Finding square roots using an algorithm

There is also an algorithm that resembles the long division algorithm, and was taught in schools in days before calculators. See the example below to learn it. While learning this algorithm may not be necessary in today's world with calculators, working out some examples can be used as an exercise in basic operations for middle school students, and studying the logic behind it can be a good thinking exercise for high school students.

Example: Find √645 to one decimal place.

First group the numbers under the root in pairs from right to left, leaving either one or two digits on the left (6 in this case). For each pair of numbers you will get one digit in the square root.
To start, find a number whose square is less than or equal to the first pair or first number, and write it above the square root line (2).

```
 2
√6.45
```

2 √6.45 -4 245	2 √6.45 -4 (4 _) 245	2 √6.45 -4 (45) 245
Square the 2, giving 4, write that underneath the 6, and subtract. Bring down the next pair of digits.	Then double the number above the square root symbol line (highlighted), and write it down in parenthesis with an empty line next to it as shown.	Next think what single digit number *something* could go on the empty line so that forty-*something* times *something* would be less than or equal to 245. 45 x 5 = 225 46 x 6 = 276, so 5 works.
2 5 √6.45.00 -4 (45) 245 - 225 20 00	2 5 √6.45.00 -4 (45) 245 - 225 (50 _)20 00	2 5 . 3 √6.45.00 -4 (45) 245 - 225 (503)20 00
Write 5 on top of line. Calculate 5 x 45, write that	Then double the number above the line (25), and	Think what single digit number *something* could

below 245, subtract, bring down the next pair of digits (in this case the decimal digits 00).

write the doubled number (50) in parenthesis with an empty line next to it as indicated:

go on the empty line so that five hundred-*something* times *something* would be less than or equal to 2000.
503 x 3 = 1509
504 x 4 = 2016, so 3 works.

```
        2 5 . 3
       √6.45.00.00
       - 4
 (45)   245
       - 225
   (503)20 00
        - 15 09
           491 00
```

Calculate 3 x 503, write that below 2000, subtract, bring down the next digits.

```
        2 5 . 3
       √6.45.00.00
       - 4
 (45)   245
       - 225
   (503)20 00
        - 15 09
 (506_)    491 00
```

Then double the 'number' 253 which is above the line (ignoring the decimal point), and write the doubled number 506 in parenthesis with an empty line next to it as indicated:

```
        2 5 . 3  9
       √6.45.00.00
       - 4
 (45)   245
       - 225
   (503)20 00
        - 15 09
 (506_)    491 00
```

5068 x 8 = 40544
5069 x 9 = 45621, which is less than 49100, so 9 works.

Thus to one decimal place, √645 = 25.4