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## Playing Games to Build Understanding

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## Playing Games to Build Understanding Michele Carnahan and Dr. Bridgette Stevens

I am fortunate. I teach from *Investigations in Number, Data, and Space* [TERC] (1996), a standards-based elementary mathematics curriculum. My evolution from teaching in a traditional teacher-centered approach to one that supports a student-centered community of learners has been a slow and gradual process during the past six years of teaching. Fortunately, through experience, professional development, and graduate level courses, I have come to appreciate the conceptual understanding students acquire from learning mathematics via a student-centered approach and how playing games is an effective instructional strategy for learning mathematics. As intended by the authors of *Investigations* and envisioned by the National Council of Teachers of Mathematics [NCTM] (2000), mathematical games foster communication as students explain and justify during play, as well as are motivating and engaging for students as they think about and apply mathematics concepts and skills (Lach & Sakshaug, 2005). Moreover, good games create opportunities for students to explore mathematical ideas (Olson, 2007) and are fun as well as educational (Hildebrandt, 1998) and provide the opportunity for me to structure lessons and activities that meet the needs of individual students and promote communication. If you value mathematics practice and view it as a worthwhile activity, you may want to incorporate games as part of your mathematics lessons.

I recently presented a workshop entitled, “Playing Games to Build Understanding” at the Iowa Council of Teachers of Mathematics Annual Conference this past February. I shared with participants some inexpensive games and activities I find useful in not only the development of conceptual understanding, but also in supporting a community of learners where students are not

afraid to take risks. For this article, I share aspects of my presentation that explain the purpose of playing games, the different types of games, and implementation. Games are a valuable instruction tool if the teacher understands the underlining mathematics concepts and skills and can effectively connect the game to the concepts and skills students should learn from the experience.

### Purpose of Playing Games

Yes, there is a purpose for playing games. For students their goal is to win. First, they set out to master the set of rules for playing. They strive to understand how the game is played in order to improve their chances of winning, and with practice, students begin to develop strategies for playing that will likely result in winning. Here, the mathematical thinking begins and the students' conceptual understanding matures. Once they understand the challenge, they seek a solution that ultimately leads to greater success at playing the game.

For the classroom teacher, the purpose for playing games is to develop conceptual understanding about a particular mathematics concept or skill, encourage communication among students, to use and develop problem-solving strategies, and to make connections within the mathematics discipline explicit. Additionally, game playing can meet the needs of diverse learners because games can be adapted. Second language learners can play games and learn strategies without the hindrance of mathematics vocabulary. The low-stress, hands-on format provides variety so anxious students that struggle to work independently enjoy the game format and experience success.

Good games support sound mathematical concepts and skills. Teachers can use games as preview, review, or maintenance of the big ideas for their grade level. As an example, multiplication is a big idea for fourth grade so games that reinforce an array model used for

multiplication can help students make connections between number sentence and the array model.

Games also provide an avenue for giving students a reason to talk. Discourse about mathematics, problem-solving strategies and justification deepens students' conceptual understanding. The more opportunities to play, the more fluent the players become as a result of the discourse that takes place while playing. Students become flexible in their thinking, and develop fluency – speed and accuracy. They are better prepared to understand and anticipate their opponent's moves. More importantly, their moves become more sophisticated and develop from the underlying mathematical concepts and skills the game is intended to address. What students might not have adequately developed on their own, student discourse permits the teacher to hear students' thinking and allows for evaluation of their level of understanding.

Once finished with a game, I ask my students to reflect about the mathematics they learned by playing the game. In talking with their opponent, they discuss strategies, how their thinking played out in an attempt to win, and what they may try next time they play. As a result, playing games challenge students to think in new and different ways causing students to be reflect about new or developing mathematical relationships. Often times, they are quite insightful and find the discussion to be just as important as the game they played.

#### Games for Instrumental and Relational Understanding

While games are enjoyable to students, not all games and activities build conceptual understanding. Richard Skemp (1976) defined two types of understanding; relational understanding and instrumental understanding. Relational understanding is knowing what to do and why. Instrumental understanding is applying rules without reason. Therefore, some games are used for procedures or maintenance of skills. Card games like *Speed* and *War* are examples

of instrumental or procedural games. Students practice their basic facts, accuracy, and speed – a precursor to procedural fluency (National Research Council, 2001). Some may think any of the *Go Fish* genres of card games are procedural; however, it depends upon its implementation. *Go Fish* can be advanced from instrumental understanding to relational understanding by adapting the rules so that the students recite an operation sentence in order to select a card. For example, in *Division Go Fish*, students request a card using a division sentence. “Do you have  $18 \div 6$ ?” where their partner responds, “No, I don’t have a three. Go Fish!” Or I may ask students to evaluate their decisions or their partner’s choices. “Why did John choose that number?” My questions are meant to draw attention to the mathematics embedded in the games by building relational understanding so that students make connections between the activity and the mathematics concepts.

A favorite game of mine that assists students in developing relational understanding of geometry concepts is Last Block Covered (TERC, 1996). It is a spatial relationship game where students take turns covering a pre-made design with pattern blocks. The goal is to be the last person covering the design with a block. I enjoy watching students visualize moves for filling the negative space because I can assess at what point they begin to see the final steps or how many moves from the end they begin to realize the results. Although this game is from a second grade unit, I have my fourth graders play it because it helps students mentally compose and decompose spatial relationships with pattern blocks. They are forced to think ahead in order to win the game and strategically plan their moves accordingly. Another example is the use of *Find the Array* or *Which Array is Larger?* for a compare-and-contrast activity that encourages students to view an array model as a visual for multiplication. Whether a game reinforces concepts or skills, students gain valuable experience in communicating mathematics with their

peers, discuss and defend their use of strategies, and find mathematics to be an enjoyable school subject.

### When to Play and Implementation

Because my students are familiar with several games played in third grade, I launch the start of the school year with these established games by selecting games that coincide with big ideas found in fourth grade. This form of review assists the transition from practicing mathematics concepts which have been taught previously to changing and adapting the games for what will be taught in fourth grade. As an example, I adapt Close to One Hundred by changing it to one thousand, or instead of counting up to one hundred students subtract to make zero. I experiment with various student groupings and sometimes let students choose their partner. Other times, I select partners based on particular skill strength and weakness, overall mathematics ability, and language ability.

Almost any time is an appropriate time to play mathematically-rich games. Opportunities arise during mathematics class or during a point of transition. I use games as activities when we have completed an investigation for the day's objective or Wednesdays when I have a shortened schedule due to in-service professional development. My students even like to play during indoor recess! Moreover, our favorite time to play is at our Fourth Grade Family Math Night. Since *Investigations* is standards-based and not familiar to many parents, the family math night gives parents an opportunity to learn about the mathematics curriculum, along with the games we play. I encourage parents to play math games at home by sharing with them the mathematics behind each game and a strategy or two so that they may feel successful when they play with their child. The comments I hear most often from students are, "I didn't know I was learning math," and, "I can play this with my dad."

## Conclusion

Games are not only for fun. It is the responsibility of the teacher to ensure the games effectively address the concepts and skills related to mathematics. So, do not lose the mathematics and do not rely upon the students to discuss and reflect without you. Games are a valuable instructional tool when teachers understand the full extent to which conceptual understanding of mathematics can develop and use class time to pull together and summarize students' thinking through discourse. Additionally, teachers should make explicit how the game reinforces an important mathematical concept at their grade level. Incorporate a game that aligns with the lesson and devote time for practice, strategy development, and student discourse. Your students will find it is a fun and educational experience. Through games and activities teachers can discuss problem-solving strategies, meet the needs of diverse learners, promote student discourse, and make the connections needed for students to develop mathematical understanding. If you are looking for an alternative to direct instruction, you might consider games as a valuable instructional tool.

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We are all familiar with Focal Points, the NCTM recommended points to be covered in elementary education. Be on the look out for Lenses, the NCTM recommendations for secondary education.