# Enhancing Team Interaction in [Introductory Physics] Instruction
[*A Faculty Learning Community Project*, $2009 - 10$]

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**Abstract**

We discuss instruction of workshop-based Introductory Physics (Team Physics) classes, pointing out some of the common problems of group interaction that can negatively impact learning. To deal with these problems an approach, refered to here as Enhanced Team Interaction (ETI), is suggested and its merits pointed out. The approach aims at improving problem solving through structured group communication.

# 1 Introduction

Instructors are always looking for ways to create a classroom environment that supports a productive and yet friendly learning experience. However, success in achieving this goal crucially depends on the delivery method(s) chosen. In this paper we suggest ways of improving the instruction of team-based Introductory Physics in universities, colleges and high schools. Here, we focus on one particular facet in this instruction, namely problem solving. It is shown that this can be achieved through an *enhanced* structured group communication.

**Historical Context:** Studies [1] have shown that in introductory Physics instruction the traditional lecture approach often ends up being mentally tiring and hard to follow, in part because the students involved are still in the process of developing the mental endurance needed to follow lengthy lectures. In 1985, Haloun and Hestenes [1] at Arizona State University did a study involving a large number of students, taking introductory physics courses (both calculus and non-calculus based). The study found that:

(i) while in studying *motion and its causes*, for example, students' initial common sense experiences about the phenomenon had a more commanding effect compared to the professor's traditional instruction

(ii) the students' low gain from the traditional instruction was independent of the instructor.

To modify the traditional lecture approach, Eric Mazur of Harvard developed the Peer Instruction approach [2]. Since then, a substantial amount of research has been focused on improving on these interactive engagement techniques. Surveys followed later [3, 4] demonstrate the effectiveness of interactive engagement approaches.

In 2004, the Physics Department of RIT adapted a workshop set-up approach previously developed by North Carolina State University, called Team Physics. This approach has been utilized by RIT, since. While the approach may support an easier learning environment than the traditional one, it can have its own set-backs. The purpose of this project is to seek further improvements on the workshop based team physics instruction by identifying some of these problems and suggesting ways to address them.

# 2 Problem definition

Team efficiency and productivity can be negatively affected by several problems. In this paper we identify three such problems as follows:

- Well prepared students (new to group interaction) tend to despise group-based problem-solving ventures, and may consider such ventures a drag on their progress. In some cases this attitude may also mask a student's discomfort with group interaction. So, when a problem is given for the group to discuss and solve, students in this category tend to tackle the given problem alone and quietly, while the others look on. This weakens group power.

- Weak or less prepared students will often mentally disengage from the group because they may feel they have little or nothing to contribute to the group. Such students can feel "exposed" by the team approach. As a consequence, the natural responsive reaction may be to despise group effort. Under this environment it is hard for such a student to benefit from group interaction.

- The combination of the two problems stated above can further lead to a scenario in which the weak student constantly, demands full help from the instructor prematurely through statements like "I don't understand this problem". Such a student will often find it difficult to settle for leading suggestions from instructor. prematurely providing the full solution approach (on demand) impedes group learning. On the other hand, offering suggestive cues only leaves the "pressured" weak student frustrated and resentful. This state of affairs can leave the instructor is left compromised.

# 3 The model: Enhanced Team Interaction [ETI]

Enhanced Team Interaction [ETI] seeks to address the above problems. The basic feature of ETI is that it fosters a natural conversational environment in problem solving by assigning temporary leadership responsibility to each individual member of the group (of three). The premise is that when fully utilized, the group can out-perform the best member in the group [5]. The responsibilities are designed to cover the entire span (or scope) of the problem solving space (or range) in the following manner:

- **Team Strategist (TS):** The Team Strategist leads the group into initial thinking about the problem, in terms of the resources available in the information provided,

and the relevant physical principles to apply towards the solution sought. The TS starts by asking everyone such questions as "So, what are we looking for?" "What information do we have?" "What principle should we apply?". This necessarily initiates a discussion within the group about the problem. The responsibility of the TS is *not to provide the answers* to the questions **but rather to set up the stage** for a logical discussion of the problem.

- **Team Analyst (TA):** The Team Analyst takes down the relevant information, including the pertinent equations and the given data as is necessary to solve the problem. While the others may write this information down too, *it is the TA's role to lead a discussion about the information's accuracy and how it is set up to find the solution.*

- **Team Link (TL):** The Team Link ensures that the structure and lay out of what is written down is consistent with the initial strategies set out to solve the problem. By *frequently questioning what may not look right*, the TL links the strategy and computational stages of the problem solving process.

  These roles can also be adapted to cases of performing a laboratory experiment. For example, the TS can read out the experiment's instructions, while the TL sets up the equipment and the TA records data.

*The ETI roles are rotated each week so that students are exposed to changing responsibilities. Each member of the team has a permanent identity as A, B or C. At the beginning of each class the students are reminded of their responsibilities through a display of an assignment sheet that looks like the one below.*

$ENHANCED\ TEAM$
$INTERACTION\ [ETI]$
$[Week\ 5\ Schedule]$

| $TS$ | $TL$ | $TA$ |
|---|---|---|
| $C$ | $A$ | $B$ |

# 4 Impact

- Since the TS' responsibility is to initiate the conversation and since after that anyone member of the group can take it up from there, the approach allows the more prepared student to play a significant role in verbally building the strategic framework. As the others join in and ask questions the prepared student begins to appreciate the role of explaining. Moreover, the same student also begins to realize they can (and actually do) learn from the deeper insight the discussion provides.

- The weaker/less prepared student, on the other hand, is now learning from the others how to build a strategy to solve such a problem. This student also learns to be verbal,

through such questions and discussions that do not pre-necessitate the student has to be correct. This builds the student's confidence by taking out the fear of being wrong.

- The pressure on the less prepared student which previously drove the need to ask questions prematurely, now subsides. Questions now tend to be more team oriented than individual.

*When I first applied the method, the class that had been mostly quiet instantly burst out in a lively conversation.*

# 5 Assessment and Feed-back

## 5.1 Assessment

Currently, there are three ways the impact of ETI on the students has been assessed. More robust assessment will produce more reliable information.

(1) **Comparative observation** of student interaction before and after introduction of ETI. *For example: previously quiet class becomes lively conversational and communicative.*

(2) **Performance**, in common exams, of students using ETI compared to the rest. So far ETI has been applied to three University Physics II classes between the winter 20092 and spring 20093 quarters. The results are that in common exams taken by all contemporary University Physics II classes, each of the ETI utilizing classes has scored at least 7 points higher than all classes' average. One should caution, however, that there are other factors that may affect a given class superior performance.

(3) **Feed-Back:** Here, the students were given a questionnaire (see Appendix) to find out how they feel about ETI. The key question was whether or not to continue ETI.

The results of a recent questionnaire are summarized below.

## 5.2 Feed-back

University Physics II class: Calculus based series. $N = 38$.

| | $Week\ 5$ | $Week\ 10$ |
|---|---|---|
| $Strongly\ favorable:$ | 51% | 52% |
| $Mildly\ favorable:$ | 28% | 14% |
| $Not\ favorable:$ | 21% | 34% |

*Each time, the students were given a feed-back of their feed-back. Based on the above results the Department has recommended the ETI approach be continued.*

# 6 Conclusion

We have discussed, "Enhanced Team Interaction", a potential approach aiming to improve problem solving techniques in work-shop type Introductory Physics classes. In this approach team members are assigned leadership responsibilities as Team Strategist (TS), Team Link

(TA) or Team Analyst (TA). The roles are used to initiate communication and to solve a given problem in a planned and logical manner. The approach appears to empower *all* the students within a group with the result that discussion evolves easily and naturally. This implies the approach may improve the students' performance: a desired overall outcome.

From initial feed-back the students express a liking for the approach. However, the impact of the approach can only be quantitatively established in future, through a sustained series of robust assessments.

# 7 Appendix: Questionnaire

Instructors are always looking for ways to create a classroom environment that supports a productive and yet friendly learning experience. It is always very helpful to such instructors to get a constructive feed-back from their students. For several years now, RIT Physics Department has adapted a team-based approach in instruction of introductory physics classes.

In an attempt to improve on this team-based instruction Dr. Mbonye has introduced a method of problem solving through Enhanced Team Interaction [ETI]. In this approach each member of the team picks up a responsibility to lead the team in problem solving discussion as a Team Strategist, a Team Link or a Team Analyst. Based on the last ten weeks that you have been exposed to this approach could you please take a few minutes and help with your feed-back by answering the few questions below? Thank you for your time.

(i) Would you say the ETI approach encourages communication within the team?

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(ii) Would you say the ETI approach helps you think more clearly about the problem as you and your team-mates discuss it?

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(iii) Would you recommend the ETI approach to be continued?

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(iv) Are there any improvements you would like to see introduced in the ETI approach?

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# References


[1] Halloun and D. Hestenes, Am. J. Phys. 53, 1043-1055 (1985).

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