative methodologies.

Proposed Solutions

The team has conducted a pilot study to test methods and approach, and will complete a second experimental round this year before conducting final evaluation in the final two years of the project. This pilot research has provided significant opportunities for identifying barriers to research and rich discussion and potential for revision. To minimize external effects, the second pilot study will increase in size to include 40 sixth grade teachers: 20 each in control and experimental group. The control group will be asked to teach the concepts of ratio, proportion and number line using their regular curriculum, but not using *Math Snacks*. The experimental group will be asked to teach ratio, proportion and number line with their regular curriculum, adding *Math Snacks* animations and using a specific protocol for consistency. Each teacher will select one classroom with at least 20 students for pre-post testing to measure student learning. These teachers will be recruited throughout the state of New Mexico and will include schools with various student populations including various ethnic groups, socio-economic designations, special education needs, and English language learners. The study will take place over an 8-week period to maximize the effect of the products. Classroom observations, focus groups and teacher reflections will also be collected throughout the process.

Desired Help

We are currently lacking a mathematics self-efficacy instrument for students. We are in the process of developing one at this time, but input from other projects would be helpful. Additionally, it would be nice to see other pre-post test instruments developed for ratio, proportion and number line concepts.

