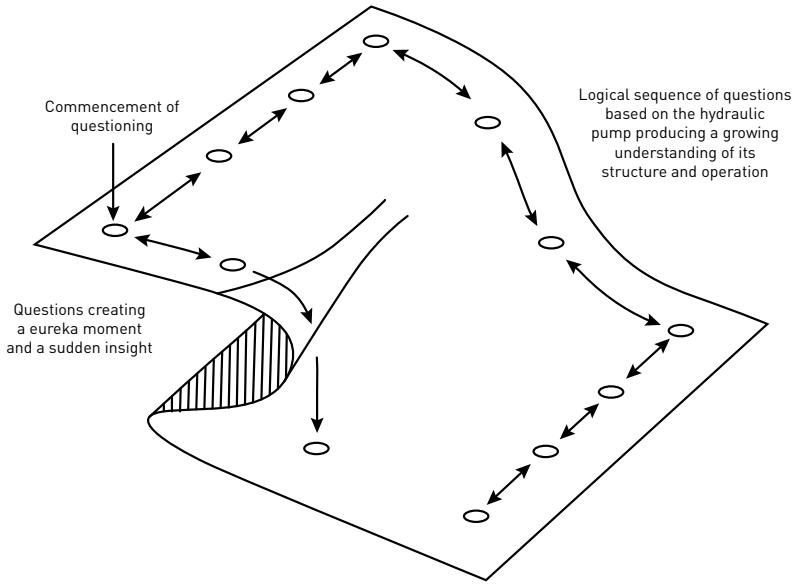
Questioning and patterns of student responses

1. Catastrophe theory is a controversial new way of thinking about change.[1]

1.1 The theory is controversial because it proposes that the mathematics underlying three hundred years of science although powerful and successful has encouraged a one sided view of change. Mathematics has been designed to analyse smooth, continuous, quantitative change. The smoothly curving paths of planets round the sun, the continuously varying pressure of a gas as it is heated and cooled, the quantitative increase of a hormone level in the bloodstream are examples of analysed changes.

1.2 There is another kind of change that is less suited to mathematical analysis. The abrupt bursting of a bubble, the qualitative shift in our minds when we 'get' a pun or a play on words, such changes can be noted between lecturers and students in the classroom, laboratory, studio or workshop.

Questioning and student responses shown as paths on the cusp catastrophe graph.



[1] Woodcock A and Davis M (1980) Catastrophe Theory Pelican Books Harmondsworth, England. p9

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2. Catastrophe theory uses a graph to show gradual change as opposed to a rapid transition associated with a sudden eureka event. Extracts of lessons appear to illustrate the two contrasting approaches.

2.1 A series of linear questions generates responses associated with the progressive realisation of a relationship or operation.

2.2 A series of questions is used to prompt a sudden recognition of the connection between different phenomena.

Each of the questioning strategies detailed in the following lessons requires different types of questions and a distinctive approach.

3. The teacher records a selected teaching performance and inserts three second bleeps on to the recording. At each bleep the teacher classifies the language being used based on the following categories.

TL : teacher describing or explaining;
TQ : teacher questions;
TR : teacher responses to student contributions;
SR : student responses to a teacher question;
SV : student volunteers a contribution;
XX : non verbal communication such as reading or writing on the whiteboard;
SS : silence.

Software written to support the analysis and evaluation of teaching performance is able to read each uniquely coded bleep. This enables the lecturer to link plotted interactions with precise points on the classroom recording.

4. Linear questioning: the operation of an hydraulic pump.[2]

The teaching episode begins with the lecturer describing his approach in the following terms.

> *"This was the second two hour lesson in a series on the principles, operation and application of hydraulics. In introducing the students to the topic in the previous lesson I had dealt with the ratio between different sized hydraulic pistons ie force ratio. The students were familiar with the concept of force and leverage."*

An important lesson objective was to prove to the students that with a little effort on their part, they could work out the design and operation of an unfamiliar component. The skill and confidence this generated would have a general application in their work.

In the first lesson it was established that no one in the group had any idea what the inside of a hydraulic pump unit looked like or the components it contains. It was decided to use this lesson to give the students an opportunity to work things out for themselves.

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[2] Sowler A, Lecturer, Leicester College of Further Education, The evaluation of a lesson for third year motor vehicle body repair students in FERN, Journal No 1, March 1980

4.1 Transcript of part of the lesson.

The lecturer began by outlining his approach.

TL *I am going to ask you all during this lesson to give information to help fill in the handout. I know none of you have seen inside the unit, but if you think very carefully of how the unit operates it should not be too difficult to build up the picture. On the outside of the unit, there are certain components that you are familiar with, that you use to operate the unit.*

He begins his sequence of questions. Each question is directed to a specific student unless otherwise indicated.

TQ *Can you name them and say where they go?*

SR *Handle on top, pipe out to the ram, on-off valve on the side.*

TR *Good, the handle or lever to give movement to the piston, the outlet pipe supplying pressure to the ram and the control valve on or off.*

TQ *What happens if I move the lever causing the piston to move up the cylinder? (General question)*

S *. . . . . ..*

TQ *What happens if a bike pump is placed in water and the slide part pulled out?*

SR *The pump fills with water.*

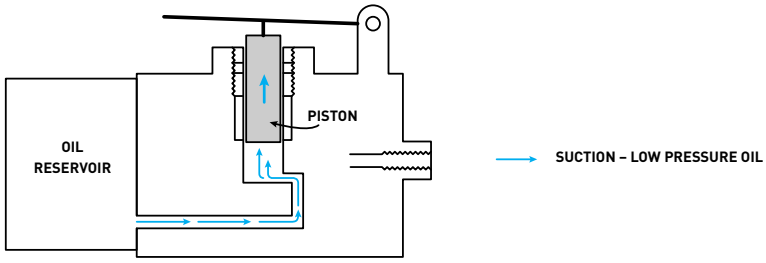
TR *Why?*

SR *The water is sucked up.*

TR *Yes, the movement of the pump slide causes a drop in pressure – the water fills this drop. It's the same on this pump only here we are drawing oil.*

TQ *What is needed on the handout to enable us to suck up oil?*

SR *A link between the piston and the oil supply.*



TQ *What will happen if I push the piston down now?*

SR *The oil will go back into the reservoir.*

TQ *What is needed?*

SR *A valve.*

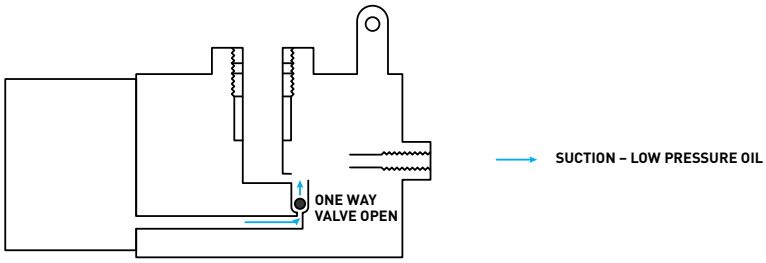
SV *You need an outlet pipe.*

TR *Yes, we need both.*

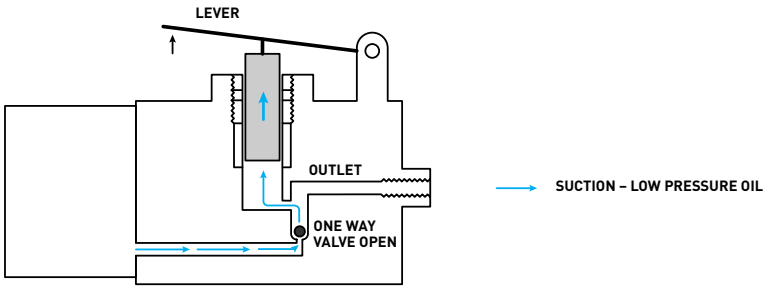
TQ *Where should we put the valve?*

SR *In the upward pipe, below the piston.*

TR *OK. I will make this pipe so that the valve can only work in one direction.*



SV *Now connect the bottom of the piston to the outlet.*



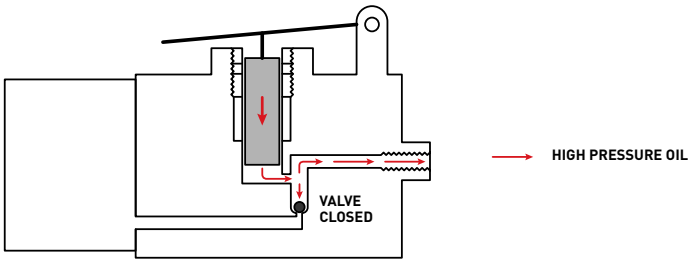
TQ *What will happen to the valve if the piston is moved down?*

SR *The oil will force the ball onto the seal.*

TR *Good.*

TQ *What will happen to the oil below the piston?*

SR *It will be forced out of the outlet pipe.*



TL *Good, we can now produce pressure on the outlet side without affecting the incoming supply.*

TQ *What will happen now when I push the piston up?*

SR *Oil will be drawn from the reservoir.*

TR *Is that the only oil to be drawn?*

S *. . . . . .*

TR *Look at the diagram.*

S *. . . . . .*

SR *Oh! Yes, it will draw oil back from the outlet.*

TR *Yes, so the oil will only go back and forwards along this pipe.*

TQ *What is needed?*

SV *Is this where the control valve is used?*

TR *Well look at the diagram and think how the unit works. Do you open and close the valve after each stroke?*

SR *No, it's closed when you start to pump and you open it when you finish*

TR *Yes, so what is the answer to your question?*

SR *No, there must be another valve like the first.*

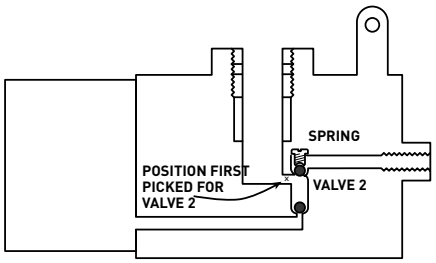
TR *Yes.*

TQ *Where can we put this valve?*

SR *On the outlet pipe.*

As time was pressing I decided to show the students the position of this valve. It is a valve that is renewable from outside the unit so pressure is important.

TL *Yes, in fact about here.*



As I drew in the second ball valve, the following exchange occurred.

SV *That's no good, when the piston goes down the oil will push that ball along the outlet pipe.*

TR *Very good. That's true, so how can the ball be kept in place?*

S *. . . . . .*

SV *(Called from back of class) A spring.*

TR *Good – just here.*

TL *Good. What we have now is the ability to draw oil from the reservoir, pressure this oil causing it to transfer this pressure along the outlet, operating the ram unit.*

At this point, most of the group sat back in their chairs and some took a deep breath as if to say "cracked it!". In fact the lecturer wished to explore the process of draining the pump and the question and answer session continued to explore this issue. Once the session was completed the students completed their diagrams from the image built up on the blackboard.

4.2 Self-evaluation of the lesson.

4.2.1 General review.

The lesson seemed to go very well. All members of the group had seemed interested in the topic and had contributed to the lesson. I find this lesson rather long, two hours of technology tends to be very tiring for me and the students. I normally give this group the opportunity to relax for five minutes after an hour. On this occasion the students did not want a break. Their involvement meant that the flow of the lesson was not interrupted.

When teaching this topic on previous occasions I have adopted a variety of approaches. For example:

- providing a completed drawing of the pump and used the diagram as a basis for any explanation of its operation;
- stripped down the pump unit whilst giving a description of its operation.

These approaches are based on the assumption that the students have no knowledge of the topic being taught. Such strategies do not recognise the ability of the students to follow a logical line of reasoning, nor the need to extend this capacity.

The lesson took the form of questions and answers. Note, however, that the percentage of questioning is only 18% of the total, TR 31% and SR 27%, indicating the proportion of time spent receiving and using information from the class. Following the introduction, the periods of TL represent the consolidation of each aspect of the work using the diagram.

In a discussion of the lesson with colleagues the question of why students could not extend their initial responses was discussed. The elaboration or explanation of answers would extend their reasoning capabilities.

As the lesson was given in a drawing office, an example of a hydraulic pump was not used as a teaching aid. In the subsequent workshop session, students did, however, strip the pump, identify the components, reassemble and bleed the unit.

4.2.2 Student-teacher language:

The transcript suggests a number of interesting differences between the use of language by the lecturer and the students.

TL *Can you name them? (the parts of the unit) and say where they go?*

SR *Handle on top, pipe out to the ram, on-off valve to the side.*

The response includes no mention of leverage, piston movement or sealed pressure pipe. These points are qualified by me in my next statement. I then ask a poor general question.

SR *What happens if I move the lever causing the piston to move up to the cylinder?*

This is followed by an understandable silence. The question is ambiguous. It would have been better to have asked “Will there be any movement of oil if I cause the piston to rise in its cylinder?” and then asked “What will cause this movement?”. The students had no indication that I was thinking about oil movement. As soon as the group were asked to consider the analogy of the bike pump there was a response.

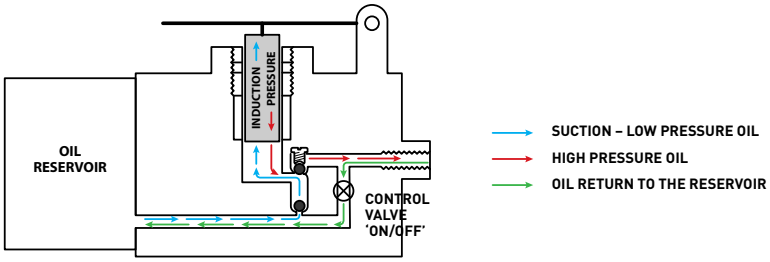
SR *The water is sucked up.*

TR *Yes, the movement of the pump causes a drop in pressure – the water fills this drop. It is the same on this pump only we are drawing up oil.*

I changed the term ‘sucked’ to ‘drop in pressure’ and ‘drawing up oil’. It is at this point, I think, that there is an interesting change in the nature of student language.

TR *What is needed on the handout to enable us to 'suck' up oil?*

SR *A link between piston and oil supply.*



Note the student now refers not to a pipe to suck up the oil but a 'link between piston and oil supply'. This may reflect a response to the nature of teacher language.

5. Questions with a eureka reaction.[3]

5.1 This lesson was a one-to-one tutorial with an adult student, aimed at getting a critical response from her of A level standard to an unseen poem. The work is Essential Beauty by Philip Larkin. My BIAS analysis proceeds past the finish of our discussion of the poem and onto a consideration of how quickly students can learn complex skills. This is a frequent cause of concern for this student, but this section of the lesson is not discussed in the report. The question I have to ask myself is whether, in assisting the student, I contribute enough to the development of her skills, rather than exercising my own. The drift of my argument in this evaluation is that I do not, in my opinion; I still have to learn the lesson of concentrating far more on the TQ and TR, rather than TL.

The BIAS percentages for the 24 minute extract from this 90 minute tutorial are as follows:

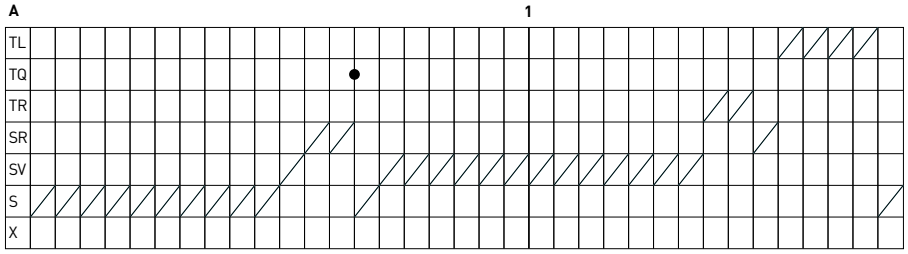
TL	TQ	TR	SR	SV	SS	XX
50%	7.8%	7.9%	15.7%	12.3%	6.5%	–

Whereas it is moderately easy to increase the number of teacher questions, it is impossible to increase the number of teacher responses without more student responses and voluntary contribution from students. But increasing the number of student questions is described as only moderately easy, because old habits die hard and I have a strong tendency to do the work for the student.

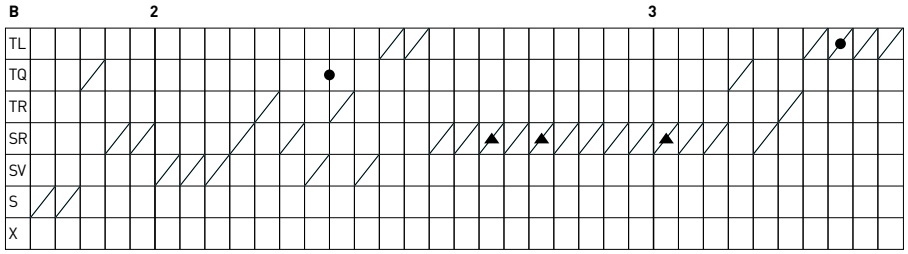
Many of my questions are theoretical and if the student tries to answer she soon finds out that these are being 'chopped'. The dots occurring in the TQ lines where there are no oblique strokes are genuine questions but too brief to be recorded by the 3 second time interval used for analysis. Only two brief questions were not recorded on the BIAS analysis in the extract discussed. With 10 rhetorical questions in the first ten and three-quarter minutes my TL has a deceptively democratic flavour!

[3] Parkinson J South Leicestershire College of Further Education The evaluation of a lesson involving an Advanced Level English Literature student FERN Journal 1 March 1980

5.2 I want to take a closer look at the first seven minutes of the extract, because during this time the student decided that she did not like the poem, and then after persistent questioning, that she did like it. Something useful may have happened.



Before the silence the student read the poem aloud. Then I started recording. The silence lasted as long as she needed, but was a mere half minute! Her comment was "I don't like it". She admitted later that she responds too quickly to poetry and does not read carefully enough. Then she said "Perhaps if I read it a bit more".



The second reading lasted only nine seconds! The she asked "Do you mean it's a picture?". In fact I had not got any specific meaning in mind, I wanted the student to study the poem in more detail.

SR *Well, he says about frames as large as rooms . . . well, why the food? Everything's to do with food, isn't it?*

TR *Motor oil's not food.*

SR *But it's part of modern life, isn't it?*

TR *It's not food though, is it?*

SR *But he likens some of it to food, doesn't he?*

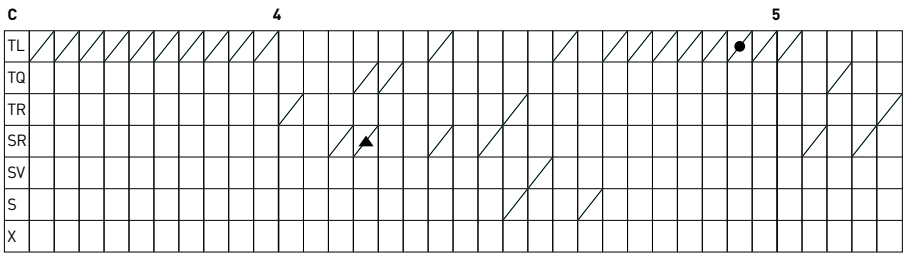
Likens what to food? It may have been helpful to follow up this chance remark.

SV *"Screens graves with custard." I dunno. That's a line on its own, isn't it?*

What did she mean? “On its own.”

TL *Let’s hear you read the first six lines again.*

Teacher feels that the bill boards will come out eventually. Student reads and makes three reading errors, then starts again and reads more carefully. Teacher corrects reading errors as they occur. The student did not ‘read on’ lines 3-4, so the teacher offers to read. Perhaps it would have been better to let the student read again after the teacher. The student needed questions on specific details, for example, “What is blocking the streets?”.



5.3 Teacher reads lines from the poem, emphasising the phrasing and the imagery. For example, stress is given to the surrealist image “A glass of milk stands in a meadow”

At ‘stretches towards’, line 12, student interrupts and asks “Is this the television?”

TR *Come on, come on. A bit more. You’re getting warm.*

SR *Do it mean we’re all absolutely indoctrinated (sic) with the television advertisements and things like that?*

TQ *What advertisements?*

Why this question? I do not know.

TQ *Has it got to be television? Has it got to be television? What other advertisements are there?*

Bad question, but…

SR *In the papers? Oh, I don’t know …. Cube? Is that what …*

Why did she go for that word? Did she think the cube was a television set? Then suddenly the eureka reaction.

SR ***Come on. Read the first two lines and there you’ll see.***

SR ***Oh, bloody Norah!***

TR ***Bloody Norah?***

SR ***Yes, I know, bill boards or things like that.***

TR ***Right kid. You've cracked it. You've got it.***

The recognition of the relationship between images and meaning is not the most profound of examples but for the student it is a connection of great significance.

5.4 Self evaluation of the lesson

The student said she makes up her mind very quickly because she believes she is basically not able to see into a poem. The problem appears to be how to ask questions in such a way that the student ends up doing 99% of the work and gets satisfaction afterwards. In the case of this poem, I think questions which may, on reflection, have helped the discussion of the poem include:

a. What is blocking the ends of the streets?

b. What is this glass of milk standing in a meadow? Or, Why is the glass of milk standing in the meadow?

These questions do not address the issue raised in the first sentence of the previous paragraph. How can a student be helped to see into a poem? This is a complex task that requires precise preparation. Was the image sought the simplest of examples in the poem that could have been selected? Would it have helped to consider the acquisition of complex skills using the poem as an example?

In discussing the lesson with lecturers of other subjects a number of important considerations were identified.

5.4.1 The student spent only a few minutes reading the poem. In one case she spent only 9 seconds looking at the poem and then attempted to guess the lecturer's intentions.

She admitted at one point:

"I wasn't looking into it. I was only seeing it on a first reading."

This is a repeat of the student's earlier admission about 'seeing in' a poem.

5.4.2 The reading process involves the sound and meaning of words, the significance of images and the links between descriptions and ideas. The student does not appear to recognise what the process of reading involves. It was suggested questions on specific metaphors or association could have helped to identify this wider process and help connect the student with the poem. Questions exploring a particular image could have been enriching.

Prompting the initial responses of the student could have been productive. Extending student contributions would have reduced student language and limited the proportion of teacher talk.

The eureka response suggests the student has the ability to read more deeply and the clarification of the questioning strategy would have given the lecturer a greater sense of purpose. The development of the teaching skills does not involve just the increasing or decreasing of language categories.The need is to explore the process of reading poems in all its dimensions.

The lecturer concluded with the following observation. This is the kind of poem where the "penny has to drop". The reader has to pursue various hypotheses, perhaps, before the opening line makes sense. The number of hypotheses a student can assume is determined initially by his or her reading ability. The reference to reading ability identifies an issue central to the reading and acquisition of complex skills.

ESSENTIAL BEAUTY

In frames as large as rooms that face all ways
And block the ends of streets with giant leaves,
Screen graves with custard, cover slums with praise
Of motor-oil and cuts of salmon, shine
Perpetually these sharply-pictured groves
Of how life should be. High above the gutter
A silver knife sinks into golden butter,
A glass of milk stands in a meadow, and
Well-balanced families, in fine
Midsummer weather, owe their smiles, their cars,
Even their youth, to that small cube each hand
Stretches towards. These, and the deep armchairs
Aligned to cups at bedtime, radiant bars
(Gas or electric), quarter-profile cuts
By slippers on warm mats,
Reflect none of the rained-on streets and squares.

They dominate outdoors. Rather, they rise
Serenely to proclaim pure crust, pure foam,
Pure coldness to our live imperfect eyes
That stare beyond this world, where nothing's made
As new or washed quite clean, seeking the home
All such inhabit. There, dark raftered pubs
Are filled with white-clothed ones form tennis clubs,
And the boy puking his heart out in the Gents
Just missed them as the pensioner paid
A halfpenny more for Granny Graveclothes' Tea
To taste old age, and dying smokers sense
Walking towards them through some dappled park
As if on water that unfocused she
No match lit up, nor drag ever brought near,
Who now stands newly clear,
Smiling and recognising, and going dark.

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