MUHLENBERG COLLEGE
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"Scratch and Win" Tickets and Team-Based Clickers in Introductory Physics

Adam B. Clark

ABSTRACT

We hybridized Team-Based Learning with the physics-native methods of Peer Instruction and Cooperative Group Problem Solving. Team-based Learning and the use of "scratch-and-win" tickets are summarized below. In the hybrid approach, students work in those same teams for clicker question discussion and for Cooperative Group Problem Solving. We discuss the advantages and disadvantages of this approach.

Team-Based Learning, RATs, and "Scratch and Win" tickets

http://www.teambasedlearning.org/Default.aspx?pageid=1032195

- Teams assigned by instructor based on prior math and physics preparation.
- Reading guides posted to Blackboard course website identify important topics, examples, concepts, and proportionalities for students ahead of time.
- Readiness Assessment Test (RAT) – in-class reading quiz. Students take RAT first individually, then again with their teams, using the "Scratch and Win" tickets, known as Immediate Feedback Assessment Technique (IF-AT) forms.

Ideals

- Permanent teams of 5-7. Conflicts resolved within teams whenever possible.
- Students figure out group roles on their own.
- Peer evaluations key.
- Pre-Class Reading □ RAT □ Class Discussion □ In-class team exercises □ homework □ exam/project

My Grading Policy for RATs

- RATs count for "bonus points"
- RAT scores are curved such that the median overall score earns enough bonus points to offset 20% of the final exam.
  - Final was weighted 25% of overall grade, so RAT median score effectively earns 5% of overall grade.
  - Bonus points alleviate student resentment
  - Students vote on first class day for relative weight of team vs. individual RATs.

Cooperative Group Problem Solving: Ideals

- Groups of 3 preferred: Large enough to have sufficient combined expertise, but small enough to ensure participation
- Groups changed 3-4 times per semester
- Group roles assigned randomly each session:

  i) Manager, ii) Recorder/Checker, iii) Skeptic/Summarizer
- Context Rich Problems: Story problems that resist solving by "pattern matching". Require understanding of the scenario and relevant physics concepts. Often have excess information or are missing key pieces of information (that will either cancel out or must be derived as an intermediate step). Target variable not always explicit. Require active decisions about physics concepts.
- Problem Solving Framework: i) Focus the Problem, ii) Explain the Physics, iii) Plan a Solution, iv) Execute the Solution, v) Evaluate.
- Limited set of "base equations" supplied to students as valid starting points.
- Each complete in-class problem should take about 50 minutes

Peer Instruction: Ideals

- Clicker questions, Think-Pair-Share, concept-focused lecture
- Problem solving mostly in recitation section
- Lone wolf problem: some students never engage, no matter what

Potential Problems with Hybrid Approach

- Appropriate difficulty level of RAT questions
- Student resentment if RAT graded traditionally: They hate being graded on material they "have not been taught yet."
- Productively using class time for teams that finish early
- Students dislike assigned seating and teams, but allowing "free seating" on traditional lecture days was counter-productive.

Goals of Hybrid Approach

- Strongly incentivize pre-class reading
- Increase engagement during clicker discussion and reduce "lone wolf problem"
- Improve problem-solving skills
- Combine "Best Practices" from each approach
- Cause no disruption to pre-existing course time slot .

Control Implementation

- Context-Rich Problems: 2/week handwritten homework + exam questions
- CPS-based framework and rubric for both handwritten homework and exams
- Extensive online homework via Mastering Physics, both quantitative and conceptual
- Clickers in lecture:
  1. First impression vote (30 s)
  2. Unstructured "convince your neighbor" time (1-2 min). Vote when done.
  3. Reveal answer, solicit student volunteer to explain, discuss.
- Roughly weekly Reading Quizzes (RQs): 3 multiple choice via Blackboard course website. Unlimited attempts allowed, but must retake whole quiz.
- Two-hour lab sections meet 2/week. Mainly using Workshop Physics Activity Guide. Occasional problem-solving exercises in lab.

Hybrid Implementation Additions

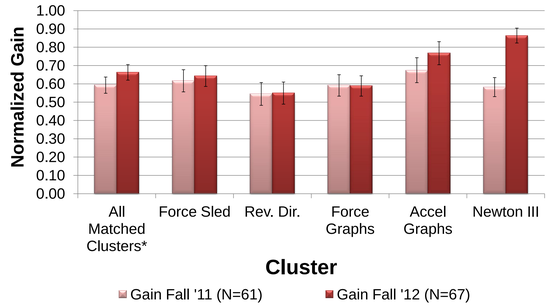
- RATs replace Reading Quizzes. RAT= 5 multiple choice (MC) similar to or based on the "Stop To Think" questions in each chapter of Knight, 5 more challenging MC, 1 free response "Most Confusing Point" question.
- Students sit with teams for RATs, clickers, and team problem-solving exercises. Sit where they please for "traditional lecture" days.
- Team problem-solving exercises: 20-30 minutes for each team to work the problem up to the "Plan" step of the framework. Work is evaluated and given feedback but not graded. Approx. once every 1-2 weeks.

Anecdotal Benefits

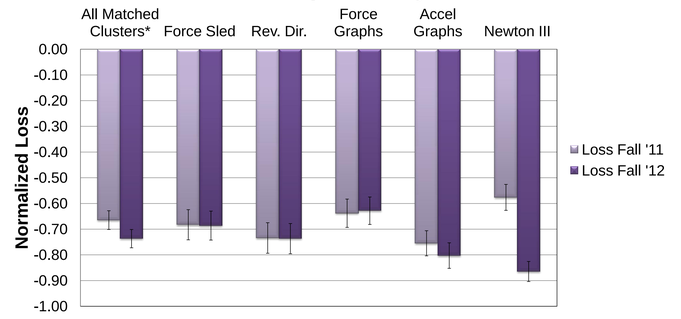
- Scratch-and-win tickets are engaging and fun. Students often exclaim, "Yes!" or something similar when they scratch off the right answer on the first try.
- Clicker engagement is vastly improved.
  - No noticeable "lone wolves"
  - Very few negative peer evaluations
- Unanticipated benefit: Unstructured clickers often saw the most popular answer from the "initial impression" vote become more popular after "convince your neighbor" discussion, even when wrong.
  - Almost never happened with team-based clickers.
  - Obvious confounding variable: "Susie is the smart one, let's just all vote how she votes."
    - Regardless of confounding variable, students are having their first round of discussion in their teams, so whole-class discussion takes place at higher level.
- Students appreciate the cycle of reinforcement from reading to RAT to lecture to homework to exam.

Results

FMCE Normalized Gain by Cluster



FMCE Normalized Loss of Most Common Incorrect Responses by Cluster



Likert Scale: "I read the textbook more thoroughly than normal due to the [RQs/ RATs]."

Fall '11 [RQs]:	**Fall '12 [RATs]:**
1.5% Strongly Agree	27% Strongly Agree
16.4 % Agree	20% Agree
44.8% Neutral or lower	14% Neutral or lower
37.3% Omit	38% Omit

* Footnote: In Fall '11, this had not been conceived as a PER study. Due to a printing error, the pre-test FMCE was missing one entire page, front and back, so pre-test data are not available for the clusters on Velocity Graphs or Energy for the "Control" implementation.

Discussion

- Team-Based Class performed better overall and for all matched clusters on FMCE
  - Difference only statistically significant for the Newton III cluster
  - Standard error is relatively high, due to low N
- Likert Scale response indicates significant improvement in thoroughness of reading, as self-assessed by students

Future Directions

- Optimize team dynamics, peer evaluations
- Improve implementation of in-class non-exam team problem solving exercises
- Explore suitability as supplement for "checkout questions" (e.g. *Physics by Inquiry,* or *Tutorials in Introductory Physics*.) in staff-limited situations

References

Heller, K. & Heller, P. Cooperative Group Problem Solving in Physics: A User's Manual. U. Minnesota. PDF distributed at AAPT New Faculty Workshop 2009.

Mazur, E. (1997). Peer instruction : a user's manual. Upper Saddle River, NJ: Prentice Hall.

Michaelsen, L. K., Knight, B. K. & Fink, L. Dee. (2004). Team-based learning : a transformative use of small groups in college teaching. Sterling, VA : Stylus Pub.

IF-AT previously implemented in physics by Joss Ives of University of the Fraser Valley with 10 minute long group quizzes. http://learnification.files.wordpress.com/2012/05/joss_ives-bcapt_agm2012-group_quizzes_as_an_assessment_that_supports_learning.pdf