Introduction

Elementary educators play a unique and critically important role in inspiring a genuine love for mathematics and logical thinking in children. To instill a lifelong passion for the subject, logic must be introduced not as a set of rigid rules, but as an accessible language of discovery. This philosophy was championed by Zoltán Dienes, a visionary of the 20th-century mathematics reform movement, who argued that logic is best mastered through play (Sriraman et al., 2007). Dienes designed manipulatives, like the Dienes geometric logic set (Dienes, 2009, Ch16), and activities to expose children to multiple concrete representations of abstract concepts which were essential for them to discover connections between ideas (Benedek, 2018). Dienes' pioneering ideas have since been validated by motivation theorists (Ryan, 1957), neuroscientists (Brown, 2010), (Wang, 2012) and educators (Boaler, 2016). In this paper, we share our experiences with the implementation of activities using the Dienes logic set. These activities are designed for students in 3rd - 5th grades, but can be easily modified for other audiences. As you will see, American students with no prior knowledge in logic, participated with enthusiasm in and achieved significant benefit from these collaborative activities.

Activity 4: Token Tracker

This game is similar to the well-known game, MASTERMIND®. To play the game, a selected Game Master hides a token. The rest of the class uses larger paper replica tokens and a magnetic board to play. Students work in groups to strategize before selecting a token to post on the board.

The Game Master writes a number under the posted token to identify the number of properties the guess shares with the hidden token. Students from alternating groups continue posting tokens, using the feedback received to narrow down the possibilities until someone identifies the hidden token. The challenge is to find the hidden token in the fewest possible guesses. This cooperative game develops students' logical thinking skills while stretching both their visual and working memory.

The Worst/Best Guess

Much like the "Is it Big or Small" moment in Barkochba, Token Tracker had its own aha moment. Students were initially discouraged when their first token shared no properties with the hidden token. However, they quickly realized that the Game Master's feedback '0' was much more informative than a very close first guess that received a '3'. This challenged their unspoken internalized belief that getting "everything wrong" was bad, and taught them to value the information they could deduce from the guess. If no properties match, then the Hole-NoHole and the Size properties are both identified as the opposite of the token displayed. In addition, they get information about the Shape and Color, narrowing down the Shape to two

possibilities and the Color to three. Students understood that here, getting a “0” was vastly more information than getting a “2” or “3”. Figure 14 shows where students used an initial “0” to quickly identify the hidden token.

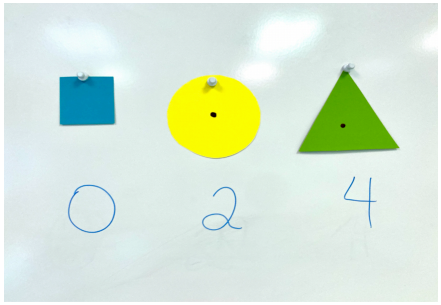


Figure 14 Zero matching properties

Although they had a little luck with the final guess, they correctly conjectured in guess two that the piece was Large, Had a Hole, and wasn’t Blue, and by guess three that it was a Green or Red Triangle.

Students Develop a “One Change” Strategy

After a few rounds of play, students fine tuned their strategy. Once they identified three of the hidden token’s properties, they would change only one attribute of the original token on each guess to isolate the final missing property. Figure 15 shows students using their “one-change” strategy.

The second guess changed only the Color. The decrease in matches meant the token was Yellow. The third guess changed only the Hole, so the decrease in matches meant the hidden token has No Hole. Next, the Size changed to small, matches decreased, so the size had to be Large. Only the Shape, Square or Triangle, remained unknown. With a bit of luck, they got it right on their fifth guess.

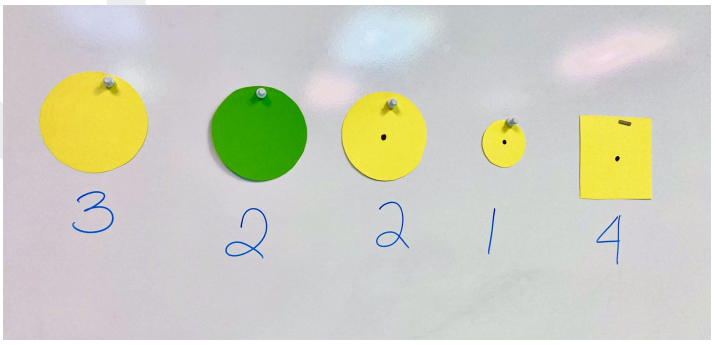


Figure 15 One-Change Strategy