# CERE slideset 2:

Concepts and Empirical Results in Education

## S2: Chi 2008: and related topics:

Jigsaw; contingent tutoring, Bloom's argument on directing applied research through effect sizes

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## Part A:

## Chi (2008): a major paper

I think this is a top-value paper: not only technically sound, but provokes thinking in many directions, some of them threatening my own views; many of them already touched on in this course.

I will be working on this for a long time from now.



## Bloom's 2-sigma argument (1984)

His question was: what should he now do research on, to increase learning in schools?

1. He did some studies with 1:1 tutoring compared to ordinary school classes; and showed a 2-sigma improvement

(I.e. a Cohen's d effect size of 2 for improvement in the amount a child learned.)

2. He had showed that Mastery Learning gave a 1-sigma improvement (one of the BIG effects mentioned in this course).
3. => So he concluded he needed to look for another intervention that would close the gap of one more sigma improvement.

The tutoring demonstrated that it was psychologically and educationally possible to get 2-sigma. A proof of possibility.
But this is economically NOT possible: hence more research.
Go (in applied research) for the biggest effect size: this is what benefits the most people by the biggest amount.

## Chi — Intro

Chi's argument structure is in part explicitly like that of Bloom (1984) in his 2 sigma paper. Effect sizes, using 1:1 tutoring as the benchmark, and looking for other cheaper interventions to achieve as-good results; but because cheaper therefore possible to use on many more learners.

Firstly: she claims that having learners watch a 1:1 tutorial on video is as effective as being the 1 learner with the tutor. (And, following Bloom, that this is probably the best possible teaching.)

If this is true AND if it generalises to other cases (than working on mechanics problems) then it will be **massively cost-effective** and we should be rolling it out (can't think of any better change to learning and teaching in HE).
Could we replace level 3 tutorials with this??



## Student "Jigsaw" discussions

about Chi et al. (2008)

(4 phases to come)



## Phase 1: Assemble in your Reading Groups (A, B, C).

a) Make a list of questions about what (none) of you understand about your topic.

b) Make a list of questions you want to ask about one of the other 2 groups' topics, "Group X's", when you get to talk to them.

c) Make a list of questions you want to ask about the other of the groups' topics, "Group Y's", when you get to talk to them.

## Phase 2: Assemble in your Discussion Groups (1 – 5?).

a) Ask / answer questions about the topic assigned to ReadingGroupA.

b) Ask / answer questions about the topic assigned to ReadingGroupB.

c) Ask / answer questions about the topic assigned to ReadingGroupC.

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## Phase 3: Re-assemble in your Reading Groups (A, B, C).

Did your questions get answered about:

a) Topic0?

b) ReadingGroup A?

c) ReadingGroup B?

d) ReadingGroup C?

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## Phase 4:

## Plenary discussions / debrief

about Chi et al. (2008)

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## Part B1:

## Introducing the Jigsaw Design

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## The Jigsaw learning design

The homework and class discussion process which you have just carried out were inspired by a recent paper, Benton (2016), on adapting to HE the Jigsaw design.

This was the work of Aronson (1978), first developed for and used in USA schools.

You are next going to hear how Sarah Honeychurch used it in this university in first year philosophy tutorials.

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## Key features of the Jigsaw design

The fundamental difference between a Jigsaw design and *conventional teaching* is that the learners, not the teacher, function as subject matter experts and the source of knowledge.

The fundamental difference between Jigsaw and *other methods of group work* is that each learner is a member of two different, cross-cutting, groups: a jigsaw group for reciprocal teaching/discussion and an expert group for preparing the teaching they must do themselves.

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## Recipe: Aronson's Jigsaw classroom

Aronson and his graduate students developed the Jigsaw Classroom learning design, originally for a special purpose: tackling the problems when US schools were forcibly desegregated. How to get the different groups of kids to work together, and stop destructive competition.

Basic answer: Make them depend on each other. Their only access to the knowledge on which their marks depend, is from other kids teaching them. Split the class into groups, each specialising on one part of the curriculum; prepare materials; present.

But this has other good effects. One of the biggest is that the work they produce is of real value to others: whereas normally all student work is artificial, with no end user.

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## Aronson's actual design (2)

The students in a history class, for example, are divided into small groups of five or six students each. Suppose their task is to learn about World War II. In one "jigsaw group", Sara is responsible for researching Hitler's rise to power in pre-war Germany. Another member of the group, Steven, is assigned to cover concentration camps; Pedro is assigned Britain's role in the war; Melody is to research the contribution of the Soviet Union; Tyrone will handle Japan's entry into the war; Clara will read about the development of the atom bomb. Students are then tested on what they have learned about World War II from their fellow group members.

To increase the chances that each report will be accurate, the students doing the research do not immediately take it back to their jigsaw group. Instead, they meet first in "expert groups" with students who have the identical assignment (one from each jigsaw group).

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## Dimensions of Aronson's version

- *Each person is a member of not 1 but 2 groups
- Total number of learners ≈ 20-30
- Group sizes are both ≈ 5

  (self-teach, and reciprocal-teach)
- No ICT / VLE used.
- Done every 1-2 class meetings; repeated over the term
- School (not HE) level

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## Part B2:

## Sarah Honeychurch:

## Using Jigsaw in first year Philosophy tutorials

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## Part B3:

## Wrapping up the Jigsaw Design

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## Jigsaw wrap up

- Aronson's jigsaw design was developed for and used on USA schools.
- Sarah's is an adaptation to HE philosophy tutorials in Level 1.
- Steve Draper's PosPsy course follows the general idea by having students create learning materials for other students in the class, but in effect only insists on phase 1: finding the knowledge and creating materials for peers.
- Benton's (2016) is an adaptation to HE Business school courses, both undergraduate and postgraduate.
- Today's exercise in CERE attempted to get phase1 done before class; and phase 2 (presenting / assisting peers) done in class. It followed Benton in stressing question-answering rather than

## Part A3:

## Further aspects of Chi (2008)

## Beyond the introductory aspects addressed in the homework and Jigsaw discussions

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## Chi (2)

**Constructivism**.

She doesn't use the term much, but has for most of her career focussed on one particular interpretation that could be seen as "how to teach/learn following constructivism": self-explanations. i.e. the benefit to learning of getting learners produce explanations themselves.

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## Chi (3)

**Scaffolding:** This is Wood et al.'s term, but Chi means the tutor tactic of prompting by a question to elicit an explanation.

Cf. My notes under constructivism (2)

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## Chi (4)

This is consistent with the data of Mazur, Miyake, Howe, and of course Chi's earlier work establishing "self-explanation" as a key issue.

And with the **Piagetian** interpretation that peers are the social stimulus that prompt learners to generate explanations (whether voiced or not); and it is this that causes learning.

A tutor is only effective to the extent they mimic this effect.

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## Chi (5)

She uses her data to argue that these videos are most effective when the best students are in them (not intuitively obvious). Effective on viewers (vicarious learners i.e. watching the video), whether the viewer is a good or bad learner.

And she presupposed (from her earlier experience) that the best tutor would be best.

This suggests an element of **learning how to learn** from them: cf. Ann Brown and the Jigsaw classroom; and certainly not just getting the answers, or even getting the procedures.

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## Chi (6)

Neo-Vygotskyian ("socio-cultural theory").

Is it the **style of conversation** that is being learned, disseminated, picked up and internalised??

Is it important that it is watched by pairs (of peers) and NOT solo? Yes. Why?

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## Chi (7)

**Orsmond & Merry**: good and bad learners do different things with feedback. Is this why tapes of good learners are more effective, even on bad learners? Seeing how to use input from the tutor better or worse?

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## Chi (8)

**Anti-feedback** message: embarrassing for me, having worked on improving feedback.

Chi says she's shown that whenever the tutor gives feedback in the normal sense of the term: telling them where they went wrong and what they should have done, learning is reduced; at least for "bad" learners, though not for "good". (This is consistent with Orsmond & Merry.)

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## Chi (9)

Challenges my interpretation of **contingent tutoring** (Wood et al. papers).

Her findings are consistent with theirs; but I want to build on it to say that contingent tutoring is optimal and so should be emulated everywhere.

She, however, implies that it's too hard to do; and with real tutors (even pretty good tutors in ideal 1:1 conditions) they just don't understand well enough where the learner is. Instead, generic tactics of eliciting explanations from learners is what works best.

Tutoring (delivery) is just too hard for most real teachers.

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## Chi (10)

But possibly, that is just the coarseness of her data analysis.

Perhaps really the tutors do show understanding of the learner; and the learner picks that up; and if they didn't perceive the tutor as understanding, then they would be less stimulated and less learning would be prompted.

It is possible to interpret Beebe's work on contingency to support my argument here.

(Beebe analyses, frame by frame, film of mothers and very young infants; and shows 2-way contingency, not transmission or domination in either direction.)

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## Chi (11)

**Deep and shallow** learning distinction.

Uses only measures of deep learning in her analysis.

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## Part B:

## Contingent Tutoring (Wood)

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## Contingent tutoring

Wood et al. (in 3 papers) report experiments to establish the optimal tutoring technique, which they called "contingent tutoring" (c-tut).
("Contingent" means 'logically conditional upon' some aspect of the situation).
Although applied to young children in a task like a 3D jigsaw, I see this as an exemplar and yardstick of ideal teaching.

C-tut means adapting the level of the tutor's suggestions continuously depending on whether the learner is succeeding or failing. The more they fail, the more the comments are made more and more specific and concrete (put your hand there ….). The more they succeed, the more abstract the comments should become (what about doing a corner next).

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## Contingent tutoring (2)

Consider showing a newcomer the way to a place; or receiving such instructions. If I let myself be taken somewhere, I often don't remember the route. I need to be trying to take the decisions, while having a lot of guidance.

When I really want someone to learn a route, I constantly stop; have them look round and tell them where they are; etc.

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## Contingent tutoring (3)

The data supported Wood et al.'s theory.

An interesting additional observation was that the c-tut, although the best tutoring method, appears to be unnatural. It is not seen in care-givers; and the research assistants, even though hired and trained to apply c-tut, nevertheless were not very good or reliable at it.

It is <u>not</u> being as helpful as you could be: which is unnatural.

But actually, it is being unhelpful about speedy and accurate **doing** (of the task), but is (if we follow Wood) being helpful about **learning**.

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## Contingent tutoring (4)

It is interactive.

It means Teachers adapting their behaviour continually to the individual learner.

It was applied to a procedure (building a jigsaw), not to declarative content e.g. learning facts. As argued earlier, procedures may be hard to learn otherwise because so many things all have to be right for them to succeed. In c-tut, the teacher holds the overall activity together even when the learner hasn't a clue about its purpose and structure.

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## Contingent tutoring (5)

Many (HE) teaching practices only work for learners at one fixed level of competence: c-tut reminds us that in general, we need one kind of behaviour (highly scaffolded, "spoon feeding") at first / for novices, and quite different kind (a few high level hints) later on / for expert students.

C-tut seems therefore to imply that:
Treating all students the same,
or having the same timetable and support throughout a year are therefore
NOT fair, good, "equitable"
BUT bad teaching.

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## C-tut : why it seems so important to me

It connects with my experiences of good (and bad) <u>tutoring</u>.

It is thoroughly <u>constructivist</u>: based on building only on what the learner can do, and attentively re-adjusting that all the time.

I see <u>contingency</u> as a key feature: and this is its origin.

It suggests, what is continually mistaken in HE, that how you teach a learner when they know almost nothing is entirely different from how you teach a learner who just needs to correct the last bits of their expertise BUT these are two ends of a continuum. Many, many activities can only deal with learners in one part of that continuum.
We must teach the top and the bottom of a class quite differently. Being egalitarian is simply ineffective and bad teaching.

## Treating learners differentially (cont.)

Wood's original c-tut work was on learning a procedural skill, rather than (declarative) facts and concepts.

But the same applies. A lecture may be all new material, but different learners will have different amounts of pre-requisite knowledge to root the new material in: requiring different teaching.

In GU level1 classes, you get seriously different levels of prior exposure to and knowledge of material.
But ALSO you get very variable levels of keenness / motivation / amount of work.

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## Does contingency matter?

Doesn't Chi08 show that watching a tutor is as good: a tutor on video cannot be interacting contingently with the learner (in the normal sense).

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This implies a limit to the importance of c-tut as a key contribution of human teachers. How can this be?

- It may be that learners, especially HE skilled learners, can tolerate quite a lot of too-detailed input from tutors and lecturers by focussing attention on just those parts off what they receive which correspond to their individual needs; i.e. they are "contingent listeners / readers" whose attention is made contingent on what is useful to them at that point.
- And c-tut may be most important for learners at the very early stage of a new topic, but later on (with contingent listening) they don't need the teacher to be contingent.

## Part D:

## Chi: recap

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## Followup on Chi et al. 2008

Here are a few points correcting or following up:

- The tutoring condition was 1:1 (not 1:3 as Bloom's tutoring study was).
- Her definition of good vs. bad learners was measured by attainment of the learning of content on the pre-test BUT amounted to a measure of how fast they learned from reading the text book before the "pre-test".
- Chi is looking at basic undergraduate learning; but should apply to all HE learning. Less dependence on a teacher, and on personal attention from a teacher, is right in line with the essence of school to HE transition.

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## Followup (2)

- The topic was maths: what about other disciplines?
- a) It was procedural skill learning (not declarative facts), so wouldn't apply to all learning.
- b) Yet in fact most disciplines involve this: e.g. creative writing is a complex skill, and the exercises learners get there are not unlike maths exercises ....
  GU psych: L3 modules vs. tutorial groups. The modules have no tutoring; but the tutorial groups offer some personal tuition for the general procedural skill of writing psychology essays.
- What if a learner wants to ask the tutor a question (can't do that to a video)? But just because a learner wants to ask, doesn't mean that that is best for them. Contingent tutoring and constructivism both stress that learning comes not from answering their question but from forcing learners to work the answer out (though perhaps from hints or abstract prompts).
  So the emotional intuition behind this point is wrong. But the important question becomes: can learners work out what they need from the video? Chi's data suggests: usually yes.

## Chi et al. (2008) recap

Skilled tutoring seems to be where teachers can make a big difference.
It requires personal attention, and group sizes of 1-3 (expensive).

Chi thus links to what the value of Teachers is.
And to contingent tutoring and to scaffolding, and to all feedback and its role in learning.

But Chi (08) seems to show that, after all, teachers are NOT necessary: it is the peer interaction, guided by the worksheet, and with the video of a tutor (one tutor per language, not per child). So Chi links to another huge theme here: the learning benefits from peer interaction, which seems here to be at least as important as personal tutoring.

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And also to constructivism.

## Conceptual links with Chi2008 (as a list)

Chi et al. 2008 on videos of tutoring connects to:

- Bloom's "2 sigma" argument structure.
- Mental processing by L is the biggest part of learning.
  Self-explanation ≈≈? "catalysis" (Draper, 2009)

- The roles & value of teachers (from session 1, and continuing)
  Tutoring: part of role 3 (delivery) of teachers
- Contingent tutoring <—> scaffolding
- Feedback; all feedback. How important to learning is it, actually?
- Constructivism (social constructivism)
- Deep learning (vs. surface / shallow learning)
- Peer interaction (vs. Teacher interaction); what is its value?

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## Overall Recap: Today's major topics

A. Bloom's argument about:
   1. Directing research to large effects on learning
   2. Seeking cheaper (less teacher-intensive) methods in order to reach more learners

B. Chi's L-design of "observing collaboratively": one method of peer interaction with strong learning gains

C. The Jigsaw L-design: a different kind of peer interaction for learning

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## A place to stop

For the slides, handout etc. see:

http://www.psy.gla.ac.uk/~steve/courses/cere.html

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