

# Domain Experts vs. Novices: A Matter of Control and Cognitive Load

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## About the WISE Project

The WISE project provides Internet-based tutorials to supplement the teaching of core statistical concepts. Tutorials include interactive Java applets, guided demonstrations, questions with feedback, and “thought” questions to test student understanding and guide classroom discussion.

Interested faculty can use our tutorials as laboratory exercises, homework assignments, or in-class demonstrations.

## Understanding of Statistical Variability

Many statistics students have only a rudimentary understanding of fundamental statistical concepts, such as variability.

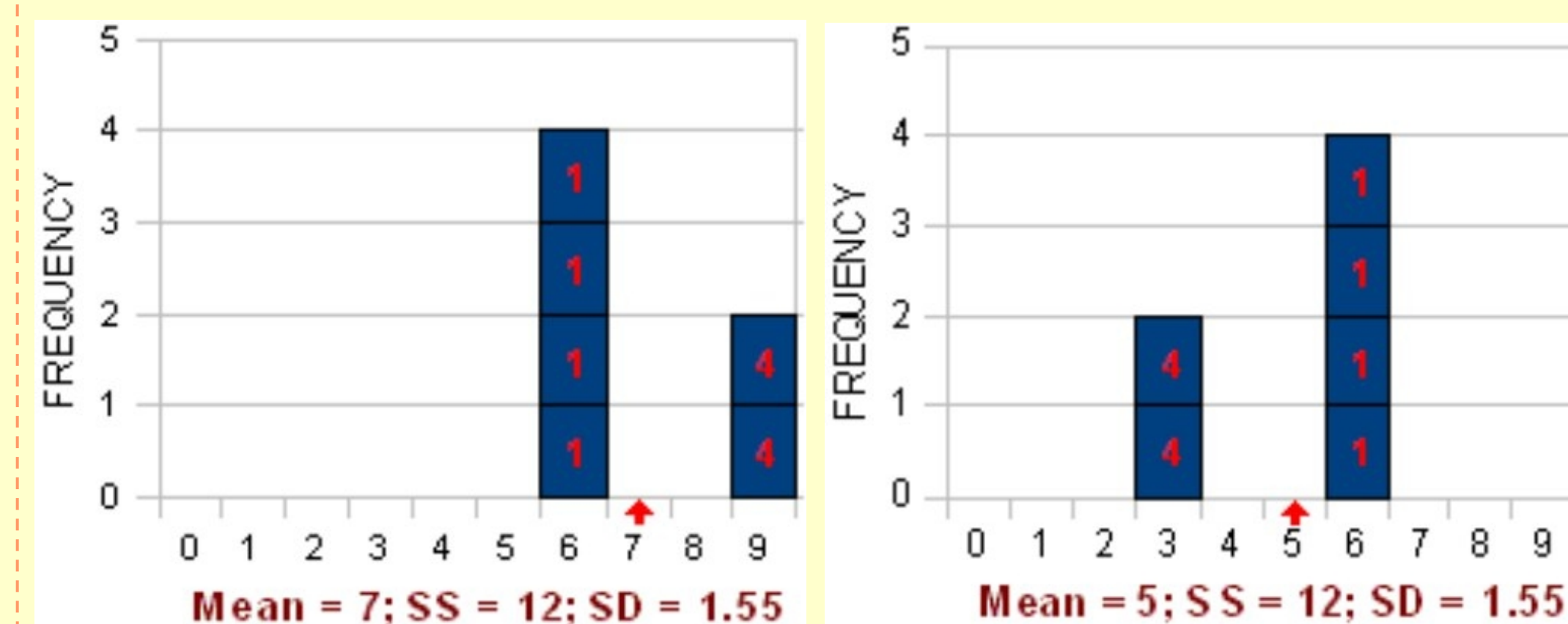
An online tutorial used illustrative diagrams and interactive exercises to improve understanding of standard deviation (*SD*) and combat misconceptions. Illustrative histograms highlighted the role of the shape of distributions, deviations from the sample mean, and the sum of squared deviations (*SS*).

Formula relating *SD* to the “sum of squares” or *SS*:

$$SD = \sqrt{\frac{\sum_{i=1}^N (x_i - \bar{x})^2}{N-1}} = \sqrt{\frac{SS}{N-1}}$$

## Which Histogram Has a Larger *SD*?

An example histogram-pair that the learner would need to compare. The red arrow represents the sample mean and the numbers in the blue boxes indicate the squared deviations that sum to the *SS*.



## Domain Expertise & Learner Control

*Learner control* (LC) over feedback and supplemental exercises varied between groups. *Cognitive load* was measured by self-reported ratings of how difficult and frustrating a tutorial section was and how much effort was exerted on that section.

It was hypothesized that novices (who had not completed a statistics course,  $N = 85$ ) and experts (who had completed one or more statistics course,  $N = 116$ ) would respond differently to differing levels of LC in terms of cognitive load and amounts of learning.

In addition, the study examined self-regulation of learning, self-efficacy, and task value.

## Self-Regulated Learning & Self-Efficacy

### Self-Regulated Learning

- Self-regulated learning is especially important in online learning.
- Highly self-regulated learners know when to seek additional resources and manage their own learning.

### Self-Efficacy

- Belief that one can succeed on a particular task and is domain-specific.
- Can impact self-regulated learning behaviors.

## Expertise Reversal Effect & Cognitive Load

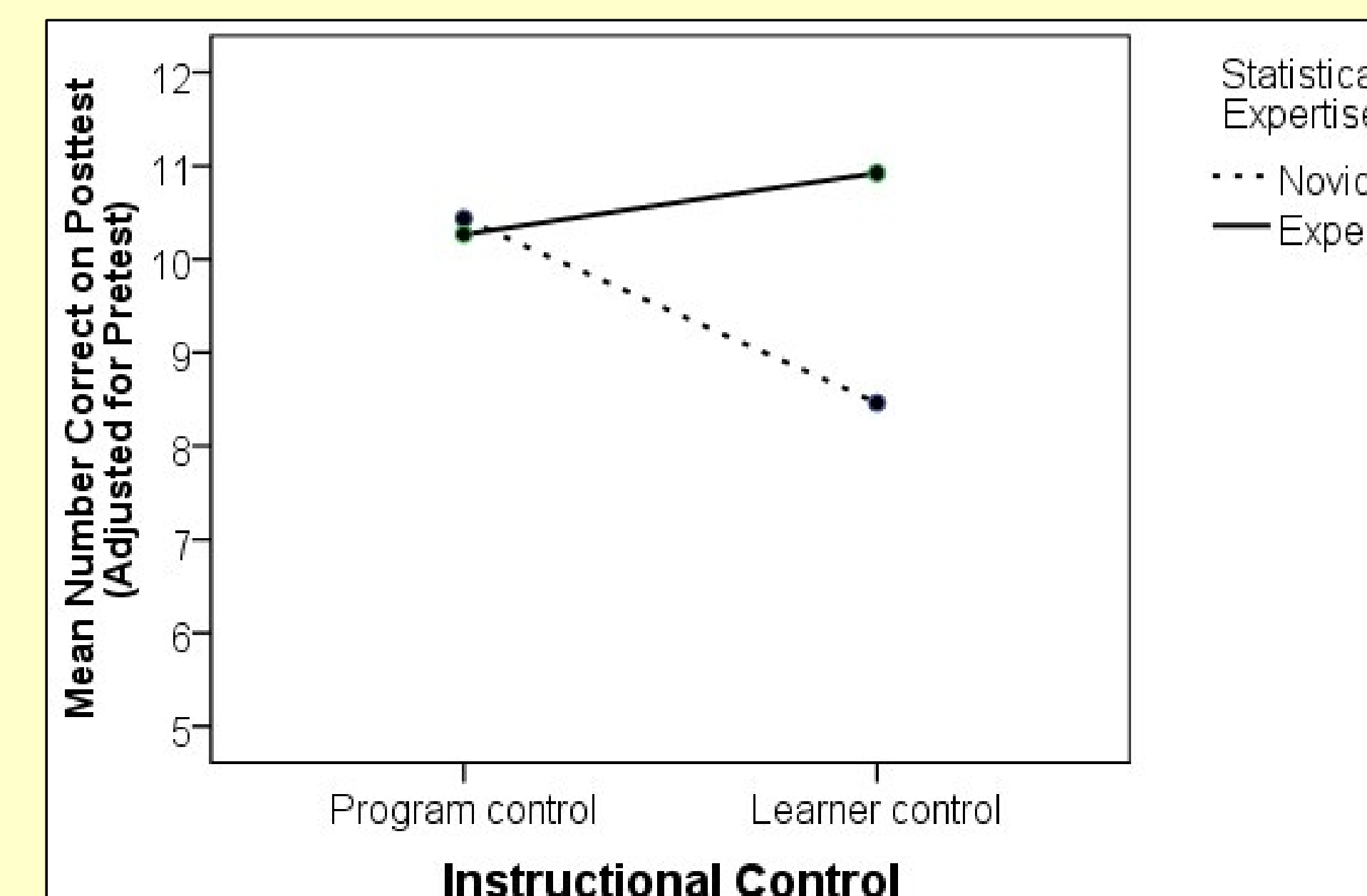
Scaffolds are instructional supports, such as advance organizers, that facilitate integrating new information with prior knowledge.

- For *novice learners*, scaffolding generally improves their learning, as the scaffold allows the learner to integrate new information with their prior knowledge.
- In contrast, scaffolding can be detrimental to *expert learners* as the scaffold may be in conflict with their existing schemata, increasing *cognitive load*.

## Experts vs. Novices: A Matter of Control

Overall this online tutorial improved understanding of standard deviation,  $d = .42$ .

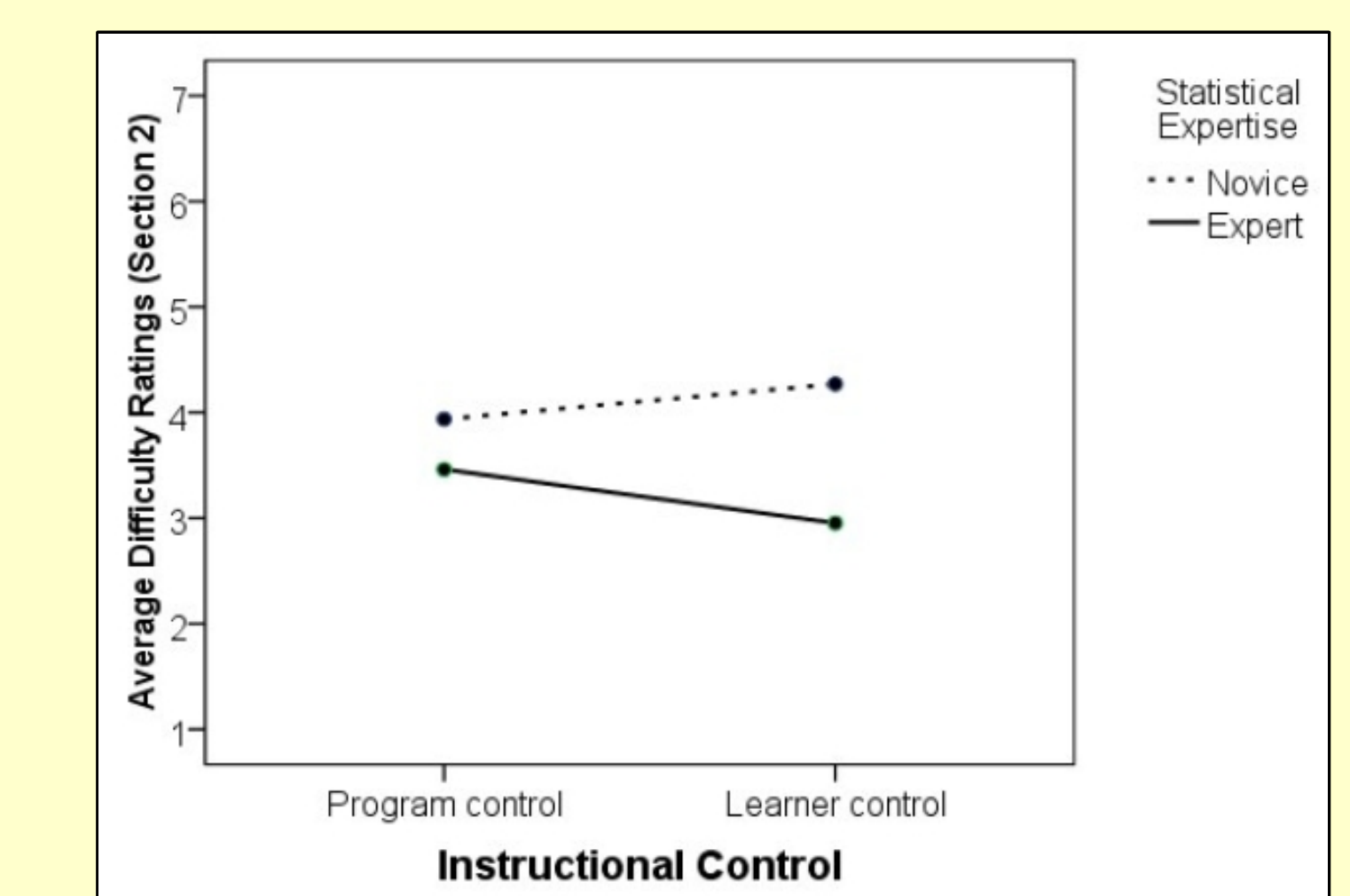
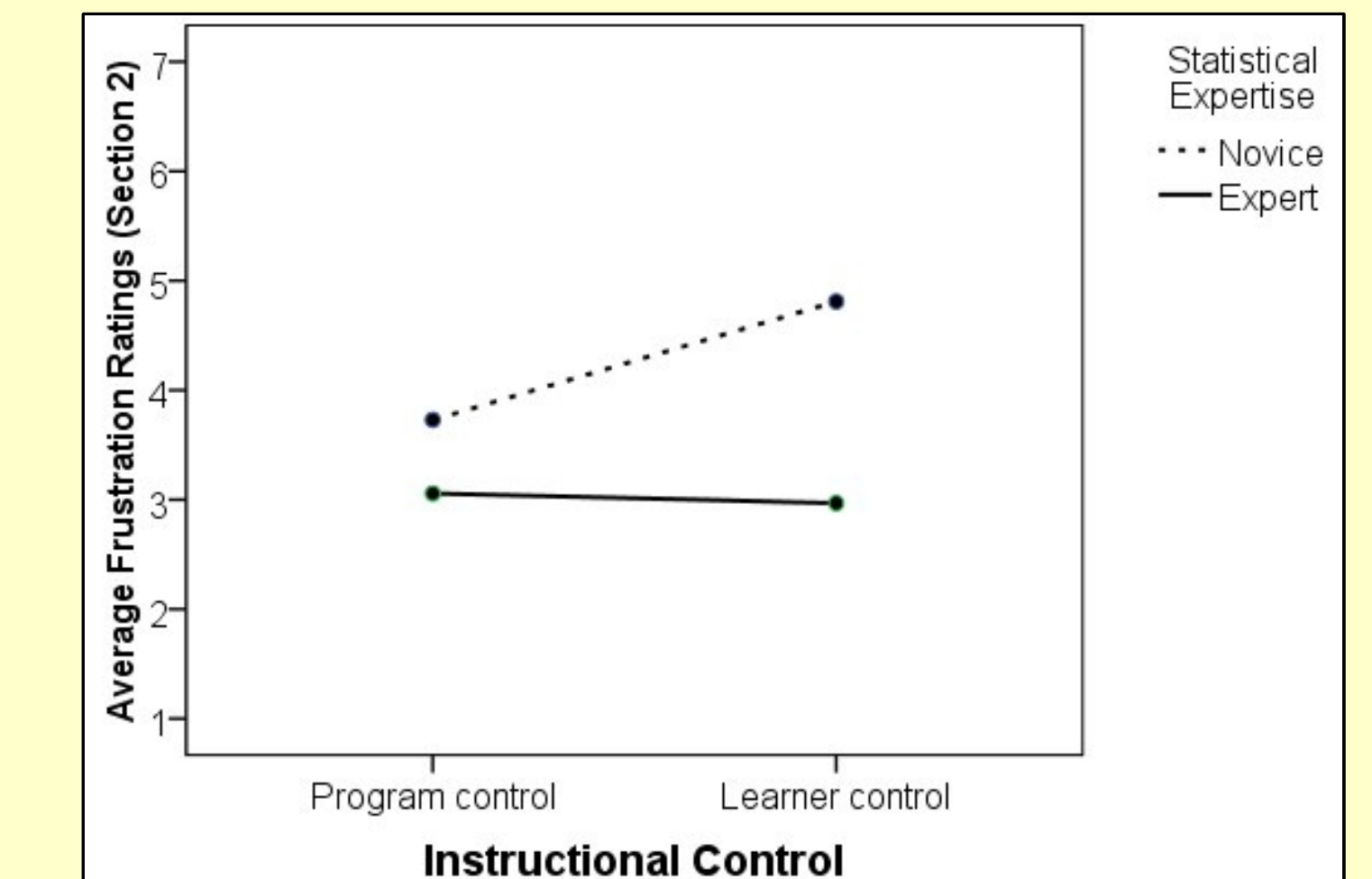
Having too much control over the instruction was detrimental to novices but not to experts, who show a slight benefit when comparing Learner Control (LC) vs. Program Control (PC).



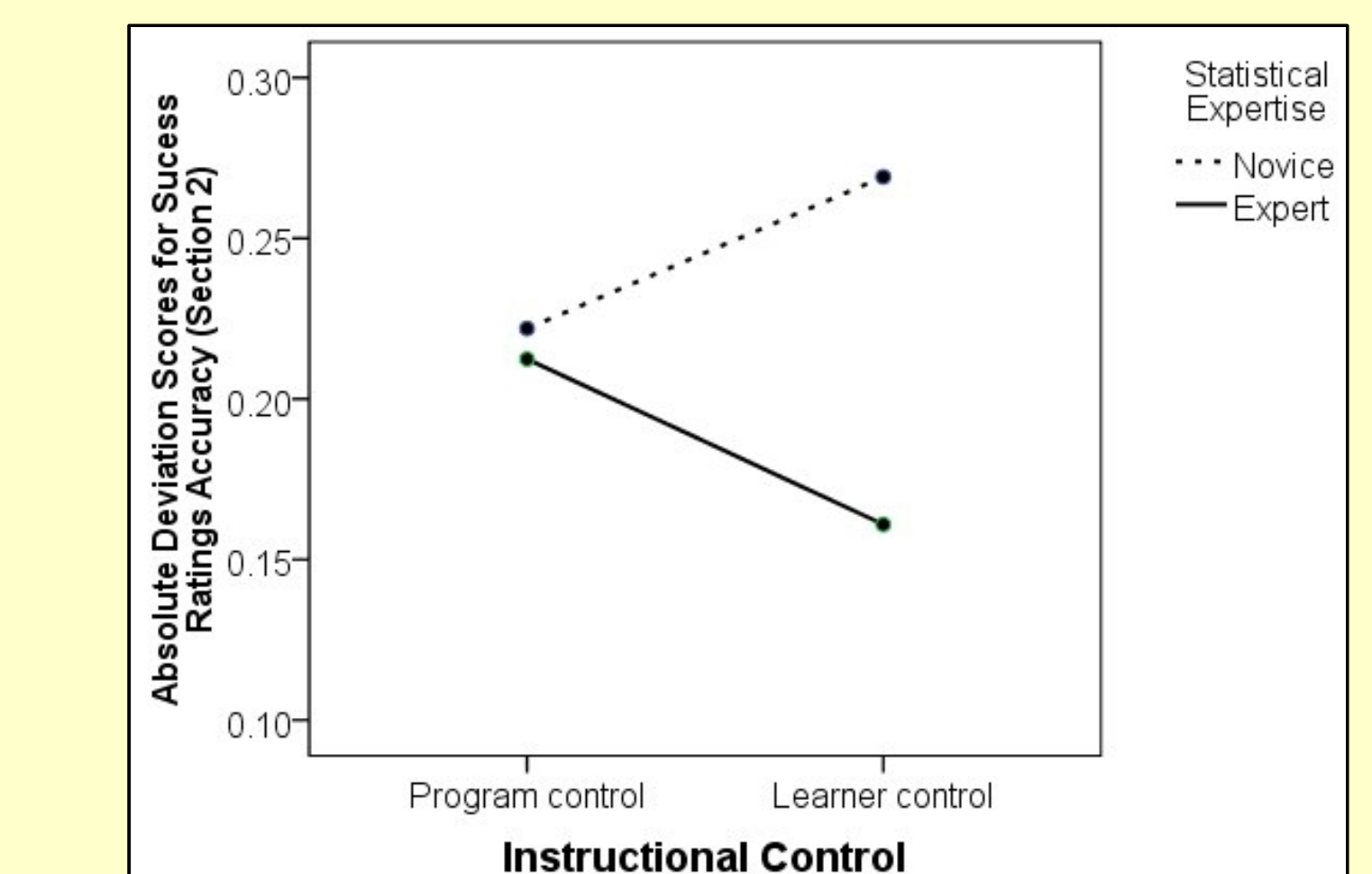
## Cognitive Load & Accuracy Differences

Compared to experts, novices were:

- More frustrated completing the tutorial and found it more difficult, especially when having more LC.



- Less accurate in self-assessing their tutorial performance, especially when having more LC.



## Implications for Online Learning

- Learner expertise must be considered so that cognitive load can be managed via instructional control that facilitates knowledge integration.
- Self-regulation of learning, self-efficacy, and task value were positively associated with learning; however, when expertise was controlled for, these predictors were no longer significant.
- Dynamic assessment and learners profiles may be useful to promoting self-regulated learning.

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