# **Pedal Power**

Mr. Parkhurst is purchasing a new bike. He has been to 4 different bike shops and is most concerned with finding a bike that has the most gears or speeds. He has found a bike that he loves very much at the Ski Rack in Burlington. Please see the picture of the hand shifters on the bike.



Determine the number of different speeds this bike will allow.

Remember to show all your work, to include a math representation and to include at least one "I noticed..." statement about your work.

Grade Levels 3 - 5

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### Context

This problem was given to a group of students that have been working with open-ended problem solving throughout the school year. It was spring and the students were eager to be outside. Their teacher was also preparing to purchase a bike and the two ideas, coupled together, provided inspiration for this task.

### What This Task Accomplishes

This task accomplishes two things. First, it allows students to apply and engage their understanding of multiplication through the determination of the number of speeds. Second, it allows the students to work with a systematic list to show that they have found all possible combinations. This task also allows students to demonstrate their skills of creating tables and charts, to systematically list all combinations or to use a more efficient approach to finding the answer, such as multiplying.

### What the Student Will Do

Many of my students began by first counting up and adding all the gears to get an incorrect answer of 10. Several of my students did this, but then after looking at it more carefully, realized that the problem was about combinations. The students received a pre-teaching lesson on math

representations, which "reminded" them to create charts that listed the combinations. Some students began to get confused as they worked with the chart because one student, for example, reversed the numbers of combinations, but later realized that this could not happen because the gears on the left handlebars were different than those on the right. In one of the most efficient solutions, the student quickly multiplied 3 x 7 (gears on left by gears on right) and found that the answer was 21 speeds. The student also generalized the solution to show how this rule could be used to determine the number of speeds on any bike.

### **Time Required for Task**

60 minutes

### **Interdisciplinary Links**

The links to this problem are varied. First, after studying inventions earlier in the year, the students could work on this problem with a good understanding of what a gear is. Most students also have bikes, so the home/school connection is a natural for this problem. In fact, one student in the class shared earlier today that s/he had bought a new mountain bike and that lead us right into this problem. One student linked his/her solution to Olympic biking, as s/he made comparisons between the number of speeds on this bike to the number of speeds on an Olympic bike.

### **Teaching Tips**

I think when introducing this problem it is important to allow the children to think aloud with their peers. This is a useful strategy to use whenever children are stuck or whenever they are just starting out. I do this as they keep their pencils down. This allows all students to have an understanding of the problem before they begin the actual task themselves.

Adapting the task for students with special needs is easy. Just change the numbers to a smaller combination or allow the students the use of counters to show the different combinations. I did this with one particular student and she was very successful with the task.

Adapting the task for students who need more of a challenge is easy as well. Just allow more choices with the numbers. You might even use the information from an Olympic bike and have the children make comparisons or change the problem so that they have to compare the gears of bikes from all of the four stores that Mr. Parkhurst went to.

Students might also be encouraged to compare the cost per gear!

### **Suggested Materials**

- Color tiles or counters that can be easily manipulated to create different combinations.
- The manipulatives we had the most success with were number cards\*\*.

\*\*On each card was a number 1, 2, 3 and then on a different color set of cards were the numbers 7, 6, 5, 4, 3, 2, 1. This allowed the students to move the cards around to create combinations that they could then document on paper.

### **Possible Solutions**

The correct answer is 21 speeds.

### **Benchmark Descriptors**

#### Novice

The children that fall into this category are the ones that attempted to solve the problem by first counting the number of gears and then adding them up. They show that they did not clearly understand the problem or what it was asking them to do. Many of the Novice pieces of work were taken a step further and the students attempted to create a math representation that would work. However, there are flaws in their charts and hence they typically did not come up with the correct solution of 21 speeds.

#### Apprentice

The work in this range was exemplified by the students who created a chart that showed the gear combinations. However, when they began to explain their work there were gaps in what their chart was stating and what they were saying in their written work. A good example of this is the student who determined that there were 21 speeds. This student first created a chart that had too many combinations and then went on to write up his/her explanation, stating that s/he had found 40 combinations. A discrepancy between his/her work and his/her explanation is evident.

#### Practitioner

A Practitioner may create a chart that is in logical order and explains how the problem was solved. Many students did this and came up with the correct answer of 21 speeds. The students were able to do this rather efficiently, but some may have lacked detailed labels on their charts. Above all, their work can be followed and the gaps (if evident) can be easily filled in.

#### Expert

An Expert may show a very efficient and effective way of finding the solution. Experts will simply multiply the two gear numbers together to determine a correct solution of 21 speeds. Experts will take their work a step further and generalize the solution for any bike. The Expert's work does lack an accurate and appropriate math representation, but from what the student has on the paper, a representation would not be the most appropriate way for this student to show the solution.

### Novice



### Novice



Attempt to create a chart is incorrect.

Apprentice

## Apprentice

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### Practitioner



### Practitioner



Expert





Student moves directly to solution.

Expert

and 7 in the back:



Jike gears are detirmined by the front (3) multipled by the back (7). 7x3=21 gears. A rule is this would work for my bike. For instance, if a bike had 3 years in the front and 8 in the back. 3x8 = 24 gears.