Intelligence-led teaching: Using the students’ conceptions to drive the learning-conversation

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Abstract – Teaching requires students and not just white boards and lecture theatres. Conventional approaches to teaching, particularly in large class settings, often appear to overlook this and become more focused on the content. Highly content-centric teaching does little for the students’ learning.

A more considered approach is one which actively seeks to gain the students conceptions and use them to help drive the lecture. Just-in-Time-Teaching, is one such teaching strategy, that is aligned with the fact that learning is an activity-based sport and also that a learning-conversation needs to be established between learner and teacher. Use of assessment tasks, diagnosis of student performance as well as their free-text responses to questions, all supporting the learning-conversation is presented.


BACKGROUND

Review most teaching philosophies, ideals, concepts and principles and at their heart you are likely to find the notion that learning requires action, it is a doing activity; quite simply learning is not a spectator sport.

Further, learning should be thought of as an iterative, dialogic and engaged activity requiring active participation from both teacher and learner. Although teaching does not equal learning, nor is it the reciprocal of learning, learning should be a function of teaching. Hence good teaching encourages learning thereby implying that teachers too have an important part to play in this learning-conversation.

Issues arise however, with teaching practices that are overly content-centric. i.e. moving to a so-called ‘stuffed curriculum’ that teaches the same material in week 7 this year, because that is what was taught in week 7 last year. With stuffed or content-centric curricula the students are in danger of simply making up the numbers and not being part of the learning-conversation.

An alternative to the content-centric view is to think about what the students know, what they don’t, and how they are performing in various tasks. This information is then used by the teacher to modify lecture 7 so as to actually help the students and correct any misconceptions. Rather than making up the numbers, the students now become a vital part of the learning-conversation. In fact without them a conversation is not possible. A move towards a student-centric, student responsive approach requires teachers to adapt their practices and develop an inquisitiveness about what the students know and what they don’t.

This article demonstrates an approach to using the students’ conceptions to help drive the learning-conversation. It is essentially an example of Just-in-Time-Teaching and blended learning. It has much potential and although given from an engineering perspective does not appear to be constrained by discipline

CONVERSATIONAL FRAMEWORK

For completeness, the notion of a learning-conversation, as presented in this paper, is not that new. Indeed a Conversational Framework has been offered elsewhere and formalises the principle of the learning-conversation and identifies actions and components that support it. i.e. discursive, interactive, adaptive and reflective. The combination of which provides the opportunity for a teacher-to-learner and learner-to-learner dialogue. The features of the four components are presented in Table I. A graphical overview is shown in Figure 1-.
Just-in-Time-Teaching (JiTT), draws on the e-learning technologies as well as the approach of blended learning to provide a highly student-focused teaching and learning strategy. Indeed definitions given by its originators suggest JiTT is ‘based on the interaction between web-based study assignments and an active learner classroom’ [2].

JiTT explicitly seeks to gain the students’ conceptions, obtained between teaching sessions, via web-based activities are then used to help re-shape or add a further activity into the upcoming lecture.

The spirit of JiTT is simple and is captured by the following ‘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’. [3].

For completeness the web-based activities are typically, warm-ups, puzzles, enrichment pages, and standalone exercises. An outline of which is presented in Table II.

Table I and Figure 1 are drawn from [1]

**Blended Learning and Just-in-Time-Teaching**

Blended learning, although having many definitions, has at its roots in the idea that e-learning should be used to support the traditional teaching and learning activities. Hence blended learning should not be thought of as using e-learning to simply replace the traditional lecture, seminar or tutorial etc., but rather that it is used to supplement and enhance it. Further, blended learning is not simply using technology for its own sake, but rather thinking about how the wiki, the blog or the podcast supports the lecture series.

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<tr>
<th>Table I. COMPONENTS OF THE CONVERSATIONAL FRAMEWORK</th>
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<tr>
<td><strong>Discursive: (1 &amp; 2)</strong> 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 student’s descriptions and adjust their own descriptions to be more meaningful full to the student.</td>
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<td><strong>Adaptive: (3 &amp; 4)</strong> The teacher can use the relationship between their own and the student’s conception to set up and adapt a task environment for the continuing dialogue. In the light of the topic goals the student must be able to use their existing conceptual knowledge to adapt their actions in the task environment in order to achieve the task goal.</td>
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<td><strong>Interactive: (5 &amp; 6)</strong> 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.</td>
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<td><strong>Reflective: (7 &amp; 8)</strong> Teachers must support the process which students link the feedback on their actions to the topic goal. i.e. link experience to descriptions of experience. The pace of to 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 topic goal.</td>
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**Figure 1. THE CONVERSATION FRAMEWORK**

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 for’s, 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 practice and follow-up the class activities.

One of the significant benefits of adopting JiTT is the immediacy of seeing the students’ conceptions. These conceptions, as noted, can then be used to help re-shape the upcoming lecture. The outcome of which being a more student-responsive teaching strategy that does not just collect student data but actually seeks to do something with it. Early intervention is now possible as is the development of activities that both develop the students’ conceptions as well as share them throughout the class. Such activities are aligned with the discursive, interactive, adaptive and reflective components of the conversational framework.

In addition to the engineering application reported here, other examples and applications of JiTT are reported in Biological Sciences [5], Economics [6] and Biology [7].
AN EXAMPLE FROM PRACTICE

Having presented a backdrop and the need for a more student-centric approach to teaching, the remainder of this article deals with its application in practice. The work reported here comes from a first year Fluid Mechanics and Thermodynamics module. The module is taken by around 200 students and is taught over one semester.

Out of class activity

The out of class activity was essentially assessment driven. It comprised a collection of student-unique, Weekly Assessed Tutorial Sheets (WATS) These WATS essentially forced the students to engage with the subject, in their own time on a week by week basis. By embedding random factors into the WATS ensures that answer sharing is not possible. Further, the WATS were calculation based hence answer guessing was also not an issue. i.e. as may be the case with some items in an objective test.

Students’ responses to the WATS were collected via a computer program. This program formatted the data ready for use by other automating products. These products, which are based in Microsoft Excel, read the students submissions, marked the students work and provided a personalised feedback e-mail. All of which happened at the click of two buttons (‘Read and Mark’ submission, and provide ‘Feedback’). This in itself, although highly successful in gaining time on task, promoting active learning, and giving prompt feedback etc. i.e. some of the core principles of good practice in undergraduate education [8], did not, in their own right, support JiTT or the learning-conversation.

The JiTT and the learning-conversation came alive when the students’ results and performance was analysed.

At the click of another button, a weekly updated League table was produced, see Figure 2. This league table demonstrated not only the individual students performance to the task, in comparison to each other (see figure 3), but also the cohorts’ performance to the assessment activity with respect to the other weekly assessment activities (see figure 4). It now becomes immediately obvious what topic areas the students found most difficult and what they did not.

Further, by drilling down on the data it is also possible to see how the students responded to each question on the weekly assessment tasks, see Figure 5. Hence not only can you see how they performed on WATS 4 but you also get to see how they performed on Q1, Q2 and Q3 etc on WATS 4. This information now becomes invaluable in supporting the learning-conversation.
now allows teachers to target what they teach and provide appropriate, intelligence-led, follow-up materials or activities.

In addition to responding to the weekly assessment task the student were also required to articulate their understandings about certain aspects of the module. Here the teaching team were not just looking for their responses to numerically-based practice questions, as indicated by the above work, but to seek what they knew and to help them construct meaning from their calculations.

Each week when submitting their work to the computer program the students would also be issued with a couple of free-text questions. These were not marked but formed an important part in supporting the intelligence-led, learning-conversation.

General questions included

- What question did you find the most difficult and why?
- What one thing, area, topic would you like more help on?
- Look back, what have you learnt so far in this module?

Topic specific questions included

- In your own words describe Bernoulli’s Equation.
- Often in manometry we ignore the density of the fluid in one of the limbs, why is this?
- In your own words please identify the meaning of ‘minor losses’ and describe in your own words ‘how you calculate them’?
- In your own words describe Bernoulli’s Equation

Examples of students’ responses to the question ‘in your own words please describe the meaning of the term ‘dryness fraction’. Indicate also when and how it is used are presented in Table III. What is immediately obvious from the posts is not only the variation in correctness of response but also the variation in their length. Compare, for example, row 20 with row 26.

It is worth noting that this module is supported extensively by the use of a Managed Learning Environment. In previous years such questions were also fed to the discussion forums for student response. In that instance only a handful of students chose to respond. Collecting the students’ responses via the computer program in a ‘closed’ environment, rather than the ‘open’ discussion forum, now provides the teaching team with around 150 free-text responses, a significant increase in uptake. Encouraging the students to construct and communicate meaning was considered a vital part of the module and hence the additional uptake, as well having the ability to see more of the students’ conceptions, was considered a real success.

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<table>
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<tr>
<th>Post #</th>
<th>Submission</th>
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<tbody>
<tr>
<td>20</td>
<td>how dry a fluid is</td>
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<tr>
<td>21</td>
<td>How dry the fluid is between the saturated and gas state.</td>
</tr>
<tr>
<td>22</td>
<td>When a fluid in two phase region is considered, both saturated vapour and saturated liquid are present. Although pressure and temperature are constant over this two phase region, all the other properties do vary. Therefore, ‘dryness fraction’ is used to specify the amount of vapour and the amount of liquid present. Then the other properties for the particular state can be determined. ‘Dryness fraction’ is expressed as the mass of vapour present over the total mass of the fluid present.</td>
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<tr>
<td>23</td>
<td>the fraction of dryness between a substance being a liquid or a vapour. It is used when trying to work out what stage a substance is in, i.e. how much of it is vapour and how much is liquid.</td>
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<tr>
<td>24</td>
<td>the mass of liquid contained in 1 kg of mixture</td>
</tr>
<tr>
<td>25</td>
<td>the dryness fraction which can also be called Quality is the ratio of Mass of vapour over The mass of the mixture it can be used for example when making use of the formula u=U(f)+XU(fg) where U(f)=internal energy of the fluid and U(fg)=Difference in internal energy from the vapour state to the liquid state.</td>
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<tr>
<td>26</td>
<td>dryness fraction = the mass of dry vapour in 1 kg of the mixture. When water boils, it turns to vapour. However, vapour exists in 2 further forms: wet and dry vapour. Dry vapour is when more heat is supplied to boil the liquid until there is no more of the liquid. Wet vapour is the state of the substance between saturated liquid and dry vapour. The state of wet vapour cannot be simply defined by just pressure and temperature; the condition or quality of wet vapour ie dryness or wetness fraction is needed. The dryness fraction is needed in order to calculate Specific Enthalpy h, Specific Volume v, Specific Entropy s.</td>
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<td>27</td>
<td>It is the total mass of a fluid (sum of masses of liquid and gas) divided by the mass of the gas. This gives the fraction of how much gas is present in the fluid, hence how much isn't liquid (wet), therefore how much is dry. It is used to work out volumes, enthalpies and entropies.</td>
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<tr>
<td>28</td>
<td>The dryness fraction is the ratio of the total mass, to the mass of gas in a fluid.</td>
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<td>29</td>
<td>Ratio between total mass of the fluid and the total mass of the gas.</td>
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<tr>
<td>30</td>
<td>dryness fraction can be defined as the ratio of mass of saturated vapour to the total mass of saturated liquid and vapour in a saturated mixture. It can be used to find the value of the total volume in a saturated vapour-liquid mixture.</td>
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**Table III**

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<th>Example Posts to a Free-Text Question</th>
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**In-class activity**

The in-class activity, lecture topics as well as the sequence of the lecture series is typically guided by the module guide – this describes the curriculum to be taught. What is unique in this approach is the use of the students’ performance to complement the pre-planned activities. Hence to continue the intelligence-led, learning-conversation the results from the students submissions, as established from Figures 1-5, are used to decide what might be re-taught and what might not.

Further, the use of the students conceptions to the free text questions are also used for re-alignment or indeed for new lecture-based activities. Here the students might be asked to review a selection of the conceptions and comment on their correctness or synthesise the submissions to produce a better articulation of meaning. Additional activity might also explore not simply the correctness of the response but the manner in which it has been articulated. The ability of a student to abstract or generalize might be useful as a demonstration too as might a comparison of the students’ responses alongside a SOLO type taxonomy [9]. Hence opportunities to correct as
well as help the students better respond to questions exists. This is useful here since the students now work with and evaluate statements from their own cohort and not those that are pre-planned by the teacher. This helps authenticate the task.

CONCLUSION

Content-centric teaching helps the teacher satisfy the demands of any auditing body and ensures that each student, throughout the years, gets the same opportunity. What it does not do, however, is make allowances for the students, their understanding or conceptions of the subject. Overly content-centric teaching simply marches on regardless of what the students know and what they don’t.

JiTT exploits educational technologies in a blended learning manner but has at its heart the student. In fact features of the teaching sessions rely on the their previous engagement in online, out-of-class, web-based activities to help drive the in-class activities.

In doing so the lecture becomes more authentic and is constructed from the class conceptions and current understandings of the lecture theme.

The learning-conversation is satisfied by the constant interactivity between the students and the teacher through interaction, adaptation, reflection and discursive exchanges. Teaching in a JiTT mode actually requires students rather than just white boards and lecture theatres.

REFERENCES


