

Diversity of Faculty Practice in Workshop Classrooms

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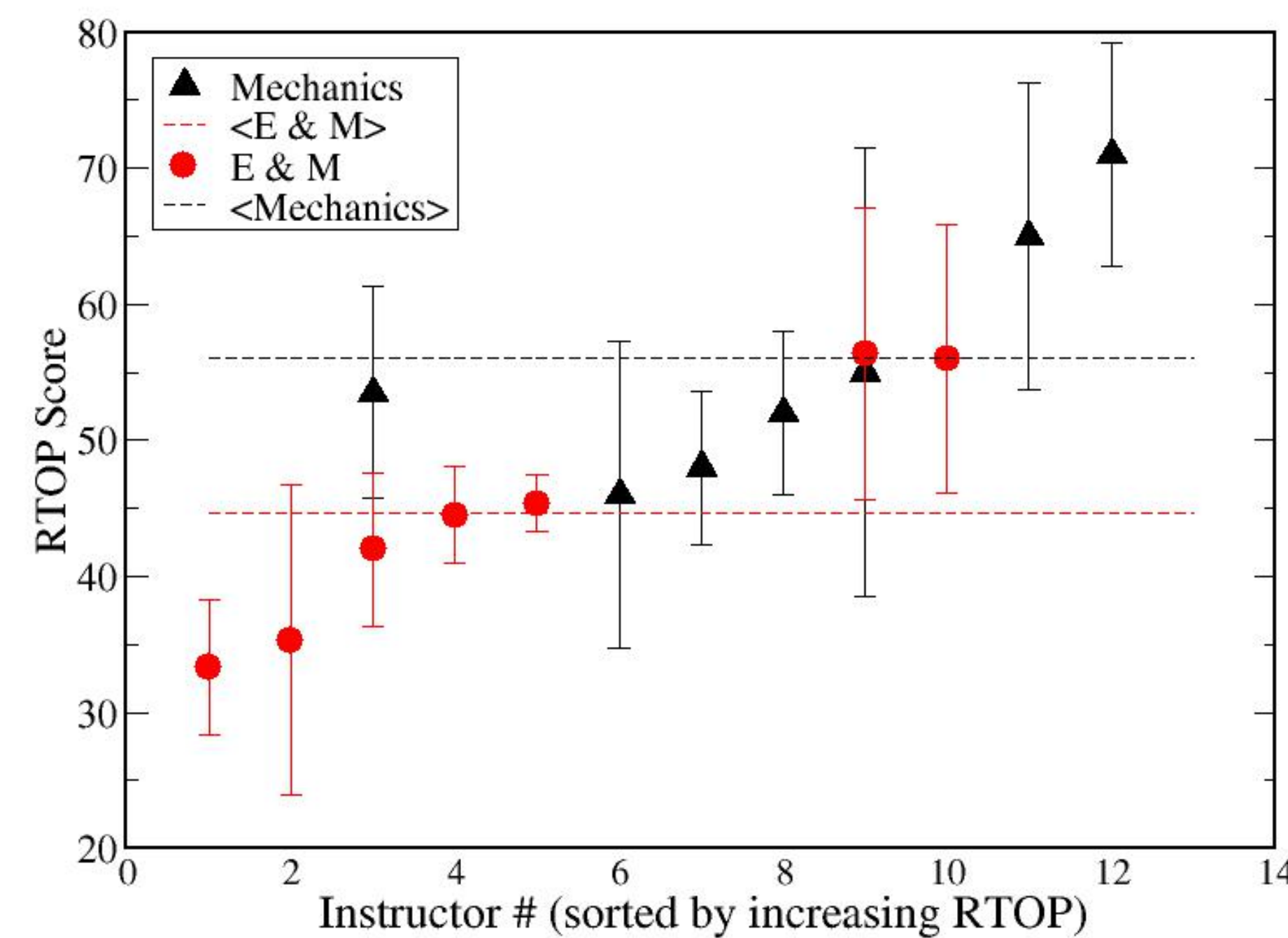
Abstract: We present a temporally fine-grained characterization of faculty practice in workshop-style introductory physics courses. Practice is binned in five minute intervals and coded through two complementary observational protocols: the Reform Teaching Observation Protocol provides a summative assessment of fidelity to reform-teaching principles, while the Teaching Dimensions Observation Protocol records direct practice. We find that the TDOP's direct coding of practice explains nuances in the holistic RTOP score, with higher RTOP scores corresponding to less lecture, but not necessarily more student-directed activities. Despite using similar materials, faculty show significant differences in practice that manifests in both TDOP and RTOP scores. We also find a significant dependence of practice on course subject reflected in both RTOP and TDOP scores, with Electricity & Magnetism using more instructor-centered practices (lecture, illustration, etc.) than Mechanics courses.

RTOP: Reformed Teaching Observation Protocol

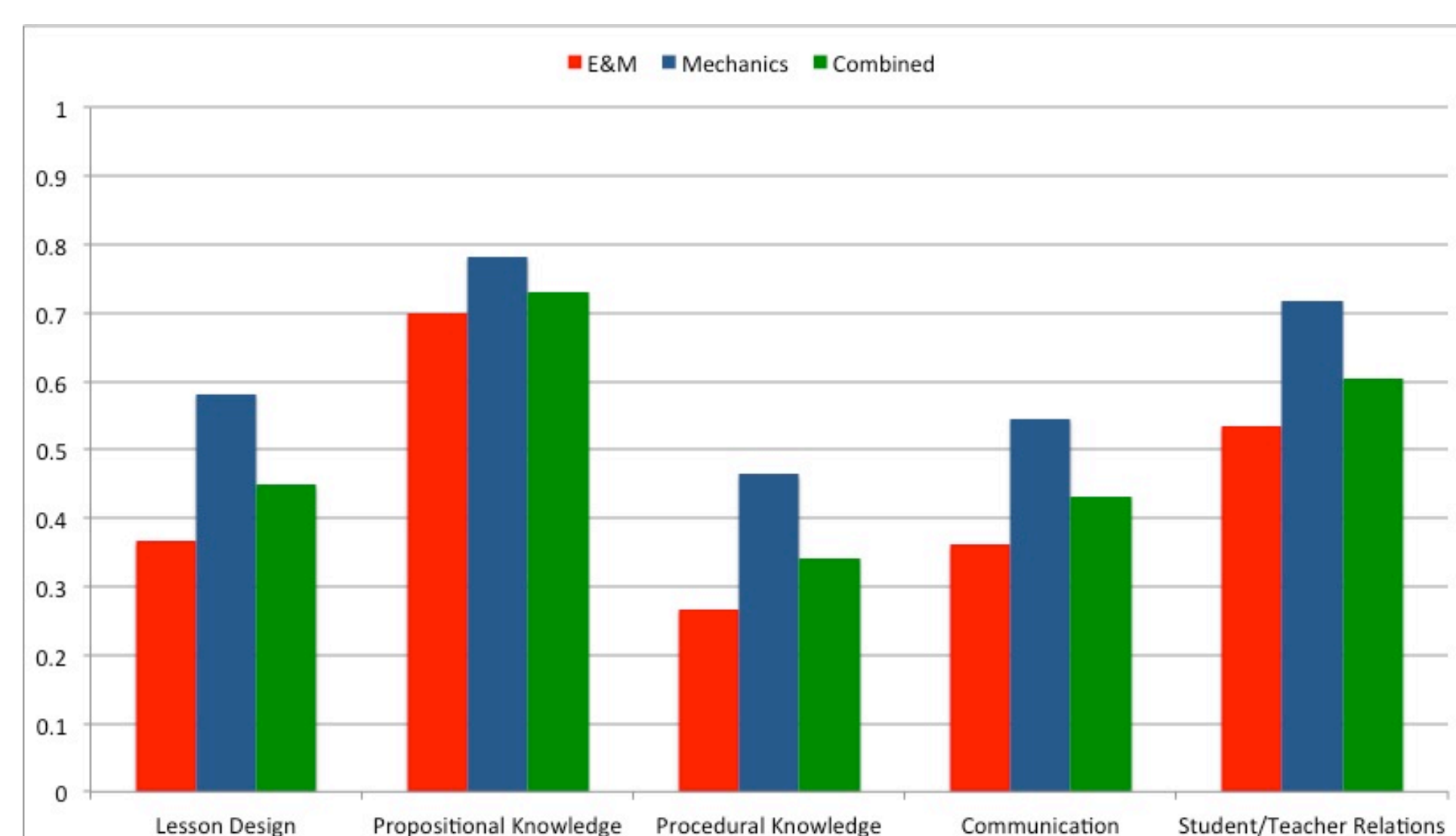
Evaluates degree of student engagement along 5 categories assessed based on field notes (25 items, 0-4 point Likert scale):

- Lesson Design and Implementation
- Propositional Knowledge
- Procedural Knowledge
- Student / Teacher Relationships
- Communicative Interactions

Faculty RTOP scores reveal a broad of student-centeredness. Electricity & Magnetism classrooms are, as a rule, less student-centered ($\langle E \& M \rangle = 44$) than Mechanics classrooms ($\langle \text{Mechanics} \rangle = 56$). Despite the workshop environment, scores are consistent with a lecture-based class that incorporates some or many student-centered activities.



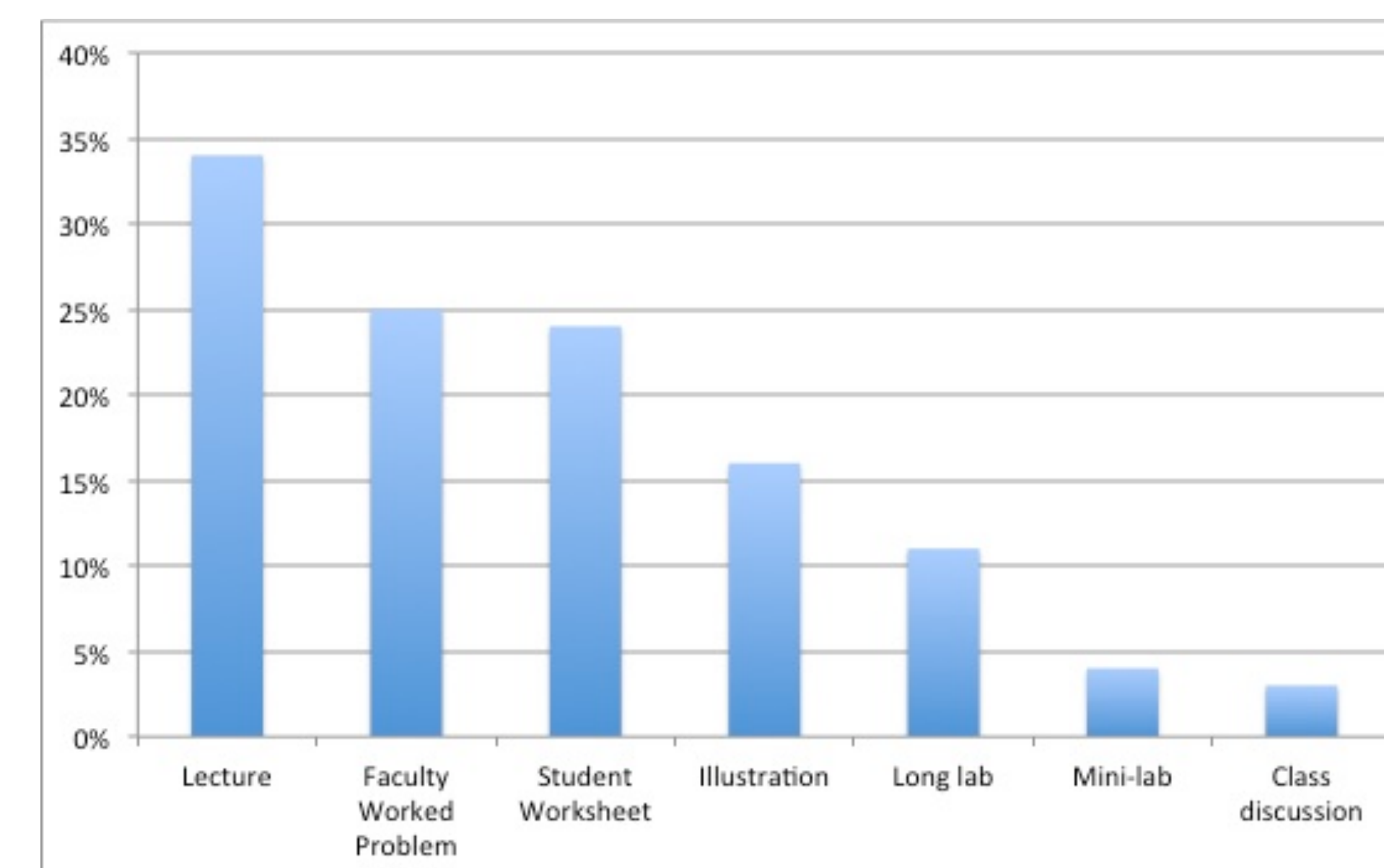
Classrooms score highest in the “propositional knowledge” sub-category which rates the coherence of the lecture and qualifications of the instructor. Scores are lowest in the categories that directly measure the reform-based nature of the activities: “Lesson Design & Implementation” and “Procedural Knowledge.” These assess the degree to which students influence the direction of the inquiry and the use of multiple representations.



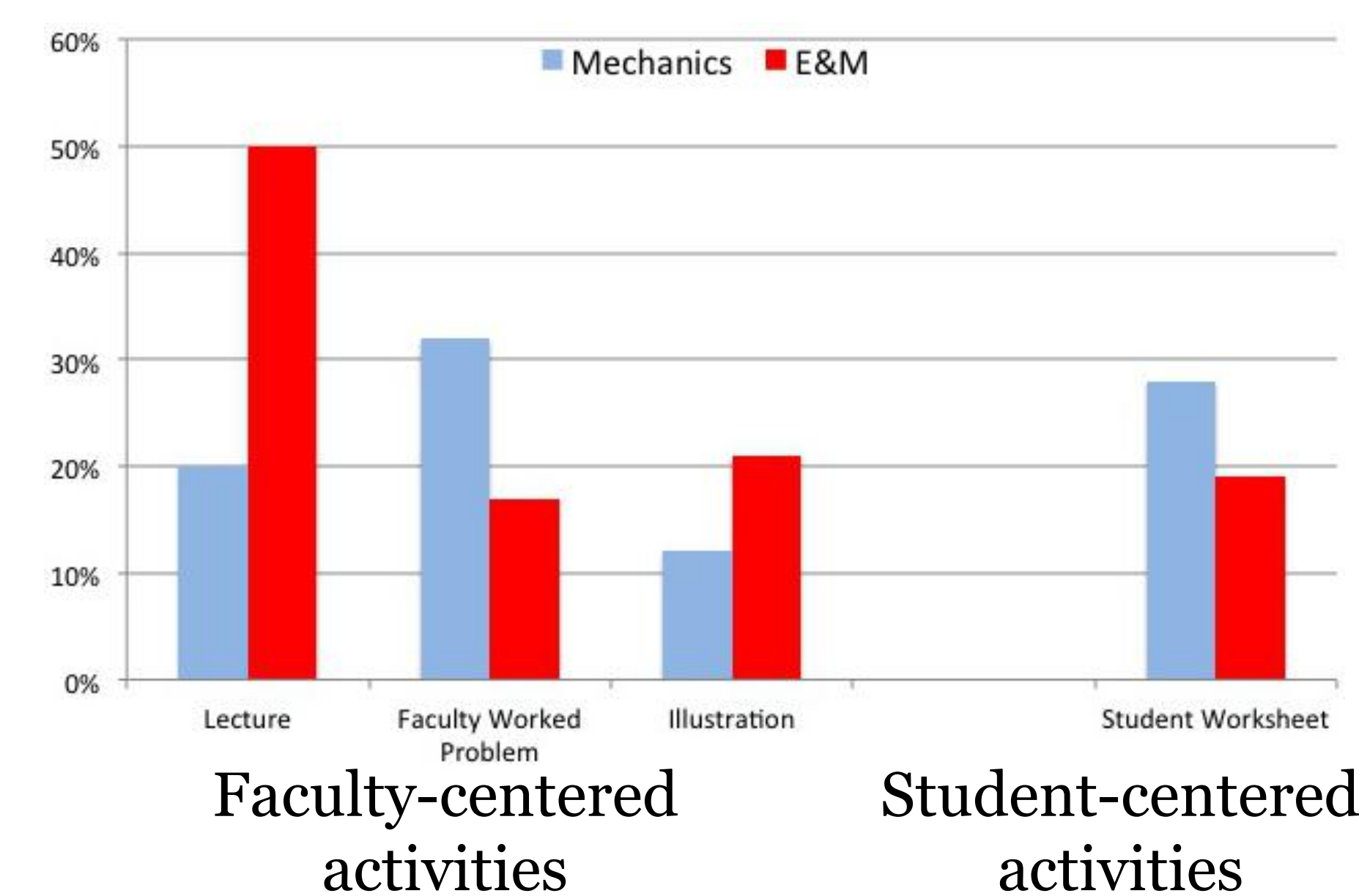
TDOP: Teaching Dimensions Observation Protocol

- 43 behaviors observed in 5-minute intervals
- 6 categories of observation recorded over the entire duration
 - Instructional Techniques
 - Question & Answer
 - Engagement
 - Cognitive Demand
 - Teaching Artifacts
 - Miscellaneous

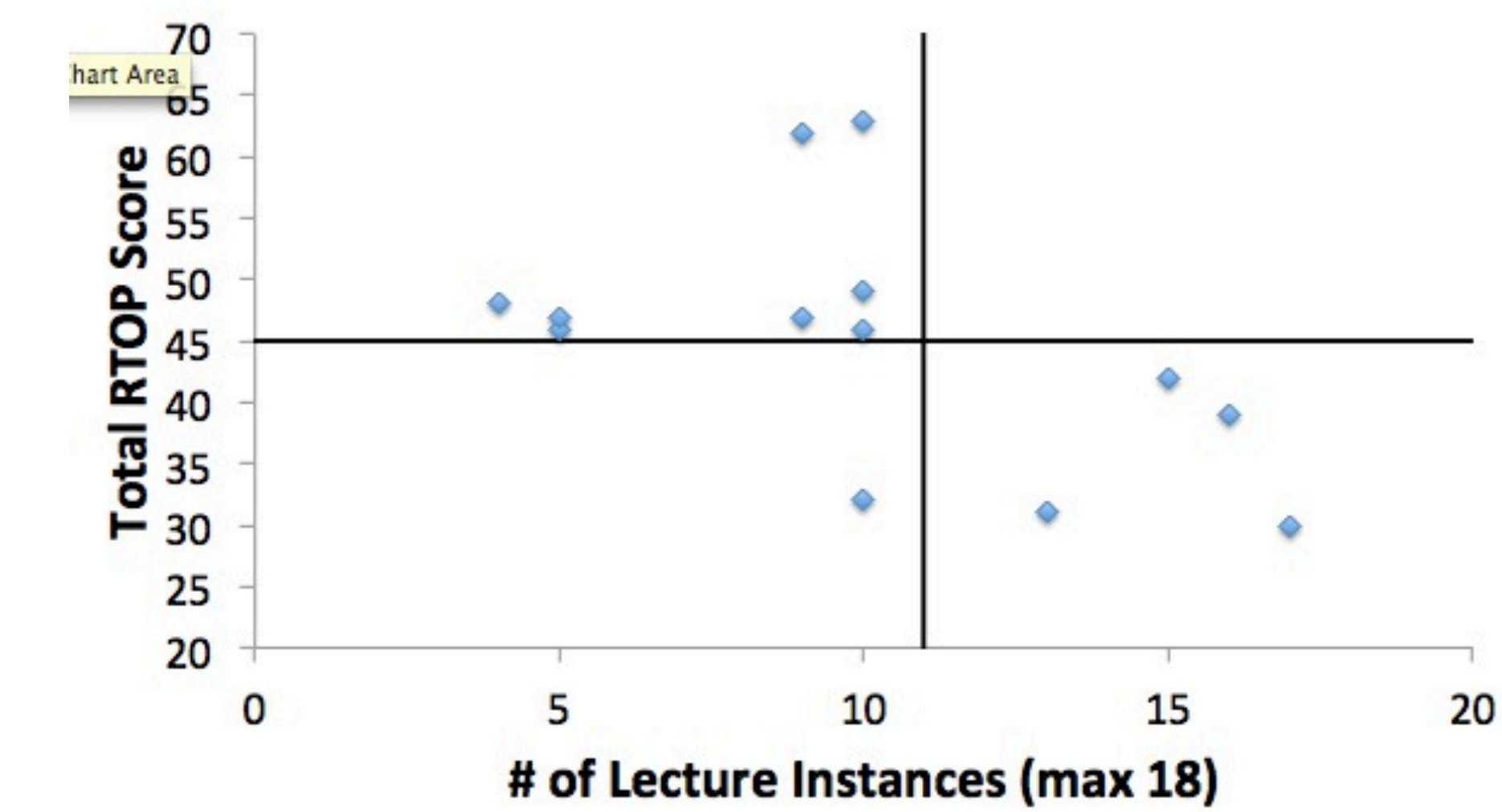
Faculty-centered activities --- lectures, worked problems, and illustrations --- dominate the observed practice, comprising three of the four most commonly observed behaviors. Class discussions --- vital opportunities for students to share and reflect --- is the least prevalent of all activities that appeared.



The difference between E&M and Mechanics RTOP scores is partially explained by the prevalence of lecture in the E&M courses. Informal faculty interviews suggest that E&M is seen as harder, more mathematical, and less amenable to conceptual or student-directed investigation. Faculty in these classes are more likely to fall back on conventional methods with which they are more comfortable.



Total RTOP score correlates with the number of observed lecture instances, suggesting that that significant reform requires a concerted departmental effort to address the faculty instinct to lecture. Radically changing the environment brings moderate changes in faculty practice.



Preliminary: 2 modes of faculty lecture: *Invent & Tell vs. Tell & Practice*

When lecture or faculty-worked-problems precede a student activity we infer that faculty are using a *Tell & Practice* model, a natural tendency for instructors without formal training in workshop-style environments in which faculty demonstrate a skill and then direct students to subsequent practice.

When faculty-centered practice follow student-activities, we assume an *Invent & Tell* approach. Giving students the intellectual space to explore a topic before formal instruction is more consistent with findings of physics and other education research and has been shown to result in higher learning gains and enhanced transfer of information.

54% of faculty-centered-practices in E&M precede student activities compared with only 25% of faculty-centered practices in Mechanics courses.

