Page 1:

* The cognitive effort involved in active learning can lead students to think they are learning less, when in fact they are learning more.
* Many instructors, when faced with student complaints, return to passive teaching methods.
* Student resistance to active teaching strategies is a barrier to the wider adoption of these methods by instructors.
* There is an inherent bias among students toward passive learning, which can limit the effectiveness of active learning.
* Students tend to prefer passive teaching methods, even when these result in lower actual learning
* The "cognitive fluency" of passive lectures can deceive students into believing they are learning more than they actually are.
* The study highlights the need for students to develop meta-cognitive skills to properly evaluate their own learning.
* Students' misperceptions of their own learning must be addressed for active teaching strategies to be more effective.

Page 2:

* The experiment involved randomly assigning students to active or passive classrooms over two class meetings.
* Both active and passive teaching methods were used in alternation by the same instructors to control for variability.
* At the end of each class, students filled out a survey on their perceptions of learning and took a multiple-choice test.
* The study design had several controls to ensure the validity of the results and to avoid bias.
* Both instructors had identical training in active learning, and their lectures were prepared with identical materials.

* Students were randomly assigned and the groups were balanced in terms of their physics background and proficiency.
* Students experienced both types of instruction (active and passive) in a crossover design, controlling for variability.
* The instructors were not involved in creating the learning assessments, and the author of the tests did not see the course materials.

Page3:

* Each test of learning (TOL) consisted of 12 multiple-choice questions, designed to assess student comprehension.
* Students were encouraged to do their best on the TOL as it would be good practice for the final examination, though it wouldn’t affect their course grade.
* Participation points were awarded for completing both the TOL and FOL surveys, which assessed learning and perception of learning, respectively.
* Students in active classrooms scored significantly higher on TOL but reported lower FOL (feeling of learning).

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* In educational research, there is debate over whether data should be analyzed at the individual student level or group level (such as by classroom or school).
* Group-level analysis is necessary when randomization and treatment are applied at the group level, as in many college science courses.
* If students are randomized individually or the study is a crossover design (where each student experiences both conditions), individual-level analysis is appropriate.
* The study did not show any overt peer interactions in the video recordings that could have affected learning outcomes.
* Three factors likely explain the negative correlation between students' perception of learning (FOL) and their actual learning:

1. Cognitive fluency of lectures can mislead students into thinking they are learning more than they actually are.
2. Novices in a subject tend to have poor meta-cognition, making them poor judges of how much they’ve learned.
3. Students unfamiliar with intense active learning may not recognize that cognitive struggle is a sign of effective learning.

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* Fluency in cognitive tasks is a key metacognitive cue that impacts judgment and perception.
* In laboratory settings, students recalled the same amount of information from fluent and disfluent lecturers, but perceived they learned more from the fluent one.
* In active learning environments, students often struggle with difficult problems, which can lead to frustration and a sense of poor understanding.
* Interviews showed that passive lectures were seen as more enjoyable and easier to follow, but after being shown the study results, most students acknowledged the benefits of active learning
* Fluency was a key factor in students’ perception of learning (FOL), regardless of whether the instruction was active or passive.
* The study suggests that novices in a subject rely on inaccurate metacognitve cues, such as fluency, to assess their own learning.
* An intervention at the beginning of the semester improved students’ attitudes towards active learning.

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* Instructors are encouraged to intervene early in the course by explaining the cognitive benefits of active learning and providing early assessments.
* The cognitive principles behind these findings are not exclusive to physics but are applicable across various disciplines and student populations.
* The study found a negative correlation between students' perception of their learning (FOL) and their actual learning in active learning environments.
* The study suggests that students may struggle to recognize the benefits of active learning without guidance from instructors, leading to potential misperceptions early in the semester.