Finding Evidence of Transfer with Invention Activities

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THIS IS WHAT I LOOK LIKE, IF YOU WANT TO TALK TO ME ABOUT SOMETHING AND I'M NOT HERE.
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I. introduction

As educators, our ultimate goal is to have students be able to ***transfer*** all that we teach to novel, relevant situations.

Our approach in the first-year physics lab to teaching many of the basic statistical treatments of data involves the use of ***invention activities***.

II. invention activities

Experts and novices differ in many ways.

- organization of existing knowledge
- application of existing knowledge
- learning of new concepts

Simply telling students the expert knowledge seems efficient but is a shortcut, the price of which is that students do not develop integrated knowledge structures. Telling becomes much more effective after the students have engaged in investigating the structure of an idea.

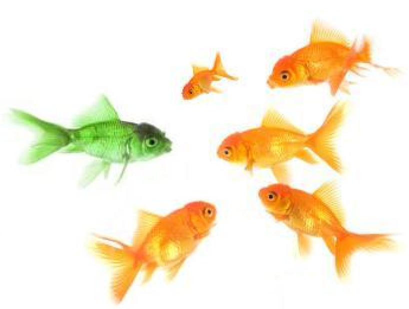
Inventions activities are designed to...

- actively engage students
- stimulate creative thinking

- reveal the structure of an idea
- form an organizational framework
- precede direct instruction

Inventions activities should have...

- a clear goal
- multiple contrasting cases



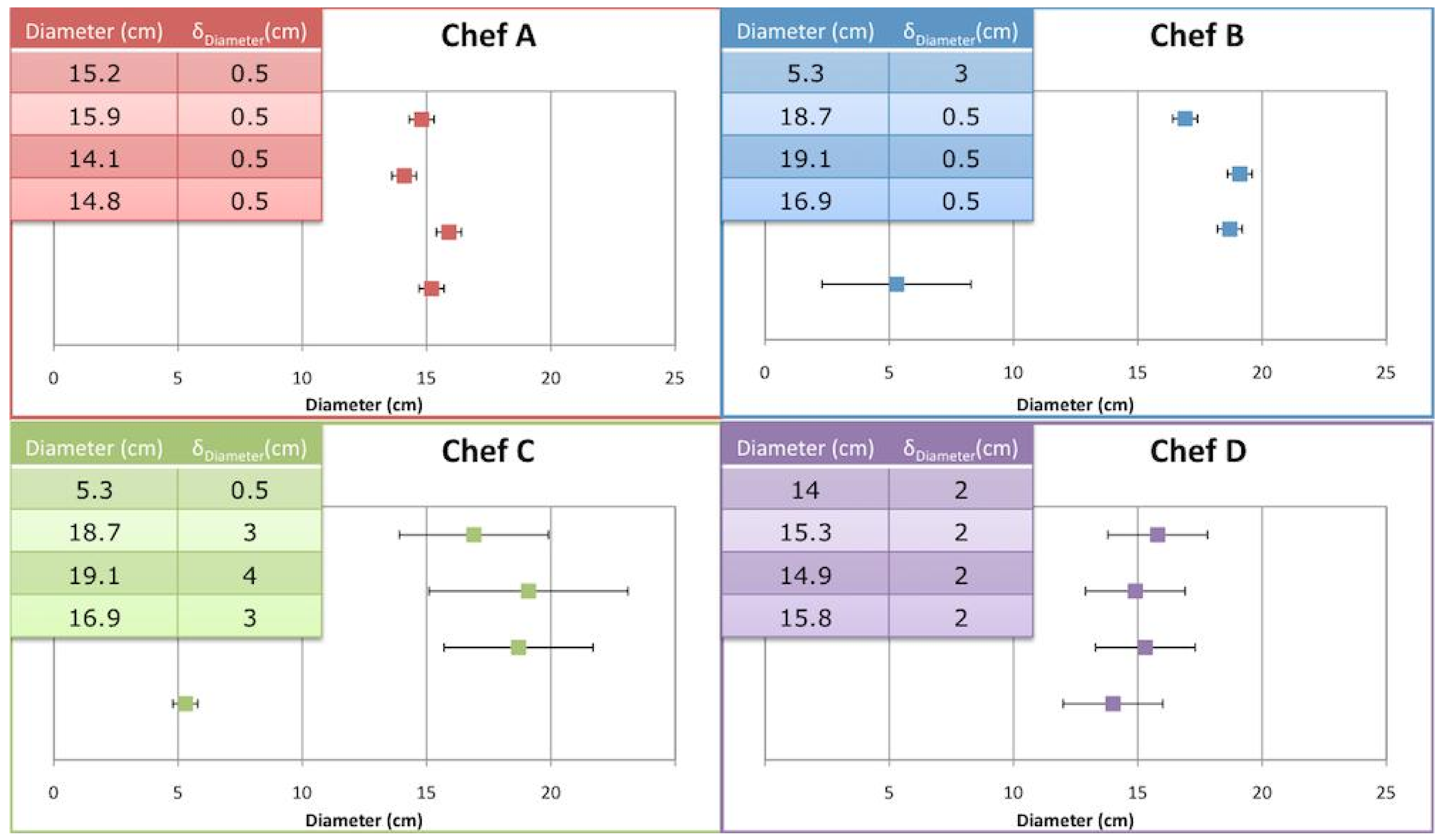
- student collaboration

III. preparing students to learn – weighted average

** The students see much more than is provided here. Ask me to see the full activity.*

Clear goal: invent a method that each chef can use to yield a single value of the diameter of their ostrich egg from the multiple measurements given below.

Contrasting cases:



Chef A

Diameter (cm)	$\delta_{Diameter}$(cm)
15.2	0.5
15.9	0.5
14.1	0.5
14.8	0.5

Chef B

Diameter (cm)	$\delta_{Diameter}$(cm)
5.3	3
18.7	0.5
19.1	0.5
16.9	0.5

Chef C

Diameter (cm)	$\delta_{Diameter}$(cm)
5.3	0.5
18.7	3
19.1	4
16.9	3

Chef D

Diameter (cm)	$\delta_{Diameter}$(cm)
14	2
15.3	2
14.9	2
15.8	2

IV. student solutions - examples

$$\overline{x}_w = \Sigma \frac{x_i}{\delta x_i}$$

$$\overline{x}_w = \frac{\delta x}{N} \Sigma \frac{x_i}{\delta x_i}$$

$$\overline{x}_w = \frac{\Sigma \frac{x_i}{\delta x_i}}{\Sigma \frac{1}{\delta x_i}}$$

V. direct instruction

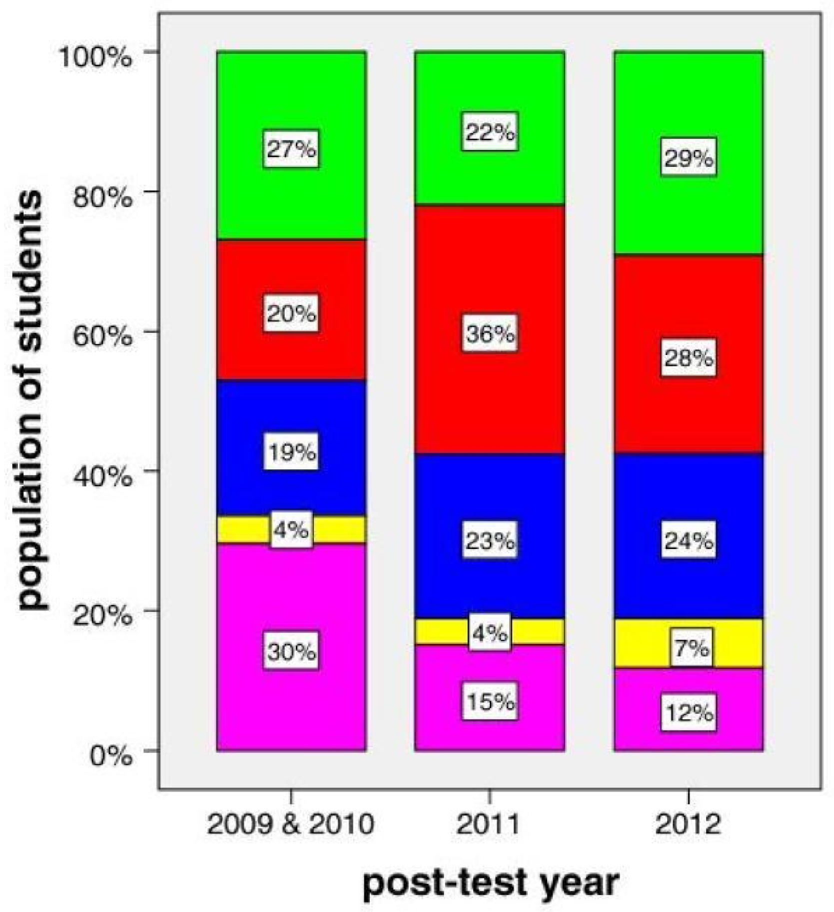
After having struggled with the problem, the students are given the expert, canonical solution. This is followed by a variety of practice and application questions.

$$x_{best} = \frac{\sum w_i x_i}{\sum w_i}, \quad w_i = \frac{1}{\sigma_i^2}$$

VI. evidence of transfer

Student A measures the flow rate of water coming from a tap and reports it to be (90 ± 12) millilitres per second. Student B follows a different measurement procedure and reports the flow rate to be (110 ± 1) millilitres per second.

How long would it take to fill a 1 litre container?



(b) 9.1 s — properly weighted average

(d) 9.5 s — improper handling of uncertainty

(e) 10.6 s — "simple" math error?

(c) 11.1 s — "simple" math error

(a) 10.0 s — straight average

** We tweaked the transfer question this year. Ask me about the change and the result.*

VII. conclusions

Invention activities help to prepare students for future learning. The invention activity described here was designed to prime students for a lesson on how and when to calculate a weighted average.

The *transfer* of knowledge can be difficult to observe, but we have found evidence that it is occurring:

Decrease in those wrongly calculating a straight average.

Increase in those paying attention to uncertainty.

(No change in those rightly calculating a weighted average.)