What's the Bug?

Objectives

When people are first learning how to do arithmetic, they usually learn the mechanics by rote, without understanding some underlying principles or conventions. For example, place value is not an obvious characteristic for someone who is just learning to count. What is this business of 'carry the 1' when adding a column of numbers? We read English from left to right, and we tend to *left align* our margins when we type (as in most of this document).

So why then do we insist on *right aligning* numbers when we write them in columns?

```
17,345
  +243
-------
17,588
```

Many beginning arithmetic students are simply mystified by these conventions. As a result, they sometimes make some interesting errors. That is, there is a *bug* in the algorithm they are trying to use to get the answer. Hence this exercise: **What's the Bug?**

The objectives of this exercise are similar to those outlined in **What's the Rule?** In addition to those objectives, this exercise challenges students to correct someone else's work. This may help them to *self-correct* their own work, a valuable skill throughout their math careers.

Procedure

This is an exercise that is presented orally. Students try to figure out the bug, but when they do, they just solve a new example rather than explain the process. It is very important that they do not *give away* the process, since this would spoil the challenge for the other students. They demonstrate their prowess simply by solving an example for all to see. In doing so, they provide another clue for their classmates. We ask the students to solve the problem on paper and then read their answers to us from *right to left*, the way they would generate the answer to an addition problem. By presenting their answers this way, they are less likely to give away the *bug*. This will make more sense when you see the examples given below.

The teacher's verbal instructions for the students might go something like this:

> "I'm going to write an arithmetic problem on the board. But I'm going to make an error when I solve the problem. It's as if I'm a computer, and there's a bug in my arithmetic program.

"Your job is to figure out what the *bug* is. However, ***do not give away the answer!*** If you think you know what's wrong, I'll give you another arithmetic problem; you work the process through on a piece of paper, make the *same mistake*, and then read me your ***correct incorrect answer!*** It's important that you read me your answer from *right to left*, the way you would solve an addition problem, so that you don't give too much away. If you are *correctly incorrect*, I'll write your answer on the board, and I'll know that you understand the bug. ***But do not tell how it's done. Do not give away the bug!*** Let the other students have a chance to figure out the bug for themselves."

Here are some examples:

Example 1

The following example is written on the board. It contains an arithmetic error that the students will try to identify.

```
354
+27
----
371
```

Students try to figure out what has gone wrong here. Give them a new problem and tell them that their job is to generate the *correct incorrect* answer.

```
587
+46
----
```

The correct incorrect answer here is 523, since the bug in the algorithm is in forgetting to '*carry the one*.' This example is fairly simple, and most students will pick up on it right away. However, keep giving examples and let more and more students demonstrate both that they know the answer and that they understand the process. In fact, give one or two examples that *do not* cause the problem--that is, that do not require *carrying the one*. In this case, the *correct incorrect answer will actually be correct!*

Eventually, move on to a new problem with a new *bug*. Examples 2 and 3 are more difficult.

Example 2

The following example is written on the board:

```
234
+56
----
794
```

So what is the *correct incorrect answer* for these? Ponder these a moment, then see below for the solution.

```
458                        678
+26                        +99
----                       ----
```

Example 3

The following example is written on the board:

```
483
+54
----
438
```

So what is the *correct incorrect answer* for these (see below)?

```
267                        795
+28                        +36
----                       ----
```

Answers for Exercise 2

The error in Exercise 2 occurs when the student copies the problem down and *left aligns* the numbers:

```
234
+56
------
  794
```

Thus the correct incorrect answers are: 718 and 1668, respectively.

Answers for Exercise 3

The error in exercise 3 occurs when the student works the problem from *left to right* and *carries to the right*. Thus the correct incorrect answers are: 2851 and 7221, respectively.

For another math exercise that uses a similar classroom technique, see **What's the Rule?** For a wider-ranging exercise, see **Before and After**, an exercise that deals with more complex, real-world changes. How does a green pepper change to become part of a salad? How does a freshly dead clamshell become gray and smooth and pitted?

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