Patterns as a Winning Strategy

The National Council for Teachers of Mathematics (NCTM) recognizes communication as an important aspect of the mathematics classroom. As students develop in their understanding of mathematics they must be able to clearly communicate their mathematical thinking with their teachers, peers, and others. Oral and written communication of mathematics gives students opportunities to justify their thinking, formulate questions, and summarize important concepts (Whitin, 2002).

In order to help and encourage my students to improve upon their mathematical communication skills I implemented the use of strategy games in my classroom. Games have the ability to engage students in the content that they are studying and also allow students to make connections between different strategies and their ability to perform their best. Ralston (1997) states, "One way to create situations in which students recognize, formulate, and solve interesting and substantial mathematical problems is to use carefully chosen games. Such games should allow a player to do better by thinking mathematically to find intermediate solutions that may be less than perfect, but better than random play" (p.430).

Students participated in nine strategy games that were based on the ancient game of NIM. Aspects of the game were changed each time to see how students were able to evolve their strategies to win. While students played the games they filled in a worksheet to document the strategies that they were developing.

The first NIM game that the students played was Stuff NIM. There were three
strategies that the students came up with to try. One strategy was if there is an odd number of pieces take two away and if there are an even number of pieces take one away. Another strategy was if your opponent takes one piece then you take two pieces and if your opponent takes two pieces then you take one piece. For the last strategy students noticed that when they got down to three pieces the players whose turn it was would lose. Students worked backwards and found that you want to give your partner a "count by three number." When you give your partner a "count by three number" then you want to use the strategy when your opponent takes two you take one and vice versa.

The second NIM game that was introduced to students was Classic NIM. Students recognized that if there was only one pile left the person whose turn is next would win. This idea led students to the strategy of giving the same number of tiles in each of two rows.

Students were then introduced to Array NIM. Students used three strategies when playing this game. The first strategy was if your opponent places one piece you should place two pieces and if your opponent places two pieces you should place one. The second strategy was to spread out the pieces. The last strategy was that you want to get three empty boxes. If the boxes are next to each other you have to place your piece in the middle to win. The students recognized that three was a "good" number in this game as opposed to the game of Stuff NIM.

The fourth game was Calculator NIM. There were three strategies that students used when playing this game. The first strategy was if your opponent takes away one then you take away three, if your opponent takes away two then you take away two, and if your opponent takes away three then you take away one. The second strategy was to give your
opponent even numbers. The final strategy was to give your opponent "count by four
numbers." The students realized that when you give your opponent a "count by four
number" you want to play with the first strategy. It was also recognized that this was a
similar strategy to the winning strategy in Stuff NIM.

The students were then introduced to Pattern Block NIM. The students recognized
that this game was similar to calculator NIM. They said that the triangles represented one,
the rhombi represented two, and the trapezoids represented three. This recognition
allowed students to use the number strategies that they already developed to try to find a
winning strategy for this game. The two strategies that were used to play this game were to
spread out the pieces and to give your opponent a "count by four number" of empty spaces.

The sixth NIM game that the students played was Add Up NIM. During this game one
student made a realization that you want to give your partner "count by five numbers."
This will help you win because "it is one more than the highest number that you can take."
When playing Stuff NIM the highest number of pieces you could take was two; therefore
you wanted to give your opponent "count by three numbers." In Calculator NIM and
Pattern Block NIM the highest number of pieces you could take was three, therefore you
wanted to give your opponent "count by four numbers." This was evidence that the
students were relating the different NIM games.

The students were then introduced to Triangle NIM. The students realized that this
was similar to Array NIM. The strategy was to get three empty triangles and if they were
next to each other then you should put one triangle in the middle space to win.

The eighth strategy game was Integer NIM. This game followed the student's
previous realization. The greatest number of pieces that you can take away in this game is
two. According to the student you want to give your opponent "count by three numbers." Another student stated on this day that if you give your opponent "count by three numbers" you are giving them a "multabal" (multiple) of three. The students that recognized this pattern could start at any number of pieces and recognize who should go first and how many pieces to take away.

The last Nim game that we played was Path Nim. The students recognized immediately that once you were in the third row the person that moved into the fourth row would lose. Therefore their strategy was the give their opponent the position in the third row with no moves but down.

During the sessions the students were able to recognize patterns in the games and apply them to the problem to develop the best strategy. Once students recognized that there might be a pattern in the winning strategies, it made it easier for the students to develop new strategies. They would modify a strategy from one game and apply it to another. This was determined through one of the student's ideas that you want to give your opponent multiples of the number that is "one more than the greatest number you can take away." There was also evidence of this when the students were able to view pattern blocks as numbers in Pattern Block Nim. This allowed students to use number strategies that were already developed to determine a winning strategy for this game. Students also learned that they could benefit from other students' strategies. Evidence of this was seen in the games of Stuff Nim and Calculator Nim when students used their own strategy in combination with another student's strategy to develop a winning strategy. Strategy games are an effective way to help students apply patterns to problem situations. Students determined that patterns are a useful method for solving a problem. This is an important
realization because it will help students in their understanding of algebra.

Throughout playing the NIM games students were actively involved in sharing their thoughts and strategies with their peers. Students gained confidence in their ability to communicate. They also recognized that the more specific they were in their explanations, the easier it was for their peers to understand. Students realized that vocabulary was very important. They began to use the word "opponent" to identify who was playing because it became confusing when they used the terms you and I. Students also recognized that when identifying the winning position they needed to state whether you should give that position to your opponent or if you wanted to play from that position.

The strategy games were engaging and provided a means for communication. The students were not afraid to share their ideas because they were confident that they had made their strategy work and that it could be used in conjunction with another student's strategy. Students wanted recognition for finding the winning strategy. In order to achieve this they had to be able to explain their strategy effectively.

Throughout this research the students also became more confident in their ability to write about mathematics. In the beginning they did not want to write down their strategies because it was "too difficult." However, once the students had a chance to communicate their thoughts orally they were able to write them down. By orally communicating their strategies students were able to formulate the words that they needed to clearly express themselves. The students found that it was beneficial to write their thoughts down because it made it easier to go back to modify their strategy.

Strategy games are an effective way for students to build their confidence and ability to write about mathematics. This is an important skill because students need to
know how to explain their answers. Students wanted to write down their strategies so that they would be able to use them again when playing the game. Students recognized the importance of clearly listing each step of the strategy, so they would understand it when they looked at it again. If their writing was unclear then they may not remember the winning strategy. Implementing strategy games into my classroom was an effective strategy to help students make connections among mathematical concepts and to communicate their mathematical understandings.

References


**Reflection:**

This is my first attempt to write an article from my Master’s Thesis.