Using Just-In-Time Teaching (JiTT) to Understand Student Thinking, Improve Preparation for Class, and Enhance Student Learning

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What is Just-In-Time Teaching (JiTT)?

Just-in-Time Teaching (JiTT), originally developed for use in physics education [see Novak, Patterson, Gavrin, and Christian (1999)] is an intentionally structured teaching and learning strategy that makes use of students’ responses to web-based questions covering upcoming course material to: (1) promote time on task; (2) encourage better preparation for course meetings, (3) provide prompt feedback on students’ conceptual understanding, and (4) inform “just-in-time” modifications of in-class (or online) activities and discussion.

The JiTT strategy is straightforward. Between classes, students complete carefully constructed exercises and submit them using course management software (e.g., Blackboard or Moodle) by a preassigned time a few hours before class. These JiTT exercises, or “JiTTs,” are short assignments typically focusing on material that will be covered in the next class – that is, students are required to read ahead on their own to answer the questions. Once submitted, instructors review students’ JiTT responses a few hours prior to class and use the responses to organize and modify the upcoming classroom session – hence the “just-in-time” label. Excerpts from students’ submissions are presented during the class as the basis for discussion, replacing the traditional lecture, and are used to develop follow-up exercises that groups of students work on in class.

While JiTT was developed with face-to-face courses in mind, JiTT techniques are easily adapted for online courses. The principle is the same: students respond to intentionally-designed questions by a specific deadline and the responses are used to dynamically inform and adjust upcoming course activities – synchronous or asynchronous – focusing on specific learning issues uncovered by the JiTT responses.

JiTT Promotes a Learning Feedback Loop

What makes JiTT work so well? One reason is that out-of-class JiTT exercises impact what happens during class sessions; the students’ work helps to direct the flow of the course and in-class activities are directly linked to student learning difficulties highlighted in the JiTT exercises. The tight connection between out-of-class and in-class activities produces a positive feedback loop that promotes student motivation and learning. Because students see their own work presented in class, they develop a heightened sense of ownership of their learning; thus, they are more likely to complete the JiTT exercises and actively
participate in the ensuing classroom discussion and activities. As a result, students come to class better prepared and gain more from each class session.

In addition, students receive immediate feedback on their understanding of the concepts covered in the JiTT exercises, providing a “teachable moment” that is absent with traditional homework assignments or quizzes, which provide feedback only with a (sometimes significant) lag. At the same time, instructors receive valuable feedback about student learning gaps that helps to make in-class teaching and learning more effective and efficient. Because the JiTT exercises are completed between classes, instructors can uncover students’ misunderstandings of course concepts prior to class and design classroom activities to overcome these misunderstandings while the concepts are still fresh in students’ minds.

**JiTT Complements Interactive In-Class Pedagogical Practices**

JiTT exercises work best when combined with other class-based interactive pedagogical practices, using excerpts from students’ responses as the basis for in-class (or online) activities. For example, students’ responses to JiTT exercises can be used as the basis for a variety of in-class cooperative learning activities, such as think-pair-share, jigsaw, or send-a-problem exercises. In large classes, JiTT can be used to develop questions that intentionally target student pre/misconceptions, with student responses used to construct multiple choice questions used during class in conjunction with “peer instruction” [see, e.g., Simkins and Maier (2010), Chapter 3].

**JiTT Promotes Student Learning**

JiTT is consistent with good teaching practices grounded in learning sciences research. For example, JiTT promotes many of the “principles of good practice in undergraduate education” emphasized by Chickering and Gamson (1987): active student learning, time on task, prompt feedback, frequent student-faculty interaction, cooperative learning (in class), and multiple perspectives. In addition, JiTT supports key research findings on student learning, as summarized in Bransford, Brown, and Cocking (2000): promoting expert (vs. novice) learning, developing the ability to transfer learning from one environment to another, uncovering and addressing student pre/misconceptions, and developing strong metacognitive skills.

The multi-faceted approach of JiTT – out-of-class web-based exercises followed by an interactive lecture, class discussion, or collaborative problem-solving exercises based on students’ responses to the JiTT questions – creates a positive learning cycle that actively engages students in the learning process and puts students at the center of that process. This type of student-centered teaching, supported by both learning theory and classroom experience, improves learning outcomes for all students.
Starting Points: A Collection of JiTT References

1. Good Teaching Practice and Learning Science Foundations for JiTT

Principles of Good Teaching Practice

- [http://www.celt.iastate.edu/teaching/7principles.html](http://www.celt.iastate.edu/teaching/7principles.html)
- [http://www.uis.edu/liberalstudies/students/documents/sevenprinciples.pdf](http://www.uis.edu/liberalstudies/students/documents/sevenprinciples.pdf)

- [http://www.csuchico.edu/%7elsederberg/ceeoc/teachers_dozen.pdf](http://www.csuchico.edu/%7elsederberg/ceeoc/teachers_dozen.pdf)

Summary of Key Research Findings from the Learning Sciences


2. A Sampling of Published Papers/Books on JiTT

Broad Overview

Simkins, Scott and Maier, Mark (Eds.) (2010) Just in Time Teaching: Across the Disciplines, and Across the Academy, Stylus Publishing.

[Note: This book provides general background on JiTT pedagogy, as well as examples of how JiTT can be integrated into classroom instruction in the natural and physical sciences, the social sciences, and the humanities.]

- http://www.aaas.org/publications/books_reports/CCLI/PDFs/03_Suc_Peds_Patterson.pdf


- http://www.amazon.com/Just-In-Time-Teaching-Blending-Learning-Technology/dp/0130850349

[Note: The original book on JiTT, focusing on physics education]

**Discipline-Based**


**3. Complementary Pedagogies**

**Reading Questions**


**Peer Instruction (Eric Mazur, Harvard University)**

A variety of articles on Peer Instruction are available at:


**Flipping the Classroom (a sampler – Google “flipped classroom”)**


*One of the original/early discussions (and research results) on “flipping the classroom”*

Derek Bruff's *Agile Learning*
- [http://derekbruff.org/?p=2108](http://derekbruff.org/?p=2108)
- [http://derekbruff.org/?p=901](http://derekbruff.org/?p=901)

The Flipped Classroom Infographic

The Flipped Classroom Model: A Full Picture

The Flipped Classroom – Aaron Sams
- [http://www.youtube.com/watch?v=2H4RkudFzlC](http://www.youtube.com/watch?v=2H4RkudFzlC)

Five Best Practices for the Flipped Classroom
4. A Collection of Web-Based JiTT Resources

SERC – Just-in-Time Teaching Module – background and examples

[Note: These web sites provide a comprehensive set of resources on JiTT, including descriptions of JiTT pedagogy, research on JiTT effectiveness in the classroom, instructions on how to use JiTT, and a collection of JiTT examples from multiple disciplines]

MERLOT ELIXR Case Stories – Just-in-Time Teaching
- http://pachyderm.cdl.edu/elixr-stories/serc-geoscience/

JiTT Web Site – the original JiTT developers’ site, with lots of information about JiTT
- http://jittdl.physics.iupui.edu/jitt/

JiTTDL Wiki – a wide variety of information related to JiTT
- http://jittdl.physics.iupui.edu/sign_on/

Tomorrow’s Professor – an article on JiTT from a conference session presentation

5. Pedagogical Innovation in Context

- http://www.carnegiefoundation.org/perspectives/no-drive-teachers
Implementing Just-in-Time-Teaching (JiTT) Techniques in a Principles of Economics Course - Examples

JiTT Example #1

Develop a verbal model to explain the relationship between two variables that describe the behavior of an activity related to your own personal experience (e.g. time spent studying and grade on upcoming exam - but don't use this example). Also, how would you illustrate your model graphically? What would the graph look like? Explain.

Text reference: pp. 28-32

Sample Student Responses (unedited):

Model 1

I have been working in a restaurant-eatery for a few months now and I have been noticing that when the employees smile a lot to customers, the most likely they are to get big tips. The smiler we are, the more money we get. Graphically I would put on the Y-axis the amount of tips left by customers and on the X-axis I would put the "average of smile" form the workers. The bigger this number is, the upper the line goes, at least for a while. After, even if the numbers of smile is still going up, the amount of tips left does not increase as much.

Model 2

If I put in more hours at my job, I would make more money. And therefore I will have some extra money to spend on what I want. In my situation variable 1 is hours spent working and variable 2 is wages earned. In this situation there is a positive relationship because if hours spent working is increased then wages earned will also increase. In the graph there will be an upward curve that will continue to go up.

Model 3

My day is just not long enough to accomplish everything that I want to accomplish. There is an opportunity cost for everything that I do. I have noticed that if I do not spend any time with my girlfriend that our relationship suffers. My girlfriend is not happy if everyday I do not at least call her (15 minutes). If I see her (1 hour) she continues to be even more happier. However after an hour while her enjoyment continues to grow, it is at a slower rate. After 3 hours, her enjoyment stops growing and begins to decrease. This model has allowed me to maximize her enjoyment without increasing my opportunity costs. For example I have to eat so I have lunch with her 1 hour. The increasing opportunity cost of having to spend more time with my girlfriend for her to get the same amount of enjoyment occurs at the one hour mark and increases at the two hour mark. As we get closer to three hours I know that the rate at which the increasing opportunity costs grows until at the three hour mark her enjoyment actually decreases. Yes with Economic Models even personal issues can be studied and handled much more effectively. From now on I will spend only one hour a day with my girlfriend and spend the other two hours studying Economics.
Model 4

I work at a camera store, I have attended several workshops about cameras and sale techniques. Because of these workshops my sales has increased; therefore my commission will increase along with my knowledge. Graphically: I would use a line graph with two variables. Variable one (axis x) would be how many workshops I attended and variable two (axis y) would be the amount of commission I will receive. Therefore this would be positively related variables. The graph will be upward-slopping lines that will show how one variable increases the other variable increases. The more workshops I attend the more money I will make.

Model 5

An example of a model that explain the relationship between two variables that describe the behavior of an activity related is as a manager of a jewelry store, I’m able to determined the sales differences when we hired more Spanish/English speaking sales associates and decreases the number of employee that speak English only. The increase of both Spanish and English speaking increases our sales. A bar graph is a graphical model that describe the situation in a clear manner. On the x-axis, it would be the number of Spanish/English speaker and on the y-axis would be the sales amount. By looking at the bar graph, the bar tend to move up as we increases the number of Spanish/English speaker. Therefore, there would be a slope going upward, showing that there's a increase of sales as we increase more Spanish/English speaker.

In-Class Think-Pair-Share Activity

Pick one of the models described in the responses and answer the following questions:

1. Based on the information in the verbal model you selected, draw a graph illustrating the cause-effect relationship being described. Describe your graph in terms of the example. What implications about the cause-effect relationship can you draw from this graph? Why?
2. In what ways is the cause-effect relationship described in the verbal model affected by the level of the activity? Is the cause-effect relationship described in the verbal model weaker/stronger or even reversed as the level of the activity (the cause) increases?
3. What is unclear about the verbal model description that affects your ability to draw the corresponding graph? Explain briefly. How could the description be improved?
4. Is it easier to understand the cause-effect relationship from the verbal presentation or the graph you have constructed? Why?

After answering the questions individually, pair-up with another student and share/discuss answers. What new insights did you gain from sharing/discussing with your partner?

Follow up by sharing some examples with the full class, perhaps asking a few students to come to the board/overhead/tablet PC to draw the graph corresponding to one of the verbal models and explain the cause-effect relationship with respect to the graphical representation.
JiTT Example #2

Last year my wife and I made plans to take our family to the beach for the Labor Day weekend, accompanied by another family. Each family paid a non-refundable beach rental payment of $350 a couple of months prior to the trip. As Labor Day approached we watched the weekend weather report with growing interest. The weather forecaster was predicting rain for the entire weekend! As we packed up the car to go to the beach, I asked my wife if perhaps we should stay home for the weekend, rather than going to the beach. After all, we had recently moved and needed to unpack (and paint). She responded, “We’ve already paid $350 for the beach rental, of course we’re going to the beach!”

Was my wife’s argument ”rational,” in an economic sense? Why or why not?

Sample Student Responses (unedited):

Student #1

I think I would decide to go to the beach, rather than staying home to unpack and paint. I think the wife's decision to go to the beach was a good economic decision. To me, the additional benefit of the activity is greater than the additional cost of the activity. I feel like if I have already paid for a $350 trip, if I fail to go I will be wasting money. There will always be more time to paint and unpack. Even if it is raining at the beach, the family might have the additional benefit of spending some quality time together. My opinion of wasting money is a lot more important to me than wasting time. I would rather waste time over money any day.

Student #2

No because you will spend most if not all of your vacation inside due to the rain. That time could be spent working on your house. You also save money because you're at home versus being on vacation where you'd spend money on keepsakes, gifts and other needless items. By not going, you also save money on gas and food. The marginal cost of going to the beach outweigh the marginal benefits and thus it is not rational to go the beach.

Student #3

I believe that your wife's decision was a rational one in an economic standpoint because the non-refundable $350 deposit could have been used for some other type of activity for the new home. Even though the weather did not suit your standards it would be irrational to waste $350 by not taking the vacation.

Student #4

Well I personally feel that her argument is very rational, because the trip was already paid for and the trip was going to be restful something that was more worth her time.
**In-Class Collaborative Learning Activity**

For this exercise I might include the following questions with the four responses listed above (or hand out on a separate piece of paper). These questions then form the basis for an in-class collaborative learning activity.

> Which of these responses comes closest to the argument that an economist would make? After selecting one of the responses below, how might you improve the answer, based on your understanding of the material for today?

In four-person collaborative learning groups, have each person develop a response to the questions, then share with the group. Based on the individual contributions, have each group develop a consensus answer to the questions, then have each group (or a sample) report out to the full class. Assess (or have other groups assess) whether students are able to display the correct economic reasoning in their responses.

Finally, have each student develop a response to the following question and hand in:

> After completing this exercise, what questions do you still have? What concepts are still unclear?

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**JITT Example #3**

*There is a major political debate in our country about taxes. Based on your reading, choose one tax (or part of one tax) that you think should be lowered and one tax (or part of one tax) that should be raised. Then, present an argument in favor of each change that will be convincing to your classmates. Your argument may be shared with them.*

**Sample Student Responses (unedited):**

**Excise tax**

Raise it!
The items that fall under this tax are tires, cigarettes, liquor, gasoline, and phone calls. The reason why this tax should be raised is to reduce the consumption of these products to nearly zero percent. There are too many families that have a relative die of a cigarette related disease or a drunken driver. The environment is also affected by the smoking of cigarettes. Gasoline should be taxed more so that people who want to drive cars with V12 engines and other sport type vehicles will refrain from doing so. The smog from such cars also affects the environment and our ozone layer

Lower it!
The one tax that I would like to reduce are excise taxes. They should do this mainly because its a regressive tax. Not a lot of people in this nation is rich and are not as easily available to pay for these extra taxes. If taxes on products would be less, this would motivate consumers to go shopping, which would be beneficial to our economy.
Sales tax

Lower it!
State sales tax should be lowered in some states, because of the followings: 1 This is a regressive tax and higher proportion of poor people’s income is subject to this tax because they consume almost all of their earned income. 2 According to our textbook, in states like CA, rich can avoid paying this tax by simply buying his big items from other states with lesser tax rates or no taxes at all, or they can pay cash (they have the power) to merchants who don’t report their income. 3 Because of high sales taxes in some states, businesses move to neighboring states with lower rates and conduct their business from there. The businesses will stay in the state, the rich will less likely go out of state for his purchases, and the poor will have more buying power.

Raise it!
I believe state sales tax should be higher. The money you gain out of sales tax can go into so many areas that need help today. Making state tax higher does not affect the cost of food items because these items are exempt. Therefore, a higher sales tax would affect consumer products and the poor, although would be affected by it, would not go hungry because of it. In foreign countries where state tax is high, the money generated can be fuelled into social endeavors such as social security and welfare. We know that the baby-boomers are aging and we are not going to have enough assets to take care of them all and that the system might collapse, all the money generated by a higher sales tax can be poured in to solve this problem. A higher sales tax could also go towards a better standard of living for many.

In-Class Small Group Activity

Students were placed into groups of four and each group received a set of student JiTT responses covering four taxes (Federal income tax, payroll tax, sales tax and inheritance tax) including one response in favor of raising the tax and one response in favor of lowering the tax. Each student in the group chose one tax to study. After reading the two responses for the chosen tax, students were asked to identify the strongest argument on each side, circling where the argument appeared in the response.

Then students formed new groups in the classroom based on the tax they chose so that there was one group studying each tax. In the new groups (relatively large in number because there were now only four groups), students shared their choice of the strongest argument for each side. Each student was asked to choose one of the arguments (raising the tax or lowering the tax) as closest to his or her own viewpoint. Everyone in the new group did not need to agree.

Students returned to their original group of four. Each student had two minutes to explain his or her choice to raise or lower the tax chosen for study.
Questions and Activities to Accompany:
Using Just-in-Time Teaching to Understand Student Thinking,
Improve Preparation for Class, and Enhance Student Learning

Questions Midway Through...

1. What do you find interesting about the example JiTT exercises in this presentation/workshop? What questions do they spark? What comments do you have about the questions – their content, phrasing, scope, etc.?

2. How could JiTT questions be adapted for use in your course?

Interactive Activity

Think about the current assignments you use in your course. Pick one and begin to determine how you would do this assignment differently using JiTT pedagogy.

1. Individually, develop one or two JiTT questions related to your own course.

2. Share these questions with your table/group, and then select one to share with the entire room.

3. How would you use student responses from your JiTT question to adapt, modify, or inform follow-up classroom activities in the next class?

Concluding Questions...

1. Based on what you know so far of JiTT, what would you say is its most important pedagogical feature?

2. What would keep you from trying it?
Activity Space – Putting JiTT into Practice

1. Potential JiTT exercises/questions to be used in your class:

2. Potential follow-up classroom (or online) activities that make use of student responses to one of the JiTT exercises listed above:

Course:

Course Topic:

Course Level:

Targeted Learning Outcomes: