Preliminary Explorations into Just-in-Time Teaching

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Summary
Accepting that learning is dialogic necessitates the development of teaching and learning activities that support a learning-conversation. Further, Blended Learning requires learning technologies to support the conventional teaching settings by constructing activities that enhance, rather than simply replace, the conventional teaching settings. Just-in-Time Teaching is one such strategy that actively exploits the students' conceptions from out-of-class web-based activities to support the in-class activities. In doing so, it integrates the notion of a learning-conversation with Blended Learning.

This paper presents a preliminary exploration into the use of Just-in-Time Teaching of which the initial results are positive. In-class learner engagement has been enhanced as has the opportunity to gain an early insight into the students' conceptions.

Background

Learning is not a spectator sport. It is an iterative, dialogic and engaged activity requiring active participation from both teacher and learner.

Even with the increasing emphasis on developing the independent/autonomous learner, such notions do not exclude the importance of dialogue nor the necessity for the teacher to be an active and engaged agent in the learner's learning. Models of independent/autonomous learning should still encompass the duty-of-care that is placed on the teacher to inspire, enthuse, challenge, stimulate and support their students. Autonomous learning is still a supported/scaffolded activity where teachers have an important role. The scaffolding arises from carefully constructed learning activities that help convert *teaching* into *learning.* Naturally such learning activities need to be authentic, aligned with the module learning outcomes and should not inadvertently promote a surface approach-to-learning (Biggs, 2003). Ideally these activities will also allow students to share conceptions and learn from each other as well as the teacher.

These ideals are not new nor are they peculiar to today's drive towards a digital classroom. In fact, the challenge for the digital classroom is to develop technologies and learning experiences that allow such teaching philosophies to be realised. For whilst the digital classroom may provide new and exciting opportunities it should not, in doing so, exclude or remove opportunities that support existing effective practices and pedagogies.

Increasingly these new learning technologies are being used not *instead* of conventional teaching settings but rather in *conjunction* with them. There now appears a move from e-learning towards an approach which seeks to integrate the learning technologies with conventional teaching practices. This was noted in the response on HEFCE's consultation to e-learning 21/2003 (Newby, 2004) and was also a central feature in the University of Hertfordshire's (UH) bid for a Centre for Excellence in Teaching and Learning – i.e. the creation of the Blended Learning Unit. In that bid Blended Learning was defined as *'educational provision where high quality e-learning opportunities and excellent campus-based learning are combined or blended in coherent, reflective and innovative ways so that learning is enhanced and choice is increased.'*

Central to the UH vision of Blended Learning is StudyNet – the University's bespoke managed learning environment (MLE). However, like many other learning technologies, StudyNet will not ensure learning; it only provides an additional connectivity between teacher and learner. It is the way the connectivity is used and exploited, by both teacher and learner, that will determine if learning is likely, i.e. the use of StudyNet as a digital repository, whilst providing benefit in the form of a central store, will not adequately support the notion that learning is a dialogic activity.

This paper, therefore, introduces and also presents a preliminary application of a teaching strategy that uses learning technologies in out-of-class activities to support the in-class activities. This strategy, referred to as Just-in-Time Teaching (JiTT), exploits the additional connectivity for the enhancement of teaching and learning and provides a practical example of real Blended Learning. JiTT is also aligned with the dialogic teaching philosophy, and as such, a formalised definition, the *Conversational Framework* (Laurillard, 2002)*,* is presented.

Conversational Framework

The Conversational Framework identifies four principal components; *discursive, adaptive, interactive* and *reflective*. The combination of these provides the opportunity for a teacher-to-learner and learner-to-learner dialogue. The features of the four components are presented in Table 1. A graphical overview is shown in figure 1.

Table 1. Components of the Conversational Framework (Source: Laurillard, 2002)

Discursive: (1 & 2)	• Teacher's and students' conceptions are accessible to the other and the topic goal is negotiable. • Students must be able to generate and receive feedback on descriptions appropriate to the topic goal. • The teacher must be able to reflect on students' descriptions and adjust their own descriptions to be more meaningful to the students.
Adaptive: (3 & 4)	• The teacher can use the relationship between their own and the students' conceptions to set up and adapt a task environment for the continuing dialogue. • In the light of the topic goals the students must be able to use their existing conceptual knowledge to adapt their actions in the task environment in order to achieve the task goal.
Interactive: (5 & 6)	• The students can act within the task environment to achieve the task goal and they should receive meaningful intrinsic feedback on their actions that relate to the nature of the task goal. • Something in the environment must change in a meaningful way as a result of their actions.
Reflective: (7 & 8)	• Teachers must support the process by which students link the feedback on their actions to the topic goal, i.e. link experience to descriptions of experience. • The pace of the learning process must be controllable by the students, so that they can take the time needed to reflect on the task-goal-action-feedback cycle in order to develop their conception in relation to the task goal.

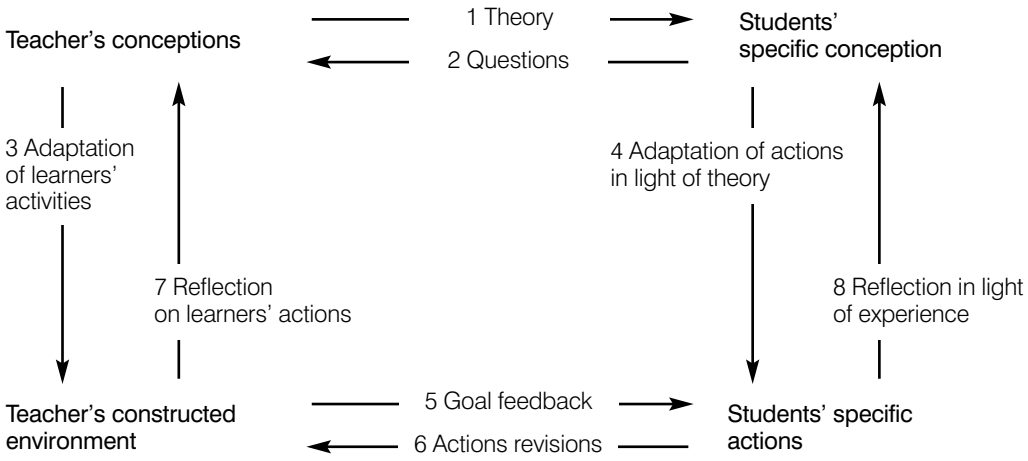

Figure 1: The Conversational Framework.

In presenting the Conversational Framework, it is apparent that a didactic *'I talk – you listen'* approach to teaching misses the dialogic opportunity. JiTT, however, as an alternative approach to teaching, actively seeks to engage in dialogue and uses the students' own conceptions to drive the learning conversation.

Just-in-Time Teaching

JiTT is an identifiable teaching strategy *'based on the interaction between web-based study assignments and an active learner classroom'* (Novak *et al,* 1999). It is the timeliness of the teacher picking up the students' conceptions, just before the lecture, that gives rise to the name JiTT, i.e. the teacher has gathered the students' conceptions just-in-time to help re-shape or guide the up-coming lecture. The strategy explicitly seeks the students' conceptions, between teaching sessions, via teacher-constructed web-based activities. These conceptions are then taken back to class for further activity or indeed to re-shape the upcoming lecture.

The spirit of JiTT and the importance of the student in the teaching session is succinctly captured by Cubero when he suggests *"As you enter a classroom ask yourself this question: If there were no students in the room, could I do what I am planning to do? If your answer to the question is yes, don't do it."* (Cubero, date unknown). This student-centric view of teaching and learning is a long way from a content-centric view of teaching and highlights the alignment of JiTT with the principles outlined in the Conversational Framework. Indeed, in some sense it is an example of the Conversational Framework in operation.

The use of teacher-constructed web-based activities in JiTT exploits the additional connectedness provided by the learning technologies such that planned, rather than accidental, learning takes place. Further, the out-of-class nature of the web-based activities

encourages better student preparedness for the up-coming lecture. With better prepared students, it is possible that the pace of the teaching session may actually be increased rather than slowed with the additional in-class activity. And so the more content-centric teachers may also have something to gain from this teaching strategy.

The web-based activities are typically – warm-ups, puzzles, enrichment pages, and standalone exercises. Components of the Conversational Framework are shown italicised.

The *warm-ups* include quizzes, discussions, pre-readings with analysis or other methods to gain the students' conceptions of the subject. By definition, the warm-ups are typically presented and undertaken by the students prior to a teaching session.

The *puzzles* are tasks set *after* the teaching session and essentially form a web-based wrapping-up activity. These are used to encourage the students to re-evaluate their understanding of the subject having gone through a warm-up and the supporting and accompanying teaching session.

The *enrichment pages,* also known as *good fors*, add authenticity to the current area of study. They might be used to show application or on-going research in the subject area. Typically these would be distributed to encourage motivation and demonstrate why the current area is an important study area, i.e. what it is good for. Similarly, news items could be used to act as a so-called *drum-beat* to support the students' momentum and regular engagement with the in-class and out-of-class activity.

The *standalone exercises* provide further opportunities to practise and follow up the class activities.

The blending of the web-based activity with the class activity arises because JiTT explicitly uses the students' conceptions gathered from the warm-ups to help shape the up-coming teaching session. For example, a couple of hours before the lecture, the teacher collects the students' responses/performance/conceptions and uses them within the teaching session to establish follow-up class-based activities.

These class-based activities might be:

1. To clarify with the students why they responded as they did – *Discursive.*
2. To shape some of what is taught or indeed re-taught during the first part of the lecture – *Adaptation, interaction, reflection.*
3. To share and discuss other students' conceptions and see how these align with their own conceptions – *Adaptation, interaction, reflection.*

What is particularly valuable is the increased opportunity for the learner-to-teacher and also learner-to-learner connection and the immediacy of seeing, as a teacher, the students' current conceptions. No longer do you have to wait until the exam to establish they cannot describe the first law of thermodynamics or show its application to the real world.

Although originally conceived to help teach Physics, JiTT does not appear to be constrained by discipline. In addition to the original Physics applications, experiences and applications are reported in, for instance, Biological Sciences (Potter, 2005), Economics (Simkins & Maier, 2004) and Biology (Marrs & Chism, 2005).

Preliminary activity

Having outlined the background and justification for JiTT, the following presents a preliminary exploration in the use of *warm-ups* and the subsequent use of the students' conceptions gained from the warm-ups. For reference, the preliminary work was undertaken on a new second year BSc Engineering Module – Engineering Science. The 15 credit point, single semester module was taken by around 140 students.

The students on the module were due to respond to fortnightly assessment tasks which have previously been noted as having a significant and positive impact on their examination performance and study behaviours (Russell, 2005; 2006). These assessment tasks, however, mainly concentrate on calculations and developing the learners' confidence in the ability to solve differing classes of engineering problems, i.e. they do not present the teacher with an opportunity to read the students' conceptions nor do they present the student with a need to articulate their conceptions. The warm-ups used here sought to bridge that gap and tap into the already proven approach to assessment.

When the students now submitted their results to their regular summative assessments they were also asked to respond to specific questions that sought their understanding of the subject; this latter part being formative and collected as *free-text*. Both data sets, the numeric responses and the free-text responses, were collected by a dedicated computer program – the *WATS data gatherer,* i.e. not StudyNet. It is hoped that this work will help in the development of StudyNet which will allow wider uptake of this teaching and assessment strategy.

Naturally, the necessity for the students to communicate their understanding has always been considered important, as has the encouragement of a self-help culture through student-to-student discussions. Unfortunately, previous attempts to engage with the students, via the StudyNet discussion forum, proved difficult because large numbers of students chose not to respond. In fact, the largest number of posts to a learning-oriented thread, within this module, was 15. Five of these were from the teacher with the remaining ten coming from five students. Whilst there is no doubt that the non-participants will gain something from the on-line conversations, in lurking they are not articulating their own conceptions, a useful learning experience in its own right, and hence not maximising this learning opportunity.

An example of warm-ups

During their heat transfer investigations the students were presented via StudyNet with an animation of two-dimensional conduction. The animation showed lines of constant temperature (isotherms) as well as streamlines of heat flux – heat flux streamlines run normal to isotherms. The streamlines were moving through the object which was constructed from two materials having different thermal conductivities. This meant that one material would act more as an insulator whereas the other would act more as a conductor. The impact of this was a non-uniform, skewed distribution of heat flux through the object. In addition to undertaking numerical calculations the students in this example were asked to describe what they saw and also describe why this behaviour was occurring. They were not told the object comprised two materials. Indeed, to respond to the question the students needed to abstract their knowledge of heat transfer to this new, previously undiscussed example.

Examples of the student responses include:

Student 37 wrote: *"In the Conduction Animation I saw that the Conduction across the plate started fast at the top and worked its way slowly into a V shape where at the sides the heat travels slower. It travels slower down the middle section also as it lags behind the main part of the flow. When it gets to the bottom of the plate it slows down in comparison to the top of the plate."*

Student 139 wrote: *"The rate of heat transfer is constant until it reaches an unknown object. The heat then carries on past the object and cools down and disappears. Some of the heat is conducted in to the unknown object where it is conducted very slowly in comparison to the surrounding fluid. This is cooled down as it moves along the material which then is dissipated in to the air and the energy is lost."*

Student 47 wrote: *"I found the heat moved like a water/sound wave, with it curving at the edges where it had slowed down due to resistance. The square in the centre slowed down the heat transfer and after the wave had passed through it continued at its original speed."*

These students' posts, together with a few others, around ten in total, were anonymised and taken to the class to discuss, share and dissect. In this instance they were asked to identify misconceptions for correcting as well as indicate those posts that seemed to show good understanding. At the end of this activity there emerged a growing, student-led consensus on what they saw, i.e. the students were actively participating in their collective knowledge construction.

In addition to conceptions, an in-class discussion also took place on the appropriate use of language as well as the students' actual response to the question. Note how, in the examples shown, there is little discussion on why they saw a skewing or indeed what properties the central object had with respect to the rest of the object. It was this, after all, that caused the skewing.

Although the student contributions shown here are of limited length this approach may also prove useful for teachers wishing to evaluate the students' contributions against instruments such as the Structure of the Observed Learning Outcomes (SOLO) (Biggs, 2003). As with the conception itself, early diagnostic and discussion on the nature of the contribution from pre-structural through to *extended abstract* might help the students' future submissions and work.

Being anonymised and formative suggests that the students had no need to hide their mis-conceptions, as is often the case with summative assessments, and they also appeared safe to post their genuine understanding of the subject. This gave an opportunity to get closer to the students' own, and honest, understanding of the subject. It is this level that helps the teacher re-affirm or adapt their teaching to actually help the students. As an out-of-class wrap-up, the complete set of anonymised student posts were uploaded to StudyNet enabling the students to continue with this activity in their own time.

Discussion and conclusion

Accepting the notion that learning is a conversation relying on active participation from learner and teacher requires actions, activities and tasks that facilitate the dialogue. JiTT is one approach that supports a dialogue and does so by blending web-based out-of-class activities with those undertaken in-class. The teaching strategy provides ample opportunity for the discursive, iterative, adaptive and reflective components of the

Conversational Framework to exist. Feedback and the students are at the heart of this teaching strategy as are all of the Seven Principles of Good Practice in Undergraduate Education (Chickering & Gamson, 1987). It could be argued that JiTT is another example of the Conversational Framework and also of the Seven Principles in operation.

JiTT presents teachers and learners with opportunities. There are opportunities to use the additional connectivity between teacher and learner, such that teaching can be transformed into learning. Seizing the connectivity may bring students to the lecture better prepared, by motivating them with regular and authentic activities that join up the out-of-class activity with the in-class activity.

There is, however, a need for the lecturer to be adaptive and modify some of what they had planned based on emerging conceptions. In doing so, this approach to teaching and learning puts the students at the centre of the learning experience. It is not an approach to teaching that is overly content-centric or one that ignores misconceptions just to progress single-mindedly through the entire content of the curriculum.

This immediacy of firstly seeing the students' conceptions and then subsequently providing evidence-based feedback is central to this approach to teaching. It is useful for both the learner and also for the teacher wishing to help diagnose understanding through both learning and teaching.

What was valuable from the initial application was the sharing of conceptions, the appraisal of others' contributions and also giving the students an opportunity to read other students' responses to the same question to help develop their own conceptions. These students' conceptions were key to some of the class activity and also to the learning-oriented discussion. Providing an opportunity for the students to verbalise their understanding was also a useful addition to the existing assessment strategy.

On a personal note, getting closer to the students' genuine understanding of the subject was a fascinating experience. It forced the author to stand back and reflect on his teaching to establish how some of the students had the understanding they did!

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Biographical notes

Mark Russell has been teaching at the University of Hertfordshire for ten years. His interests lie in engineering education and using a range of educational settings to both support and challenge his students. Mark was awarded the Times Higher Education Supplement / LTSN generic centre E-tutor of the year in 2003, was one of the first five recipients of the Vice Chancellor's Award for excellence in Teaching and Learning 2003/04 and more recently awarded a National Teaching Fellowship (2005).