A Discrete Look at Discretion?

by Anne Carroll

Codes, if not the heart of communication today, are at least the feet! Without the bar codes on our mail and packages, written communication would slow to a crawl. However, codes are entered by human hands or machine printers, and mistakes will always occur. Thanks to a presentation by lead teacher Br. Pat Carney (LP '91) and a little independent research, I now feel a bit more secure that if I request 20 copies of *The Joy of Mathematics*, a small mistake (human or otherwise) will not result in an avalanche of manuscripts of "Hamlet".

My students learned about codes after I decided to begin the New Year with something a bit different. I teach the second part of a two-year Algebra I course, Consumer Mathematics, Essentials of Calculus (non-AP), and two sections of Advanced Mathematics. My students range in ability and desire from traditional college-bound seniors to hard-to-motivate, non-college-bound sophomores. We also have a heavy concentration of non-English speaking students. I tried a version of this lesson in each of my classes and found that the topic of codes was accessible to all and held some degree of interest for each group.

Using the bar-coded zip code on reply mail torn from magazines as my tease, I asked the students to discuss its purpose and to explain how it works. Someone in each of my five classes was able to identify the purpose, but no one knew the way in which the bar code is analyzed beyond "a scanner does it." The door was open---the teacher knew something that the students didn't, and it was something that affected their daily lives. There is nothing like a good secret! And that, after all, is what codes are all about.

I explained the algorithm for reading the bar code for zip codes (see box).

> The first and last bars form "frames." The rest of the bar code is broken into blocks of 5 strokes or bars. Each bar represents a digit (short bar = 0, long bar = 1) and each block of 5 bars represents a number:
>
> | | | | |
> |---|---|---|---|
> | 11000 = 0 | 00110 = 3 | 01100 = 6 | 10100 = 9 |
> | 00011 = 1 | 01001 = 4 | 10001 = 7 | |
> | 00101 = 2 | 01010 = 5 | 10010 = 8 | |
>
> These numbers can also be obtained by the "expansion algorithm" by multiplying the value of the bars in sequence by the numbers 7,4,2,1,0 respectively, and adding (mod 11, so that 11000 = 0).
>
> For example, 10010 is equivalent to (1x7) + (0x4) + (0x2) + (1x1) + (0x0) = 8.

Block 1 — 2 … Check Digit — 1

Bar Code for 20077-7330

It was interesting that the students in the calculus and advanced mathematics classes found it easier to use the expansion algorithm to decode, while the others found the matching list faster.

The last block of 5 bars (before the end frame bar) is the correction digit, or check digit. In the zip code, the rule is that the correction digit must create a sum that is divisible by 10. This brought us to a discussion of modular arithmetic, i.e., that the sum is equal to 0 (mod 10). I tackled this topic with the calculus and advanced mathematics classes. With

(Continued on page 10)

Tennessee...

(Continued from page 2)

a portfolio of their work, including an essay on Discrete Mathematics. These essays have been very positive! The last day of the semester was the 2nd Annual "Discrete Math Appreciation Day", in which students in my class let other students in the school know what Discrete Math is all about by presenting results of their projects in other classes. The students have greatly enjoyed learning about these new approaches to math, and have especially enjoyed applying mathematics to real-world problems.

References:

1. Crisler, N., Fisher, P. and G. Froelich, *Discrete Mathematics through Applications,* W. H. Freeman, New York, 1994.

2. Peitgen, H., et al., *Fractals for the Classroom: Strategic Activities* (Vol 1), Springer-Verlag, New York, 1991.

> Note: If you are interested in reviewing the text [1] for a future issue of the Newsletter, please contact the editors.