HCI matters but does HE teaching skill?

A search for common lessons, and a selection of big and surprising effects in teaching innovations

Following Richard's malicious advice, this talk wasn't written on Sat., wasn't written on Sunday. It has been freshly baked this morning, steaming in the morning air just as dung beetles like it.

Steve Draper, Psychology

For the slides, references, access to the students' work, etc. see:
http://www.psy.gla.ac.uk/~steve/talks/troles1.html

Part A:

Introduction.
HCI vs. Education as themes

Festschrift brief

Chris' brief was to give a talk Phil would like to listen to.
One of Phil's most unusual attributes is that he has taught at all 3 levels of the education system:

- Primary school
- Secondary school
- Higher Education

So my major theme here is an idea from my research field of education: of learning and teaching in HE.
I will argue that there are not 1 but 3 separate functions of a teacher, and ask which has most effect.

However this occasion has made me think about, and notice, some connections with HCI and computing science in general:
This is the minor theme in this talk.

Work only on the bottlenecks

In the 1970s some Unix guru said as a dictum that if you wanted your code to run faster it was no good polishing it all: you had to find the 10% of the code which accounted for 90% of the execution time and focus effort only on that.
Nobody who loves theory, good practice, principles would ever say that. But applied scientists, who want things actually to work better, should take this as the first commandment.

It is actually a principle that applies widely in applied fields.
e.g. Parisitology

What about in education?

In search of what makes a difference

When I finally, rather recently, came across an education paper that was reasoning like this, I woke up.
Much of the time I've spent looking at theories of the LTP (Learning and Teaching Process).

To advance theory, finding unexpected effects and working to explain them is the way to go.
For instance the mind boggling papers showing that where a student sits in a lecture theatre causes a difference in their final course mark.

This is amazing, worrying, and interesting. But the effects are not very big: this is not a bottleneck, significant as it may be for theory, and interesting as an anecdote at a festschrift.

In search of what makes a difference (2)

So: never mind theories: what is most likely to make a difference, rather than to describe and explain what goes on?

Actually, theory is so weak in this regard that no-one knows where the bottleneck is. So a first clue is to scan the literature for the biggest demonstrated effects (improvements in learning outcomes). The bulk of this talk is a tour of some truly big effects in education, starting with the least and working up.

But first: do teachers even make any difference anyway?

Part B:

Do Teachers make a difference at all?

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Effect no.1: Learning not organised by teachers

Allen Tough, a Canadian researcher active in the 1970s, (http://allentough.com/) looked into:

How much learning adults did:

- 90% had done at least one project in the last year
- Average 5 projects per year
- Average hours per week: 10

How much of it was independent of courses and teachers (about 4 out of 5 projects).

But also notable is that almost no-one at first said this: they actually didn't realise that this was serious learning, and largely self-directed and self-managed.

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Allen Tough's Adult learning projects (2)

Definition: any period of time in which your primary motivation (over 50% of the motive) is to gain and retain knowledge and skill.

(N.B. very many of these are for practical reasons, but you pursue the eventual practical end through spending time first directed at learning.)

Spend a few minutes writing this down (then we'll do some sharing):

How many such projects have you done in the last year? Start writing down the ones you can remember; and if possible, a guesstimate at how many hours altogether you spent at it.

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Allen Tough's Adult learning projects (3)

Tough and his followers have found a similar pattern in samples from age 16 to 60.

Clearly people have no trouble doing learning, nor in managing their own learning, and more often than not do not find organised teaching (courses) the most useful for their purposes. LifeLong Learning is not new, and doesn't seem to need help.

Most of the literature turns its back on this;
Just as drug companies might prefer you not to compare the effect of their drug with the effect of giving no treatment at all.

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Effect no.2: General effect of teachers

According to Dylan Wiliam:
The biggest causal factor in most studies, is which teacher a child gets: differences (in learning outcomes) are almost always more affected by which teacher than by whether you get the "new" or old teaching method in an experiment.

It will make more difference to a child whether they get the best or worst teacher in a given school, than whether they go to the richest or most "deprived" school in a region.

And most of this depends only on how many years experience the teacher has.

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Implications: the effect of teachers (2)

Since teachers can only get experience by practising, there is no way to give every child a good teacher.

=> The important aspects of teaching must be, not conscious knowledge, but a tacit skill.

=> It implies that teacher training may be useless:
If we knew what good teaching was, then surely we could teach it to teachers and avoid the dependence on experience?

When we do experiments on teaching methods, we should use as a scale, the size of change that teacher experience makes.
Methods with as big an effect are important….

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Part C:

Delivery / implementation / execution

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Role 1 of teaching: Delivery. The "Dr.Fox" experiments

There have been experiments on whether lecture delivery skill made a difference to learning.
Hired an actor; fixed the script; had it delivered with high or low "expressiveness".
But also, tried it on 2 groups: students who expected to be tested, and students who did not.

If they thought they had to learn it, it made a difference to their ratings of the lecture but not to their learning (test scores);
If they thought they didn't have to learn it, then the well delivered lecture caused higher learning.

So in HE, student will power overrides teacher delivery lack of skill. Good delivery is good professional practice, but it isn't a bottleneck to learning.

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Neo-Vygotskian arguments

There is another type of "delivery" that may be important, but I haven't seen direct evidence about it.
Vygotsky's argument about child development was that every important pattern of thought begins with a type of conversation with, and scaffolded by, and adult. Gradually the child takes a bigger and bigger role, and finally internalises it to do it solo.
It is a very big leap to suggest this is relevant to HE. But …
Showing students types of thinking, problem solving, not knowing stuff but being a programmer, a psychologist, ….

The real role of a tutor: not marking work and being a walking FAQ repository, but doing pair programming with a student, …

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Part D:

Learning activity design

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Learning activities

Most of the education literature is about the effect of differently designed activities on learning. Designing these is a second, different role for teachers (than delivery / execution of these activities).

Here are some massive published gains from changing the design of the learning activity.

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Hake

Hake (1991): "The results [course feedback] showed quite clearly that my brilliant lectures and exciting demonstrations on Newtonian mechanics had passed through the students' minds leaving no measurable trace. To make matters worse, in a student evaluation given shortly after the exam, some students rated me as among the worst instructors they had ever experienced at our university. Knowing something of the teaching effectiveness of my colleagues, I was severely shaken."

So he went looking for better ways to teach physics …..

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Hake's survey

Hake (1998) published a survey of 62 courses (6,542 students) all studying the same subject, all using the same standardised test, and using it both pre- and post-.

He graphed the mean gain on each course against whether or not it had used the method of "Interactive engagement".

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See fig. 1 in:

Hake,R.R. (1998) Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses Am.J.Physics 66(1), 64-74

Hake's results

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Mazur

Crouch & Mazur (2001) published an analysis of 10 years of Mazur's MIT course.

Again, the standardised pre- and post-test.

He concludes he has doubled the amount of learning, but the graph suggests that really, he tripled it.

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See fig.2 in:

Crouch, C.H. and Mazur, E. (2001), "Peer Instruction: Ten years of experience and results" American Journal of Physics 69, 970-977

Mazur's gains

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The learning design

So more effective teaching can be achieved.

"Interactive engagement" and "peer instruction" revolve around asking students questions. These may be presented using Electronic Voting Systems (EVS).

But what kind of questions? Brain teasers.

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Brain teaser questions

The point is to provoke debate, internal and between peers.
Cf. Socratic questioning, and "catalytic assessment"

Remember the old logo or advert for Levi's jeans that showed a pair of jeans being pulled apart by two teams of mules pulling in opposite directions. If one of the mule teams was sent away, and their leg of the jeans tied to a big tree instead, would the force (tension) in the jeans be:

- half
- the same
- or twice what it was with two mule teams?

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Typical test scores

Summative achievement scores

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Carroll and Mastery Learning

In 1963-1980 the work by J.B.Carroll and then Bloom showed the irrationality (and damaging nature) of the standard attitude that school tests measure ability.

If you assume the learning and teaching must be constant, then the spread of test scores looks like a measure of learner ability.

But (they showed) if you vary the time and/or teaching method, then the spread largely disappears: so the former spread can't be a measure of learner limitations.

ML set out to give every learner the experience, not of praise, but of objective success.

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Carroll's view of the determinants of learning

J.B.Carroll's view, backed by experiment, was that learning outcomes depended on all 5 of these factors i.e. is a function of 5 variables (not on a single learner attribute):

1. Time allowed
2. Perseverance
3. Aptitude
4. Quality of instruction
5. Learner's ability to understand the instruction

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Mastery learning scores

Summative achievement scores Mastery learning scores

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The argument

Mastery Learning (ML) rests on the view that if the only tests a learner gets show differences between learners (but without comparing different teaching methods, learning actions, time taken, ….) then everyone tends to interpret them as about learner abilities.

What is poisonous about standard school and university teaching is to vary only the learner: so we are almost forced to interpret marks as about their ability. To learn effectively, instead, they need to monitor their learning after a first pass, and correct it: a totally different use of tests, with different stance on capabilities.

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Mastery Learning: the method

Mastery Learning demonstrated the same effects as the recent published studies mentioned above, more widely, 25 years earlier, using similar methods.

- Telling the students not to interpret formative tests as ability measures
- Giving them highly specific suggestions about how to improve, and the occasions to act on this.
- Showing confidence in them, based on most of the class succeeding
- Giving them the experience of success on objective tests
- I.e. basing assertions on evidence not empty words

One difference was that the first and original aim was to to change the mindset teachers have about learners: to convince them that almost all learners can succeed, and that exams are NOT there to label student performance as a measure of capability.

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Part E:

Learning content design / Curriculum design

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The final case from the literature has the biggest effect.

It isn't about delivery or a clever activity, it is about a change in what the learner is given.

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Creating knowledge: Chick sexing

To be learned: sexing day old chicks (for the egg industry)
Viewed as an implicit skill: some people could do it, but couldn't tell you how to do it yourself.
Training used to take 6-12 weeks to get a person up to speed and accuracy for useful employment. Method was loads of practice, feedback from an expert.
Then researchers worked on creating an instruction leaflet (pictures, some text). Trainees learned more in 1 minute from the leaflet than in the previous 6-12 weeks.
This is an improvement of about 26,000 times.

So discovering the knowledge, articulating it, and expressing it in a leaflet can be very valuable: one role of a "teacher".

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Interpretation

When I presented this to my education option class, they said it was training not education and they didn't see it as relevant for HE. But …

- It is about representation: and about articulating what was tacit
- A minimal manual for chick sexing
- The leaflet turned out to be more powerful than hands-on practice and personal tutoring.
- I've started to have some success with exercises of my own that try to make explicit the skills our graduates need e.g. critical thinking.
- Our culture, science generally, fails to give credit to improved representations of knowledge even when very important:
  - Calculus notation
  - Maxwell's equations in Cartesian notation vs. div and curl

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Part F:

Conclusion

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Teachers making a difference

Teachers clearly can make a big difference to learning;
but not in the way almost everyone automatically thinks almost all the time. It is mostly not the face to face contact ….

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3 roles of teaching

(Academic jobs are typically expressed as having 3 kinds of work: Research, teaching, administration.)

But in fact, teaching has 3 facets.
And a person might be excellent at one, yet rubbish at another.
I.e. good teaching is not a single thing

- Delivery e.g. lecturing, facilitating discussions.
- Knowledge selection and expression.
  Selection of topics; selection or authoring of materials
- Designing learning activities.

Cf. TEA

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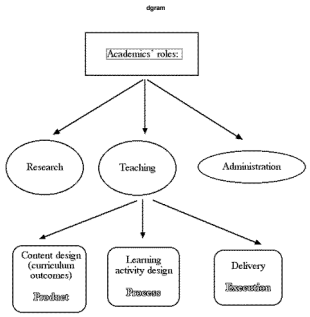

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My question to you

How do you each think we should / could generalise from the chick-sexing case to ways of making a big difference to learning in other topics?

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A place to stop

For the slides, references, etc. see:
http://www.psy.gla.ac.uk/~steve/talks/troles1.html

And also the wiki pages my students did this semester: they will cover the references you might need to follow up this talk, and have other interesting topics besides ….
You may login as guests.

http://fims.moodle.gla.ac.uk/mod/wiki/view.php?id=11826

Or try my entrance web page and link to "CERE"

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