Revisiting Board Games: A New Twist on a Familiar Activity

Margarita Jiménez-Silva, Conrado L. Gómez and Janel White-Taylor

Abstract

Through collaboration between university faculty, pre-service teachers, and local teachers, mathematical board games were developed to teach mathematical concepts to students, especially English Language Learners (ELLs). Guidelines, resources, and examples are provided.

Discussion And Reflection Enhancement (DARE) Pre-Reading Questions

1. What barriers discourage ELLs in their mathematics learning?
2. What are mathematical board games and what are the potential benefits of playing them?

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In the last few years, 13-year-old Hispanic students have shown academic gains in mathematics achievement (National Center for Education Statistics, 2009). However, achievement differences still remain between Hispanic and White students (e.g., see National Center for Education Statistics, 2009; Arizona Department of Education, 2010). The purpose of this article is to revisit the familiar object of board games with a new twist: the use of board games created by pre-service teachers to motivate the learning of mathematics for Hispanic and ELL students in grades 4-8.

Humans categorically seek out reasonable challenges (Piaget, 1972). Once the challenge is identified, humans are motivated to behave in ways to surmount challenging activities (Brown, 2007). Challenges produce a state of mind that brings about focus and engagement, leading to improved task performance (Egbert, 2003). We applied these theories to the development of board games for students in grades 4-8 in hopes of having the games serve as a catalyst for increasing motivation in mathematics learning. This goal was a direct response from our conversations with teachers, who indicated the desire for strategies to motivate students who were bored with traditional drills and textbook approaches. Finding that prizes and even grades had limited power to improve students' motivation and attitude, teachers were seeking motivating mathematics activities "for which there is no apparent reward except the activity itself." (Deci, 1975, p. 23).

Intrinsic Motivation

In an age of accountability with standards, benchmarks, and standardized tests, teachers appear to have limited freedom and opportunities to develop intrinsic motivation in students. Yet, it is difficult to instruct students without addressing motivational variables (Brown, 2007). Brown recommends that if teachers are mandated to use unattractive textbooks, they should design interesting activities to engage students with the material. Brown (2007) makes the following suggestions to develop intrinsically motivating activities:

- Develop activities that appeal to the students.
- Present the activity in an enthusiastic manner.
- Make sure students are aware of the purpose of the activity.
- Provide choice of activities and how to fulfill the goals of the activities.
- Provide activities that encourage students to discover for themselves the principles and rules.
- Embed in the activity ways for students to develop and use effective strategies of learning and communicating.
- Design activities that develop students' independence and autonomy.
- Incorporate cooperative negotiation and interaction with other students.
- Make the activity challenging.
- Provide feedback on students' performance.

Most Americans fear mathematics, but enjoy mathematical puzzles (Burns, 1998) because games make mathematical thinking painless, interesting, and fun (Moscovich, 2001). Smith and Backman (1975) catalog a number of games and puzzles that have been used in teaching elementary and middle school mathematics. While there do not appear to be any research studies on middle school students playing mathematical games, the randomized experiment of Siegler and Romani (2008) demonstrated that playing a numerical game for as little as an hour can make a significant difference in mathematical understanding of low-income preschoolers. Teed (2010) used games in teaching entry level geoscience to encourage students to learn material outside of class while Kuiper (2010) used games to teach various statistical techniques.

Incorporating mathematics games from diverse cultures also can serve to motivate students. Bell and Cornelius (1988) and McCoy, Buckner, and Munley (2007) successfully used games from various cultures, including Hubbub (Native American), Mancala (African), Toma Todo (Mexican), Driedel (Jewish), Ashibi (Native American), and Lu-Lu (Hawaiian) to make connections across mathematics concepts. These games appealed to middle school students for several reasons. First, the games provided a rich and interesting context for applying probability concepts. Second, the games connected students to diverse cultures. Finally, the games were incorporated into pedagogically sound lessons. More recently, Lesser (2010) reported solid student engagement when he incorporated the Mexican game Toma Todo into a probability lesson he taught pre-service teachers.

Benefits to English Language Learners

Although board games can provide meaningful opportunities for engagement for all students, this game project can be particularly beneficial for ELLs and other students who need scaffolding to learn academic content in English. While acknowledging that not all Hispanic/Latino students are ELLs, many ELLs in the Phoenix metro area are from Hispanic/Latino backgrounds. It is a misconception that math is less difficult for ELLs because it is based on the language of number (Janzen, 2008). One of the barriers to learning in mathematics classroom for ELLs can be the issue of academic language (Echevarria, Vogt, & Short, 2010). Although mathematics vocabulary and everyday vocabulary can overlap, mathematics language is often used to express concepts not used conversationally (Ron, 1999). Faltis and Coulter (2008) refer to the academic language used in mathematics as a register that is acquired in school settings where specialized vocabulary and expressions are learned through apprenticeship. Students, especially ELLs, may need explicit scaffolding of the academic language required in mathematics. It helps to learn language that is embedded in the visual context provided by the equipment, other visual cues, and physical demonstrations (Gibbons, 2002).

Another challenge for ELLs, especially newcomers, is that the mathematical symbols and algorithms may vary from native countries to those taught in U.S. classrooms (Brown, 2005). For example, some Spanish-speaking countries use a period in place of a comma when writing numerals for multiples of a thousand (e.g., 4.232 versus 4,232) (Chamot & O'Malley, 1994). By engaging in games, ELLs can learn English as well as learn *in* English. Through games, they have opportunities to engage in mathematics activities that provide them practice and repetition in the language and symbols of mathematics. Although the venue of learning through games is not a new idea in education, the value added for students, especially ELLs, should not be underestimated. Learning has the potential to happen naturally as students play mathematics board games which reinforce and strengthen the academic language so critical to success in mathematics.

Designing and Utilizing the Mathematics Board Games

A partnership was established between a school district in the Greater Phoenix area and the Educational Technology Department at Arizona State University. The goal was to produce quality instructional materials to reinforce state mathematics standards as well as to increase academic achievement. To be fiscally sound, the plan called for using existing resources by training pre-service teachers how to produce mathematics materials using technology. In-service teachers were involved in evaluating the created materials using state academic content standards.

The task for developing games in mathematics using technology was appropriate for incorporating into an upper-division educational technology course for pre-service teachers because it used an authentic hands-on activity to help prepare them for the profession. In addition to the requirement to use technology to create the mathematics board games, the teachers in this educational technology class were also required to share their work with classmates by uploading the templates for their games to the project's Google Site.

Pre-service teachers read articles to learn about the reasons for using games (Kuiper, 2010) for instruction, and the steps in game design (Teed, 2010). They also read a collection of journal articles to learn about the effects of games in the classroom. Next, they reviewed the Edutopia (2010) video on commercially-produced games. Then, they reviewed games produced by others (Kuiper, 2010; Teed, 2010), and sample games designed by students from previous semesters. Research readings, sample games, etc., are at http://sites.google.com/site/mathgamesintheclassroom/.

For their design of the games, the pre-service teachers were given a rubric (available at the aforementioned website) that included categories such as creativity, use of graphics, appeal, and an evaluation of the rules, board and game cards. To help those who may want to create their own mathematics board games, we have included guidelines in the Appendix. (The set of guidelines differs from the rubric used with the pre-service teachers because the pre-service teachers were fulfilling a requirement of a specific course in designing games to meet specific learning objectives.) In-service teachers also should explore any commercially-manufactured (e.g., Quinn, Koca, & Weening, 1999) or technology-based games that address the identified learning objectives. If no suitable games are available, it may be best to design a game tailored to the learning objectives.

The pre-service teachers started designing their board games by selecting a grade-level strand and performance objectives. They then studied the directions from various commercially-produced and student-produced games. They knew beforehand that their games would stay at a school site. When the gameboards were finished, a "Game Day" was scheduled at several schools for pre-service teachers to set up their games in the school cafeterias to share with students and teachers. Game Day served to pilot the games

with students to see if the students could readily learn the rules and remain engaged with mathematics content throughout the game.

Classes of K-8 students took turns playing the different games during the school day. Students often chose to spend their lunch time continuing to play the games. Game Day served as a valuable experience for the pre-service teachers because it provided an opportunity for them to observe how the students interact with the games. These observations provided an opportunity for them to see which games were popular with the students, and they often made notes of which games they wanted to obtain (from the Google Site) to use in their future classrooms. In addition, the teachers often provided helpful feedback regarding the games. This event also gave the teachers an opportunity to request which games they would like for their classrooms.

After Game Day, board games were graded by the instructor using the game rubric. Then, a team of master in-service teachers (selected by their principals for their commitment to innovative teaching) reviewed each game for educational soundness and readiness for use in a K-8 classroom, sometimes identifying what standards were the focus of the game. The in-service teachers appeared passionate about the games and spent significant time reflecting on the classroom usefulness of the games with many wanting to leave with the games that day, since the reviewing teachers were generally those who would be using the games in their classrooms. The board games that were rated as high quality were delivered to Title I schools, sometimes after modification by a team of interns. Games that were rated as not classroom-ready were returned to the student for a chance to modify and resubmit the game for consideration.

Example of a Created Mathematics Board Game: Extra Extra Exponents (E^3)

One example of a student-designed board game is Extra Extra Exponents (E^3). The game is designed to strengthen students' skills with exponents and learning conceptual patterns. The game exposes students to mathematical terms such as less than, greater than, coefficient, exponent position, and equations as well as gives students practice in writing expressions involving exponents. The game was intended for supplemental practice and for a creative way students could engage with exponents.

The E^3 gameboard is colorful and designed to be engaging to 6^{th}-grade students in order to increase their interest in using the mathematical concepts. The board is divided into seven vertical levels, each of which has its own set of question cards in one of three formats. In particular, some questions have a True/False format, while others involve rewriting an expression with an exponent to one without an exponent (or vice-versa). Students appeared to be engaged by needing to progress through the levels in order to try to win the game. E^3 provides playing instructions for students and also offers a "Helpful Hints Area" with implementation tips for teachers.

Conclusion

Incorporating mathematics board games into the classroom has the potential to benefit all students, especially ELLs. Board games can provide the motivation for students to grow in their understanding of mathematical concepts as well as reinforce skills previously learned. Additionally, through the use of board games, students are given the opportunity to interact and practice academic language that they would not typically use in peer interactions. Visit http://sites.google.com/site/mathgamesintheclassroom/ for updates such as a new math video game component, and may contact the third author to inquire about participating in the project. Additional context on this collaboration between a university and public school district appears in Jiménez-Silva, White-Taylor, and Gómez (2010).

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Appendix

Guidelines for Mathematics Board Games

When evaluating educational games:

- Identify the learning objective for the game
- Investigate if there is a commercially-produced board game or if a board game from another culture exists that meets the objective

If no game with your educational goals exists, use the following guidelines:

- Develop a concept for the game based on the learning objective
- Identify the goal for the game: How does the player win?
- Develop rules for the game
- Develop gameboard with appealing color and graphic design
- Develop or gather game pieces (i.e., tokens, game cards, dice)
- Teacher verifies game works and is free of spelling/ grammar errors
- Pilot the game with a small group of students and check that:
  - Ω students find game practical and easy to set up and implement;
  - Ω students find the game fun, engaging, and motivating;
  - Ω game is grade level / age-appropriate; and
  - Ω game is effective in helping students meet instructional objective.

Discussion And Reflection Enhancement (DARE)
Post-Reading Questions

1. What mathematics topics that you teach lend themselves most readily to a board game? Explain your reasoning.
2. From your experience in working with ELLs, what advantages do board games present in helping students develop their academic language in mathematics?
3. How might you combine assessment with the use of board games?
4. What ideas in this article apply to the website of mathematical games recently launched by NCTM at http://calculationnation.org?
5. What are the tradeoffs of using a commercially-produced game versus a game created by students or teachers and how would you decide which one to use for a particular topic?

"DARE to Reach ALL Students!"

"Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students."

-- Principles and Standards for School Mathematics (NCTM, 2000)