Hi all, Thanks for the great workshop! Please see my responses below to some of your questions from before the workshop. Feel free to see these responses as part of a discussion - you can follow up with me at jfraser@seas.harvard.edu . -James

Timestamp	What 1 or 2 questions do you have after reading the above articles and/or watching the video?	If you were to apply the pedagogies described in the above articles and video, to a large-enrollment course you have taught (or will be teaching), what do you think will be the largest obstacle to overcome?
40716.56615	how do people learn?	still how to assess effectively whether students learned?
	There are several standardized tests that measure conceptual learning in a variety of topics: FCI, BEMA, etc.	
40716.56689		
40716.59693	JiTT and PI in conjunction with a web based feedback seems to be a good way to address specific conceptual problems in the upcoming class. Are there any specific tools available to create such a web based feedback system?	The use of clickers (technology) seems to help to get direct feedback from larger groups. I don't think that flash cards will work effectively with large classes. The answer variety is here restricted to two maximal three different answers. I don't think handing out more than two/three flash cards per student is practical. Therefore the largest obstacle to overcome would be the lack of modern equipped classrooms including a clicker system.
	Check out the ILT (link on Compadre). Re: flash cards. I still prefer clickers but was impressed with what Ed could achieve with them. That really blew me away!	
40716.67193	How to organize a class/lecture so that there is as little material coverage loss as possible, compared to traditional lectures? While some of these techniques are applicable to graduate courses as well, in those courses it is still the amount of "information transfer" that is important, I presume?	Motivating students.
	The reading assignments define for the students the topics that are part of the course. Even though coverage in lecture is reduced, the course material coverage is not reduced unless you explicitly chose to do so. Re: graduate courses, active learning in graduate courses is still very valuable with more data being published regularly.	
40716.83007	What specific tips do you have for finding the correct balance between how much time you devote during class periods to PI techniques and how much time you devote to explaining problems in a more traditional lecture style? Would you change or adjust any of your basic pedagogical techniques when teaching an introductory level class of 35 students rather than 150-200?	In a large class, I feel like the time required to carefully read through all the free responses given on the JiTT quizzes, correctly identify weaknesses, and adjust what content will be emphasized in class the next morning, is extremely demanding.
	Check out Eric's book for a detailed timeline of his lecture with PI. I don't see any difference between 35 and 200 other than it would be really nice to have some TFs in the large classroom to interact with students during peer instruction.	
40716.88953	From my personal teaching experience, I found that the students' learning effect strongly depends on students' self-motivation. So for students who are highly motivated, they will learn no matter how good/bad you teach. So how do you motivate students who have very low motivations, especially for students from a regional community college.	two possible obstacles: 1. From the college where I am from, it is very likely that most of the students in my class will not do the pre-class reading, this will make the pedagogies not that effective for my students. 2. Now we only teach astronomy in a large class setting. How can I come up with good questions in Astronomy? A majority of astronomy materials are about facts instead of understanding.....
	Student motivation is very important. PI has been used very successfully with a wide range of students with very different backgrounds. Increased engagement is usually improved - this might be of real benefit to you. Regarding the reading assignment - when students see that their feedback from the reading assignment determines the lecture the next day, they see the value in the process. Also you MUST have assessment directly linked to PI and the reading assignments. Run midterm early in the term and make sure that a large component of it requires conceptual understanding. Also give questions on assignments on topics that were in the reading assignment but were not discussed in lecture.	
40717.26281	What are some strategies for keeping (roughly) to a schedule when so much of class is interactive. I don't want to cut short useful conversations among small groups, but how do you know when to cut off the small group discussion and have students re-submit their answer to the question?	Choosing appropriate questions! I've been doing this for a while in astronomy and have figured out which concepts need to be tested and how to phrase questions, but I have not done this in physics yet.
	As a place to start, check out Eric's book. I think telling students at the start of PI how long they will have is beneficial to them. Do not let it go to long, or it will drag. I would error on the side of cutting the discussion short for some students to make sure that you do not have a number of students sitting around waiting. Students will have time to discuss later (office hour, informally amongst themselves,)	

40717.34632	Is there a risk of losing coverage of material using the methods discussed by Dr. Mazur? My students have consistently asked that more problem-solving be done by me during lecture (probably in hopes that they will see very similar problems on tests). I fear that these methods, although extremely useful in teaching physics, will require cutting the amount of material covered significantly. If so, what do we cut and is that justified?	Probably maintaining order in the classroom during peer-discussion, and then getting the class back on track during instructor lecture. Going back and forth several times during a 50-min class seems logistically difficult.
	For coverage concern, see above. I have also always had students ask that "more problems be worked through" and think that your guess is right. For instance, when I provided more problems (with extra solutions) that students could work through on their own (or discuss with me during office hours), very very few of them used them. As for maintaining order, find what works with you. I use a mic even though I can be pretty loud. I also flash the lights to warn students to vote during very loud PI sessions. They tend to quiet down quickly when I show them the bar plot with their results.	
40717.44948	What happens after class? Are additional problems assigned as homework as usual? Who deals with questions students may have to solve more complicated or longer problems? Recitation and/or office hours time?	the pre-class reading assignments, although my hope would be that students would get used to doing this after trying it few times at the beginning of the course.
	You are right that it does a few weeks for students to get used to doing the readings. After class, it depends on your situation. Almost always professors use homework to allow students to practice. An ideal case would be recitations, office hours and maybe even a staffed help center to provide mentoring.	
40717.54792	Does it require the students some time until they realize that the PI-style lecture is not transferring knowledge, but that they need to get this from reading the book out of class? It seems to me that it might require students several weeks (and possibly even longer for some individuals) that this class differs from all the other classes they are used to. If so, how can one deal with it? The results show that PI is in particular helpful for the average student, but less so for the weakest students. Is there some research on what would help these students?	I am wondering how one can implement the PI method effectively into recitations (which are led by TAs). Since the instructor usually brings in more experience and motivation than most TAs, it would be nice to have a way of using PI methods that requires less engagement of the teacher (in this case the TA), but nevertheless complements (rather than merely reiterates) what is done during the lecture.
	You are right that it does take a few weeks to have most students get in the habit, and you need to reinforce it (questions on exams that come from topics covered in the reading). All students achieve gains through PI, even the below average students. I think that PI could be done in recitations, but worry that most TAs would not be ready for it without training.	
40717.60419	How do students perform in physics classes with "traditional methods" after taking a class with Peer Instruction? How is problem solving incorporated into the course to prepare students for future classes that involve more advanced problems?	The courses at my institution are at most 35 students so I do not know if they would be considered large-enrollment. I think the largest obstacle would be mathematics. Students at my school struggle with mathematics and not incorporating any problem solving in class would be trouble for the students that rely on seeing the mathematics done. The other struggle I would have is giving up the control in the classroom. This is obviously an important aspect, letting the students work through things, and it requires giving up some control in the classroom.
	The readings would usually involve example problems and students could ask that those be explored in class. The important thing would be to explore the concepts required for problem solving. This can include specific mathematical tools. I definitely think you need to address the particular conceptual challenges that your students have. Having them realize what their problems are and ask for assistance will make them much more receptive when you provide a "mini-lecture" on the concepts and techniques.	
40717.82	I can see how these techniques can be applied to introductory courses, but what about upper-division classes?	Student inertia. Students are used to the standard lecture model - it's what they're used to and it's comfortable.
	There are positive results from studies in upper-yr courses. I agree that student inertia is a concern - make sure to take the time to explain to them why you are implementing a "novel" instructional technique. One thing to clearly communicate: it may be new to them, but it is not novel. It has been tested and optimized for student learning and engagement.	
40717.87554	I have been using variations of the Peer Instruction method for two years in my classes. Although some students seem to gain a better understanding of concepts in physics, many continue to show no improvement in their critical thinking skills. Slight modifications of a conceptual question or a different one clearly reveal that many students continue to lack the understanding of basic concepts. Any tips on how to help these students?	I have found that the largest obstacle to overcome, regardless of the class size, is motivating students to do the work, to engage in active learning. I have spent a considerable amount of time explaining how important this is, as well as relating the topics to be studied with fields that students may find more relevant, always with minimal results.
	It is great that you have been applying these ideas already! Motivation is a challenge - one idea is to make sure assessment is aligned with your objectives. For example, make sure students see that reading directly benefits them on tests (questions that draw on the readings but NOT on topics covered in lecture). As for improving critical thinking skills, that is essential! Lecture time can only go so far - students need to practice on their own. Recitations, office hours, staffed help centers, or if these are not possible for you, in-class time for students to work through context rich problems in small teams, might be helpful strategies.	

40718.37381	1. Is there a way to use these methods to teach derivations? Whenever I'm writing a derivation on the blackboard, I feel that no one is learning anything, yet I think it is important to understand how equations are derived. 2. How do the JiTT pre-class questions work for an early morning class? Does it work to have the questions due the day before?	I think the most difficult thing for me would be planning the class period with enough flexibility to be able to adjust on the fly based on student responses, and also to manage class time well enough to cover the essential points.
	I agree, I think that passive students "observing" a derivation do not learn. Definitely derivations should be in the reading, and through conceptests and peer instruction, you can break down a challenging derivation into parts and focus on the steps students are having trouble with. As for JITT for an early-morning class, it is up to you when you make the "deadline". Some students will do the reading assigment early - I tend to use these responses more since I can review them and think about them when I am not rushed.	
40718.37959	How do you encourage students to actively discuss the question if you are going to ask it again. Should seating positions be regulated in order ensure lower responses are interspersed rather than grouped	The amount of time it takes to break out and rejoin discussion.
	With practice you can get very quick at moving back and forth between peer instruction and professor led discussion. Students love to see the histogram of results. I would usually not ask the same question that was used for the reading assignment in lecture, unless students got it mostly wrong. If that was the case, I would use some "easier" concept questions to build up to the more challenging question. Controlling seating positions is possibly beneficial, but in most cases, very disruptive. I have never done it.	
40718.47799	When student talk to each other and change their answer to a clicker question, does that mean they understood the answer? They could just be changing their answer because they were just guessing in the first place.	Changing the lecture style. How to prepare the lectures, how much material to cover, what questions to use.
	Students have preconceptions about many of the topics covered in first year - so even a student who states they are "guessing" is probably making use of some intuition to respond. Commiting to an answer then provides a good starting point to peer interaction.	
40718.51992	1- Do you really think that solving problems in class is not important?	
	It depends on what you mean by "solving problems in class". Many many studies show that very little learning happens when students passively observe an expert working through a problem. Have you ever turned to your class after laying out a beautiful problem solution, and asked them "are there any questions?" and gotten no response or perhaps a few questions from the same small subset of students. If you can turn the class room experience so that students are actively engaged in problem solving, then I think your students will be much better off. Don't fool yourself that "classroom discussions" make the experience active - the majority of students sit passively and observe in these situations.	
40718.52554	Are the tools suggested in Just-in-Time teaching such as Interactive Learning Toolkit sold to students? That is, is it for profit? Are the techniques of "Farewell Lecture" equally practical in a class of two hundred students as in a class of 15 students?	Obtaining the right mix of lecture, in class concept quiz, demos, and discussion time. In my experience you can't fall to much in any one direction because students are diverse and different techniques only work well for some students.
	The ILT is free and you can sign up for access for you and your class. Definitely the techniques described work for smaller classes as well as large ones. Definitely finding the right mix is an important balancing act. That said, any mix that engages most of your students and has them participating as active contributors rather than passive observers, is a good mix!	
40718.52725	Some reduction, however small, of the range of material covered in the course seems to be required when trading lecture time for discussion time. Within a class that has a set of topics that the instructor is required to cover (prescribed and monitored by a dean, provost, etc), how can these techniques be implemented with minimal loss of coverage?	These methods require a significant outlay of time by the instructor. I am faced with a class of several hundred students and no TAs (and two other courses to teach beyond that one!). How can I most effectively keep on top of reading and evaluating pre-class questions, long-form exam questions, and such with the time available?
	Since the reading assigments cover all the required topics, JITT actually frees you up to spend time in lecture on what your students need! The time investment from you as the instructor is real. I maximize the impact of my time by focussing on what helps and minimizing what does not help. For instance, I do not have beautifully laid out lecture notes - I rely on the textbook even though it is far from perfect. I do not read all the responses from my students. I cycle through them so that every student gets a response every few weeks. Sampling provides a reasonable measure of what are the improtant concerns to hit in class.	
40718.55221	How do I develop useful pre-class questions? I typically pick some easier questions out of the back of the chapter but the students still really struggle with them. I try to do this question and group discussion. What do you do when the students convince each other of the wrong answer?	Technology The students have stated that they want me to do a lot of problem solving, even though half of my current class is already dedicated to that. I feel like the students would still have that comment with this layout.

	Re: working through examples for students. No matter how much you do this, students will ask for more! As someone else noted here, what they are really asking for is solutions similar to the ones that are on the assignment. They can then just solve the homework by pattern recognition and mimicry. So when students make this request, I say no and explain the reason for it: lets focus on the concepts in class, so that they are ready to attack the problems. Problems for the reading assignments should be challenging, and I like the fact that you say your students "struggle" with them. That is good! They will be ready to discuss in class! The preclass reading is only the first stage of learning so don't worry if your students are having problems with them. It is a problem if students find them so difficult that they do not even try. We grade on best effort. As for students convincing each other of the "wrong answer" or perhaps convincing each other of the right answer but for the wrong reason - make sure to provide closure to every conceptest so that students can hear what you say is the right answer and what your reasoning is for it.	
40718.57078		Students may not read materials before class and may not have enough to discuss much in class.
	This is a challenge - reading assignments that make them think about the reading are very important. Also remember that in many topics from first year, students have considerable background (even from everyday life) and so will have lots to discuss.	
40718.57112	What are the key elements of ensuring effective peer instruction?	Devising good questions
	Good conceptests that are challenging enough to generate a range of responses from students. Providing a context for the question in response to concerns raised from the JiTT reading assignment. Clear instruction of what you want students to do ("Turn to your neighbor and convince them of your answer."). Active involvement of the instructor seeking out "quiet" groups to make it clear that you expect all students to be active. Succinct closure ensuring that students know the right answer and why it is right (though at this point they might not all agree with it).	
40718.58618	I would like to hear more about the typical complaints students have and how you have addressed them. You talk a lot about using your methods in the intro physics classroom. Do you have any pointers for upper level undergraduate physics classes?	- getting a buy-in from the students, especially from pre-meds who are worried about their MCAT prep and anything that could potentially be different from what they think is "right" - the number of different questions/points of confusion, not being able to address all, and, as a result, many students feeling like they don't matter
	Active engagement in lecture allows students to gain better conceptual understand that they retain! This will be particularly valuable to your premeds! A possible complaint from students is that they want the teacher to be teaching them. I assure students that I like nothing better than lecturing - that it is really easy for me to do BUT I have learned (and many studies show) that lecturing is a severely lacking approach if STUDENT LEARNING is the goal. The only way for them to learn is for them to do the work. I as the instructor am going to help them as best as I can by focussing on the problem areas to help them where they need helping!	
40718.59785	How many times do you have to teach the same class to achieve balanced material and comprehension? Any experience from other instructors who tried this method? This method requires that students come prepared to each class. What if the majority of students (at my institution) don't? Harvard students are not exactly average...	Frankly, applying a radically new approach to teaching a large undergraduate class is a "high-risk" activity a for non-tenured faculty. Students may not appreciate it (for a variety of reasons) which will result in poor ratings for the instructor.
	Students do not need to "understand" the prelecture reading - it is really there to "prime the pump" for learning. You do need specific tasks to ensure that the majority of students do it. The most successful implementation we have found is to ask students two concept tests and have them explain their reasoning, and also ask them what is the most important topic they are still having problems with. When students realize that their reading assignment questions are determining what gets taught in class, they start to appreciate them as being useful. This approach has been successful at a variety of institutions from two-year colleges to Ivy league.	
40718.77586	Is it possible to mix the traditional way of teaching with the peer instruction, which means that in the test in addition to the multiple choice conceptual questions, you would also have problems that test the conceptual understanding and not require much math?	Manage the time to response to the students' questions/discussions.
	A lot of class time is still spent in "mini-lecture" but the difference with PI is that it is to respond to particular problems motivated by the students. In my experience, numbers and math can be part of conceptest, but be careful. If the question is asking students to "plug and chug", it will not generate good discussion.	
40719.03123	How do you get students to talk to one another during peer instruction if the students are hesitant to participate, or already think that they know the answer? How do you get students to move their seat in the classroom occasionally, so they get to participate with other students?	The biggest obstacle that I've found in my first year of teaching physics/astronomy is that creating lectures are, of course, easier than incorporating something new. Finding time to thoroughly read the JiTT answers and adjust my presentations have been difficult. So, how can this teaching method be streamlined from an instructor's point of view?

	First of, time is a major concern! I suggest focussing your effort on what has been shown to help and minimize time spent on other activities. Take a good luck at everything you are doing with your course and be suspect of anything you do since "it is expected" or "standard". Of course, certain items like calculating final grades and submitting them are essential. One major time investment I have often seen is that instructors are not happy with their text book so attempt to create lecture notes to supplment it or replace it. I have seen this backfire (ungrateful students complaining about typos in the lecture notes). No textbook is perfect. JiTT reading assignments allow you to determine what your students problems are which might be very different from what you think are the problems. For a large class, you can sample responses to find out common concerns. The ILT ensures comments from students who have not been responded to much come to the "top of the line" so that way you will have input from everyone in your class over time. Having students move seats is really hard. This year, we had an enormous lecture hall so we instead of trying to get students to move seats so they would be closer to each other, we "roped off" the back two-thirds and requires students to sit in the front 10 rows. It worked well.	
40719.19649	no question.	The time.
40719.59721	Is it practical to incorporate multi-step problems into this approach?	For a calculus based course the conceptual questions give students wrong perception of expectations on the exams. Also, limited time in recitation does not allow for a lot of conceptual problems, since harder multi-step problems need to be addressed.
	If students do not have a grasp of the basic concepts, is it right to jump into multi-step problems? I think my mistake in the past was assuming that if students could do multi-step problems, they had the basic conceptual understanding. This was a bad assumption. I would argue that basic conceptual understanding will make practice with mutlistep problems more effective.	
40719.62031	Have I been a complete failure as a physics teacher for the past year?	The largest obstacle to overcome would be spending the time to make the effort to change my teaching methods.
	I can understand your concern - I expect you have been working hard to teach well, but have used a traditional approach. That effort will be very useful to you in an "interactive" approach. Mini-lectures that you give in response to specific student problems will probably be directly taken from your current lecture notes. To reduce the amount of time required, make extensive use of the materials available to you! The end result is going to be a lot more fun than talking at a large group of students with minimal interaction.	
40719.70998	Can “Peer instruction” be used for introductory course of Modern Physics, which contains of relativity and quantum physics? I wonder if students do not have a feeling that this kind of teaching is better for high school than for university?	My biggest concern would be that as an inexperienced teacher I would not be able to check a large number of homework and then prepare well a part of material, which would be necessary to cover for upcoming class in such a short time.
	YES. I think PI would be perfect for a concept rich course like SR or intro QM. That will really serve the students well in upper year courses dealing with those topics. WRT HS vs. university, that is not a complaint I have heard. Students feel that they need to work harder (before lecture, during lecture) with PI; there is less "spoon-feeding". Re: the time problem, please see similar responses above.	
40719.72086		Relatively speaking, I think this will require more time.
	Re: time. Please see above.	
40719.74573	1. How does a professor compensate for external issues that influence a student's comprehension? For example, suppose a student has a fairly good basic understanding of a concept in physics, but lacks basic fundamental skills/knowledge in mathematics that contribute to solving a problem correctly. 2. What is the best approach to determining an appropriate amount of material to cover during the semester while delving deeper on certain topics? 3. What grading model is used for class participation and attendance?	I believe the hardest issues to overcome will be convincing students that this technique is beneficial to their understanding especially when they are accustomed to a professor regurgitating information in a textbook. Another difficulty will be found in balancing allotted enough time for peer instruction and covering a suitable amount of material.
	The topics covered are determined by the reading assignments so there is no need to reduce coverage. PI also does allow targetted lecturing so if a lot of students identify problems with math skills, you can deal with it directly in lecture. If only a few students have this problem, other approaches might be more appropriate. Pearson bundles in for free a Math Phys book with my text book order, so if students are having math problems they can work through that text. We have found that grading only on participation for in class conceptests is best: you are trying to get students to state what they really think, instead of asking them what is the "right" answer. These two approaches are not necessarily the same. For instance, if you mark for correctness, students will start using strategies to get correct answers (sit near the smart kid and copy his answer), rather than strategies to improve their learning.	
40719.79041	1. Where can I find JiTT resources for intro physics courses, in addition to a small number of examples shown on the JiTT webpage? 2. If interactive lectures do not discuss problem-solving with students, how do students learn how to solve them? 3. Mazur points out that students' evaluations of the instructor is a poor indicator of learning outcomes in the class. Still, many school administrators take students' evaluations into consideration when deciding on faculty promotions. What happens with evaluations of a typical instructor who switches from a traditional to interactive technique? Do they improve or become worse?	In my physics department, I am the only person who has been using PI techniques and clickers (based on Mazur's approach) in a calcu based E & M course. [The other introductory courses are taught based on the traditional combination of one-way lectures + labs.] At the personal level, I enjoy using the clickers greatly and found them to be very effective for establishing communication with students and learning about their psychology. It was relatively easy to introduce and use them throughout the academic year. At the end of the semester, I measured the pretest->posttest gain using a standard test (BEMA) and obtained the value of 30%, pretty much as it was expected. I had more difficulty with reducing the amount of required material or introducing a textbook that was designed according to recommendations of physics education. Potential changes in the curriculum can be a hard sell with the senior faculty. Our students are expected to learn how to solve physics problems, but PI leaves less time for teaching them how to do that during the lectures. I introduced additional help sessions dedicated to problem-solving, but this has generated negative feedback in students evaluations.
	You have many important points. Congratulations on your successes with nontraditional teaching approaches! I hope the discussions in the NFW (and iinfo on compadre) helped you identify more JiTT resources. I do not have data about changes to student evaluations. I will say that my personal experience is that if students' believe you care for their progress, if you close the feedback loop to show students that inteactive approach is working for them (showing increase in correctness gains, matching assessment on exams with in class and out of class learning), your evaluations will improve. At the pre-tenure stage, I would not suggest trying to convince senior faculty that their approach is wrong. I think most senior faculty would agree that a small group seminar is the best learning opportunity for students. Through PI, you are attempting to create a "seminar-like" experience for students (students come prepared to class, all students are expecting to contribute, ..) even in a large enrollment class.	

40719.80751	1. How do you motivate your students to actually read the assigned material before the lecture, not just look for specific sections/paragraphs that seem to contain information they can use to answer the assigned questions? 2. A big part of any physics education is to learn how to manipulate effectively physics formulas. This includes learning the whole bunch of mathematical tricks and methods. In my view, most of these ticks and methods do not have adequate explanations in textbooks. Authors often assume that their readers already have this kind of knowledge and skill. Personally, I learned most of this stuff from my physics lectures. So, my question is: Do you present proofs and mathematical derivation of physics formulas in your classes? If so, how do you find time for that?	I can mention here a number of things here. 1. One big problem is student's inertia and laziness. In order for this technique to work students must be motivated and do all assigned reading on time. This might be difficult. 2. Another thing is that in order for this teaching methods to be effective you need to have your weak student learning from the strong ones. But this is very often the case (at least this is what I often see in my classes) that weak students tend to group together in the classroom. How to overcome that? 3. If the class size if large (about 100 students) then it is very difficult to effectively guide student's discussions. 4. And of course, these discussions are very time consuming. It is might be challenging to balance this time and the amount of the material covered during the course.
	If students see that their input from the readings is really changing your lecture, and feel that their needs are been well served by this process, they will increase their effort in the readings. It also helps to test material that was in the readings but NOT covered in class (since students did not identify it as a problem area). I suggest doing this early in the term, in an early test or midterm. Be very careful in making assumptions about how you learned in class, and how your students learn. Ed is right - they are unicorns! If you are worried that your textbook is really lacking in a specific area, ask a reading assignment question on the topic. This will help students realize that it is a problem for them. Start off your discussion in class with a recap of their response ("only 30% of you got this right, so we really need to deal with this problem"). Give a mini-lecture about the problem or even start with a conceptest to remind students about this problem, and then mini-lecture. Get them to interact. They will learn much better if they have already identified it as a problem for themselves. With PI, do I work through a proof or multi-step derivation in class: no. Should you explore the "hard parts" of an important proof in lecture - definitely!	
40719.87186	1) is it realistic to expect students to read in advance the material to be covered in the lecture? what if the student as a part-time job? 2) I wonder if an hr spent by a student reading the material BEFORE the lecture is as efficient as an hr spent by the student AFTER the lecture, once he know waht the book chapter is about. The student can learn teh material on his own, but how ling will it take for him/her to do it?	- see (1) above. - you need a few (grad. students?) assistants. Will the Univ. really pay for them?
	Students do have different time pressures but I think something like PI provides them with organization for the goal of achieving deep learning. This takes time! I also think your second question is really important since I think PI is all about making use of time better. Since you are covering only topics that students' raise as a concern, you are really providing targetted teaching where students need it! I do not have grad students in my class during PI, but I certainly roam the room looking for quiet students.	
40720.16524	1) How do you handle the situation of only a small number of students coming to class prepared? 2) What separates a good PI question from a bad one?	Having the patience to implement the idea; resisting the tendency to move back into a lecture format; demonstrating the value of the technique to students.
	Re: only a small number of students coming to class prepared. I mark reading assignment questions on best effort. If students do not make such an effort, they get low marks and see them immediately. Make sure you reference students' comments in class, this will create a postive feedback loop to encourage students to make a decent effort. Also test on sections that were in the reading (and are not covered in class) and make sure students realize that you are doing this. It might take a few weeks to get students into the swing of the process.	
40720.38955	I have two questions regarding the logistics and implementation of JiTT. First, the example provided did not go into enough detail regarding the nature (and range) of questions asked. Are these essentially the same as ConceptTests, only with the multiple-choice aspect removed? Or are these generated uniquely each semester for the current batch of students? (Or both?) Second, I am still shaky about the implentation of JiTT. The reading indicates that the answers from the JiTT are reviewed 12 hours prior to class (or starting 12 hours prior and leading up to class). With a class of ~200 students and ~3 JiTT questions/students, how much time does it take to review the resulting ~600 answers? Is JiTT doen for each class period?	As indicated by my question above, I think the most challenging aspect of the implementation wil be to review all the answers from the JiTT assignments in order provide a tailored learning experience for the students. However, an extremely close second-most-challenging aspect for me will be the creation of JiTT and PI questions that are both challenging and instructive.
	RA questions can be reused from year to year. Use what resources you have to make them. I think they should require more thinking than a conceptest, and include a free response for students to "explain" their answer. The most valuable question is the third question which is always the same "What did you find most confusing? If you did not find anything confusing, why did you find the most interesting? Please explain." In terms of time management, using the ILT I can sample student responses, and it will bring to the top of the column students who have had less response from me. That way students are routinely have interaction with me (but not every class).	
40720.48557	How much time do students take to to complete the JiTT pre-class assignments? Do students with other commitments - jobs, families etc. - often not complete the assignments?	
	It is important to stress that you do not expect students to "understand" everything in the reading assignment. The point is for them to identify one or two things they would like help on (in lecture). PI with JiTT requires students to spend time more time before each class, but hopefully less time is required for doing assignments and preparing for tests.	
40720.50126	I like the focus on conceptual questions with PI in the classroom that Prof. Mazur advocates. But I would think that it's also important to spend *some* time on problem solving. What's the right mix? Is there research on how best to use PI for problem solving, especially in an introductory physics course? Also, what's the target time between JiTT pre-class question due dates and class time?	Selling this pedagogy to the students seems critical both in terms of keeping enthusiasm up during class and in terms of their satisfaction with the class and with me as the instructor.

	Selling the students is important - make sure they realize that you are employing a thoroughly tested approach. Students definitely need to learn problem solving. I would argue there is little value in working through a problem on the board for them. The best way for them to learn is to practice, but you do need to create the right set of conditions for them to succeed (good textbook that they actually make use of, make sure they understand the underlying concepts, provide some mentoring/guidance through tutorials/help center/office hours, whatever works best in your situation). If you are really limited in resources, at least make the "problem-solving" time spent in lecture as interactive as possible with students engaged in the process.	
40720.57814	I have a comment, not a question. Two of the ideas that Professor Mazur mentioned were very helpful to me. One is that he takes notes for students' wrong answers for the source of making good questions. The other is the open-book tests that he decided to incorporate in his assessments. Both of them requires time and effort on the instructor's side, but it helps student understanding.	I am using peer instruction and clickers in my lecture classes. I found that preparing good conceptual questions that are appropriate and intriguing for the students is the most challenging aspect of the strategy.
	It is great that you have been using interactive techniques! Hopefully the resources discussed in the NFW are useful to you!	
40720.59929		Large enrollment courses at my school are coordinated; despite interest in clickers, I have my doubts that the other professors would be happy with this kind of activity, especially considering the failure of PER-based activity in the majors' introductory course.
	That is going to be problematic. What would be really interesting would be an analysis of why it failed. I have experience with two courses where PI or a variant of it "failed" and I as an outside observer can point to certain problems in both cases. In one, the obivous hesitations on the part of the instructor to reduce their role of lecturer led to a lot of lecturing and students began to wonder about the value of PI. It was a downward spiral. Another case, initial reluctance on the part of the students to doing the prereading led the instructor to attempt to teach all the material, which encouraged students to NOT do the reading,.... Perhaps in your dialogue with fellow faculty members you might want to jointly discuss research results showing that interactive teaching, when done correctly, makes dramatic improvements to teaching. You would think this approach would bear fruit except it is easy to "criticise" PER ("Our students are different.""That approach will not work here.""That was tried and didn't work."...) Perhaps the best way is to have students complete something like pre and post FCI. When an instructor sees a gain of only 20% on such easy material, it is hard for them to maintain that their traditional teaching is optimum.	
40720.65416	How do you choose what questions to cover in the classroom?	Overcoming the conservative expectations of my students. Students expect a lecture course. Any deviation from this format leads students to question the organization of the course. They do not always understand that they are learning even if other students are speaking.
	I choose questions based on how many students have a similar concen, and my past experience based on where students have problems. Regarding student conservatism: I agree with you. That said, if you can show to them that their learning will benefit that will help. Also, PI and JiTT usually have more marks assigned to formative assessment (often based on best effort) with reduced weight on the final exam. Students often like this! "If you do your work, you will likely do well!"	
40720.66106	The technique of JiTT and PI as described in the articles and video is very much aimed at large enrollment introductory physics 'service' courses. While this does typically represent the bulk of the *students* taught, it is not always representative of the classes that the bulk of the *teachers* are teaching. In major or even graduate classes (average of 20 student) the practice of 'lecturing' is just as widespread, and JiTT and PI probably have to be adapted to be effective in those contexts. Students are (I think) by then past the conceptual stage, and the goals of the advanced courses are often exactly the learning of problem solving techniques that the author criticizes. Would PI be applied by having the students discuss problem solving strategies only, instead of going through the full solution? I would be interested in hearing some anecdotes of JiTT and PI in these advanced classes.	The unpredictable nature of the individual lectures (and by extension the material that will be covered in the course) might be an obstacle. Depending on the students' conceptual understanding, and assuming 5 concept tests with between 2 and 7 minutes depending on the outcome, leads to a third more (or less) time available per 1:30 hour lecture. Although I assume that this will average out over a semester, it still has the possibility of completely messing up the schedule of the course.
	With JiTT and PI, you cannot cover all the material in lecture - this would backfire dramatically. Let the reading assignments "cover" all the material, and spend class time on the particularly important concepts. I am not sure if I agree that students in major or gradaute classes should not be concerned with underlying concepts. If I grab my Milonni and Eberly "Lasers" text (from sr level course), I see many important concepts like dispersion, polarizability, etc. that are important to understand to be able to understand the field of optics and lasers.	
40720.75308	I'm interested in the ILT software: how difficult/tedious is it to implement and use? I currently use Blackboard and the iclicker software, and find that they work, but not efficiently. I feel like I spend so much time setting up and deploying tests, etc.	Getting students to talk to me and to each other effectively.
	Check out the ILT software online - it is easy to sign up. It is optimized for PI and JiTT so at least you will be better off than Blackboard/Moodle/etc. I think getting students to talk to each other effectively is extremely important. One very basic problem is time on task: you can set certain expectations that all students will be contributing early and then during PI, move around the class to reinforce those expectations.	
40720.76262	My main concern is how to implement such teaching strategies in upper division and graduate courses, where the students may feel that forced assignments for every lecture is paternalistic. I used flash cards in my last class and found them to be a bit awkward. I definitely preferred using the clickers, but once again in a graduate class I think that the students would revolt if I asked them to pay $40 for a clicker.	As illustrated in my questions above, I think that the biggest issue that I worry about is how receptive the students will be to the change in pedagogy.
	I think the way Ed used flash cards in the NFW showed how a master can use them very effectively. As for clickers - at least students can resell them at the end of term.	
40720.77829	- Can you use it with any (or most) standard textbook? Students tend to get upset if you teach stuff not covered in the textbook. - Seems like JiTT and PI focuses most on conceptional understanding. How do students develop quantitative skills, calculations...?	Apart from just getting familiar with the type of teaching and knowing how to find the right material in the question bank, I think the hardest part will be to find the time between the students submission time (midnight?) and lecture time (could be 8 or 9 am) to go through the answers and have time to prepare the topics where the students struggle the most and pick the best clicker questions. But I guess that would become easier the more times you've done it...

	It is easier with practice. Also, you can start sampling student responses before the deadline. I think that with JiTT you would have to be very careful of teaching material beyond the textbook (since the reading assignments define the topics covered). Perhaps you could do this with additional readings that you could provide in pdf format so students would have access to them before the class. WRT student time: if they see the time preparing as an investment to reduce the time required to do the problem sets and prepare for tests, your students will grow to demand JiTT. As for quantitative/calculuation/multistep problems, which are very important, the best way for students to learn these skills is by practice. You do need to help them create the right conditions for success. Part of this is ensuring that they have appropriate conceptual understanding before they start doing the homework. I think that often my students would just attack the homework problems without reading the text, without "learning" the topics covered in lecture. They would employ strategies that got them to the desired end: find a similar problem and solution and mimic it, or ask a friend to explain to them how to do the problem. By helping them learn the underlying concepts, they are much better prepared for the assignments.	
40720.82554	I'm curious: how does JiTT and PI appy to graduate level classes? I can see how some aspects carry over easily, but it's not clear to me whether tedious but necessary derivations, for example, are meant to be just pushed into reading assignments? How much time can I really ask my students to spend on my class *in addition to* what I would still consider necessary tasks of solving problem sets? What resources do I have to give JiTT and PI a try -- in general, and for specific classes?	I have not yet taught a large-enrollment course. Based on the very little experience I have, one generic challenge that I have come to expect is that there can be a huge spread in knowledge levels -- some students struggle in their problem set solutions with keeping track of the difference between a number and a vector, while others feel like they do not get challenged enough? In the end, the time students have at their disposal is finite. An instructor who manages to engage their students may be able to draw students' time from other areas. Overall, the total amount of available time is conserved, of course. What do surveys say about the amount of time needed from students to implement JiTT/PI? Or, more provocatively, can this even work if every single class a student has to take in a single quarter/semester was structured this way?
	Great questions. I do not have good data to answer them. We are far off from every student in a science curriculum having JiTT/PI courses.I see my additional structuring of their time as a way to help them manage their time more effectively (and drop-out rates are lower). Frankly, I am not trying to steal time away from other courses, but have students invest time early in the term and all through the term, then just during midterm weeks and finals. As for upper year courses, the evidence is slowly coming out showing improved conceptual learning in higher level courses taught with interactive teaching techniques. As for resources: a text book that you split up into reading assignments, reading assignment questions, and a selection of conceptests that you have at your disposal ready to go. Avoid making your own if time is an issue for you (and of course it is!)	
40720.85211	1. When I have tried to hold breakout sessions with students in my classes (not in nearly as organized a pattern as Dr. Mazur now uses), I feel like the class devolves and no learning takes place. It is chaotic, but not a good kind of chaos. Students will start to talk about sports or will flirt together. I do realize that I need to do a better job of helping the students to see the connection between the breakout session and their learning (and performance on an exam). One part of my question then is, how do a do a better job of making that connection? The second part is, how does peer instruction alter if the students you have are not Harvard students. There is a difference between a class where virtually every student in it was a top student in high school, and a class with all ranges of students, some who really don't care what grade they get as long as they don't fail.	I teach at a school with 500 students. The largest classes here are 20 students. So the questions really does not apply to teaching at my school. If I did have to teach a large class, I would say the biggest obstacle would be keeping the class under control and being able to cover an acceptable amount of material each class.
	I think it is important that students are held accountable for being productive in peer instruction. With clickers, they know you have a record of whether they were right or wrong. With flash cards, they are forced to commit to an answer (that you see). I have used breakout sessions where students need to submit a one line answer with their names on it that I then mark quickly (out of 3). It needs to have a clear goal that students need to respond to. It can't just be an "opportunity for students to improve their learning". Also, be very careful about giving too much time. It is better for students to feel rushed rather than that they have lots of time. More successful PI instructors wander the room and interact with students to make sure they are on track, but also to show that they care about what is being discussed. Finally, you might want to consider assigning groups.	
40720.85784	- How to balance the constraints given by a class coordinator, the other instructors, etc with trying to implement PI teaching. - Besides the changes in the class room, what other changes help to successfully implement PI teaching (what type of homework problems; when is homework due on specific material, eg after reading and before class, after class; class forum with mandatory participation, etc) - How does PI teaching versus traditional teaching affect office hour usage?	How to ensure that all students participate (and not have some private discussion). Find good questions (like mentioned in the video).
	I have found MUCH more discussion with students immediately after class with PI. Some students come to argue with me about the answers to the conceptests, because they thought they understood this stuff, but they got it wrong. It usually turns out they did not understand it at all! Trying to impose JiTT on a single section of a class with multiple sections is not something I would do. It takes a bit of time for students to see the benefit of JiTT and it would be too easy for them to back out early (switch sections). That said, even in such a case, you should employ interactive engagement techniques as much as possible, that involve all the students.	
40720.89392	Is there any evidence that instructors with generally bad student evaluations gets significantly improved scores from students and more confidence that learning was finally happening after applying pedagogical methods described here?	the fact that the class is extremely heterogeneous, with an extremely wide distribution in the motivation to learn (physics), meaning that, no matter what techniques are going to be used, there will remain at least half of the class for which a given method will not appeal or work.
	Sorry I do not know of such data. I agree that heterogeneity of the classroom is a challenge. That said, but employing a "parallel" teaching structure like involved with PI (many conversations going on at once), learning is improved for most students.	
40720.93661	- How to motivate the students? How to effectively engage students into discussions? - What's the student response?	- I would imagine that coming up with the right set of questions that really illuminates the (mis)understanding of students would be very difficult. It's great to see that there are sets of questions and databases one can access to help in this process. - Engaging the students is key, for me this will probably be the most difficult aspect of this method. - Getting the timing right may also be difficult. Having a 12 hour turn around, it may not be possible to go over responses from 350 students in time, and it's not uncommon that the instructor will have some other emergencies they have to attend to. Having a shorter turn around time means the students will have to turn in their pre-class responses earlier which is probably not ideal either.

	Positive feedback to help students see that the process is working for them will help keep students motivated. As a strategy to dealing with JiTT responses, sample a few of the early responders ahead of the deadline to get a sense of where the discussion is headed. You will never be able to read all 350 but if you can sample them in such a way that you directly respond to every student in a regular fashion, the students will keep doing the assignments.	
40721.15804	I'd like to know more about the ILT software -- in particular I like the idea that cell phones/laptops etc can be used to poll student answers in class. Last semester I used the iclicker system for that purpose, but reducing the gadgetry that I and the students have to have in class is certainly appealing. My only concern is that while I can ask students to purchase an icklicker for this class (they tend to use it for multiple classes anyway), I cannot ask them to purchase a laptop or a smart phone. Is this a difficulty you encountered? Students being able to use their neighbor's laptop to answer a question seems like the only option.	Last semester I thought a large enrollment class (~260) for the first time. I had tried to generate some peer/class discussion around concept questions. I found that the biggest difficulty for me was generating good questions. They would typically either be far too hard or too easy. Hence only a minority of them generated any decent discussion. Test banks (as mentioned in this article for example) are of course a great help here. Having students answer a few questions ahead of class (JiTT), would certainly help me in writing/selecting the questions for discussion in class.
	The ILT is not a classroom response system. It is best for managing JiTT assignments, distributing lectures, etc. There are several products already on the market that make use of iphones, etc. but I am not sure if your student population all has the appropriate technology. That said, here at Harvard in a class of about 90 students only 2 or 3 did not have a device. We had on hand some itouch units that were leant out (in exchange for student's id card) to students who did not have appropriate hardware. I think web enabled cell phone usage will become ubiquitous within our student population but I am not sure if it is there now. About conceptest level of difficult, I agree with you. I really like Eric's collection in his PI book (in pdf format on the CD). I will mention that I have often used questions that I considered "too easy" but found them very useful.	