The research teaching nexus in the computing disciplines:
a comparative study

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Many institutions make claims in strategy documents and official publications that students will receive an education which is research-led, research-informed, or guided by the scholarship of teaching and learning. Academics who teach regularly experience at first-hand the sometimes conflicting demands of research, teaching and supporting learning. Curricula guidelines are unlikely to help in developing any sophisticated understanding of ways in which research and teaching can be symbiotically applied, since such guidelines most typically deal with the content rather than the educational process experienced by our undergraduates. For these reasons an academic's understanding of the research teaching nexus is more likely to be informed by their own workaday experience of designing and delivering educational experiences than from an analysis of the students' perspective. If academics in the computing disciplines are to effectively deliver on their institutional missions to be scholarly, research-led or research-informed in their educational approaches, a clearer understanding of the possible meanings and implications of these terms in the context of the typical computing curricula would be of assistance. This paper presents and analyses the results of a survey conducted at two Universities which sought to identify how far their undergraduate curriculum was informed by research. This data is presented alongside qualitative data gathered from academics which explores their attitudes towards, and understanding of, the various terms commonly used to describe a research-informed approach to education in the computing disciplines.

Research and teaching

"In universities, learning should not be [defined] in terms of the passing on of well established knowledge, but always in terms of not yet completely solved problems."

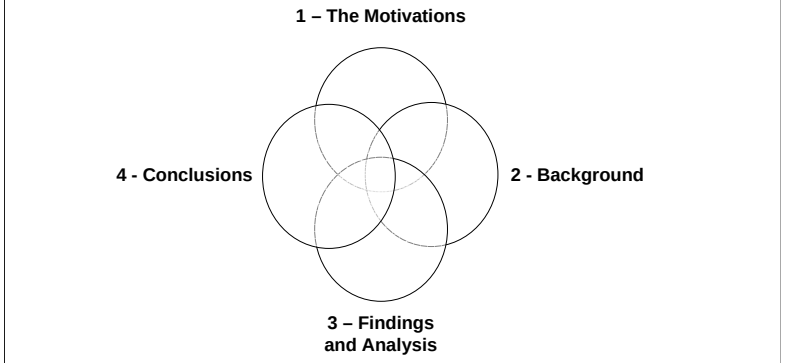
Humboldt, 1807
Thanks to Lewis Elton

SoT&L + CPD = R&T

It will be 200 years in 2007, since Humboldt laid down the programme for the new University of Berlin, which – on teaching and learning - included the statement:

"In universities, learning should not be in terms of the passing on of well established knowledge, but always in terms of not yet completely solved problems."

Shape of this talk



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Plan for the order of presentation

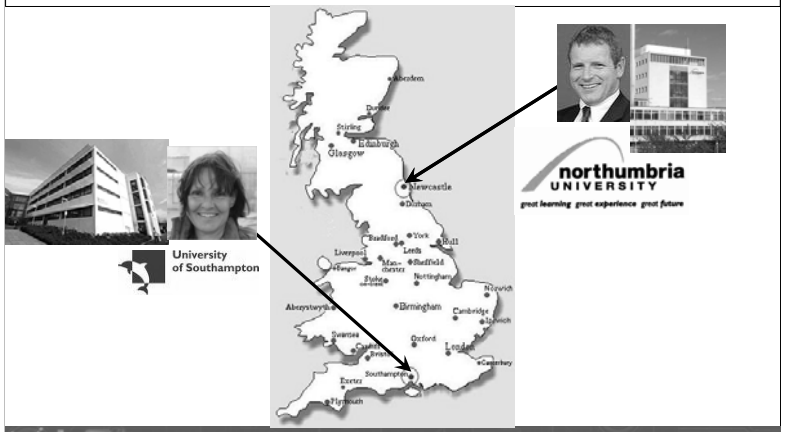
Motivations – why we are motivated to be interested in thi

Background – previous work

Method, Findings and analysis

Conclusions, discussion and future work

Collaborate and compare



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Distant universities. Also quite different

Soton – research intensive, CS, SE

Northumbria – Forensic Computing, Games Computing, Business Computing, some part time

Common beginnings …

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We all have students

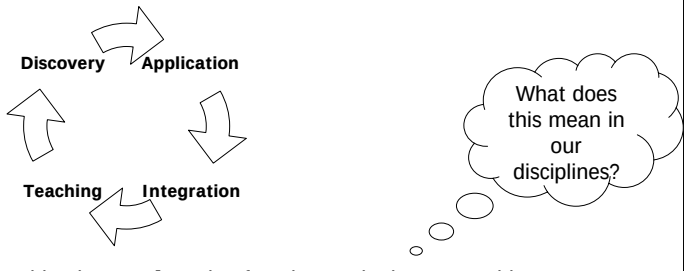
And – relationship between R&T is on the agenda for both (soton and Northumbria)

Also on the agenda for every institution

But I believe the relationship between R&T is of interest to all in our discipline

Half life of information, information age mindset, and ref back to Humboldt

Scholarship's four domains



"[Teaching is not a] routine function, tacked on, something almost anyone can do. When defined as scholarship, teaching both educates and entices future scholars"

Scholarship Reconsidered, Boyer 1990
Reinventing Undergraduate Education, A Blueprint for America's Research Universities
Boyer Commission 2000 http://naples.cc.sunysb.edu/Pres/boyer.nsf/

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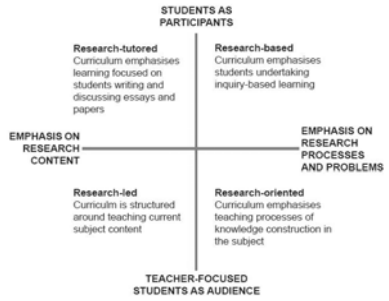
Carnegie foundation, debate over the future of of University education – with which we can see parallels to the arguments so current in SIGCSE and CPHC and ? European fora about the future of our discipline – requirements of agaility, nature of graduates, how to retain etc

Curriculum design and the research-teaching nexus



Healey, M. (2005)
Linking research and teaching: disciplinary spaces

Enter politics and educationalists in the UK??

Community concerned with the scholarship of teaching and learning

Many universities are not research intensive

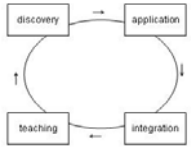
Many university teachers are not active researchers

Some feel that the Boyer perspective draws people towards a simplistic model where the relationship between research and teaching is typified by I research, I teach my specialism and I supervise project students, so my teaching is research led

Maybe this has something to do with the nature of our discipline

Comparing two models

Start with the academic?
Scholarship of education

Student Experience (Boyer)	Curriculum Design (Healey)		
	Students as Participants		
	**Research-tutored**	**Research-based**	Processes and problems
	Curriculum emphasises learning focused on students writing and discussing essays and papers	Curriculum Emphasises students undertaking inquiry-based learning	
Research content	Curriculum structured around teaching current subject content	Curriculum emphasises teaching processes of knowledge construction in the subject	
	Research-led	**Research-oriented**	
	Student as Audience		
Adapted from Boyer's Four Scholarships [7]	Adapted from Healey [24]		

Start with the student?
Curriculum innovation

Put the models side by side they are quite different.

Tried to do matrix but not yet completed my thinking (aside) – matrix will feature in journal version of paper alongside additional data

cf – Kolb and bloom

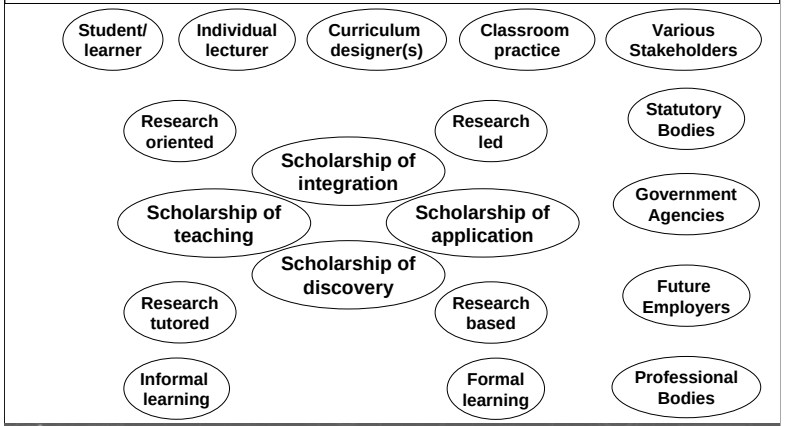
1 concrete experiences

2 observation and reflection

3 forming abstract concepts

4 testing in new situations

Multiple perspectives



Tutored, based, led, oriented

Fours scholarships

The R&T nexus as it is experienced

Stakeholders and agendas are also an issue

Learning is both formal and informal -> life long learning, and back to information half life, and the net generation, millennial generation

GenX GenY,

Classroom practice

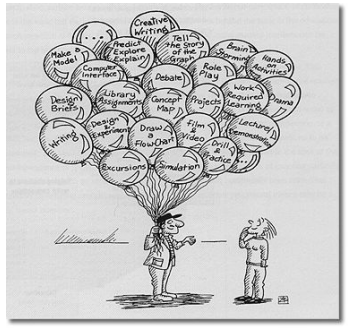
Knowledge, skills and understanding

Domains of learning

- Cognitive (knowledge)
- Affective (attitudes)
- Psychomotor (skills)

Other Considerations

- Student's journey
- Curriculum map
- Disciplinary demands



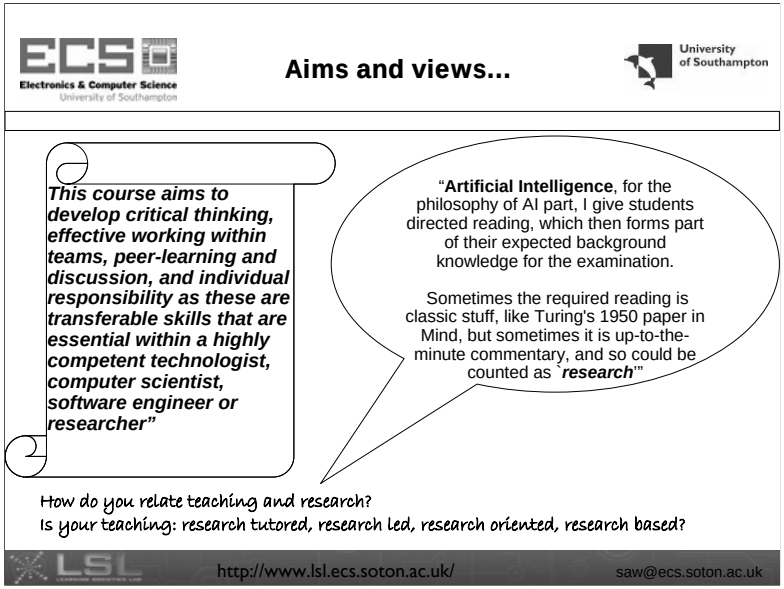
http://www.discover.tased.edu.au/sose/essay.htm

Think about the affordances of the means of instructions

What we can do, and how we can teach will be constrained/enabled by the space

Also, although we mostly consider education from the perspective of the cognitive domain (bloom's taxonomy) we need to remember that there are components of our UG teaching which operate in other domains, affective and psychomotor (crude definitions of attitudes – what it is like to think as an engineer/computer scientist) and psychomotor – who to manage a computer environment -> relates to disciplinary demands and field of study

Iterative refinement of understanding, training>eucation



Something about the method

Surveyed two departments

Examined the curriculum, module descriptions, stated aims and outcomes

On a larger scale study might be possible(?) to quantify, although there is a gap between formal description and what actually happens in the class

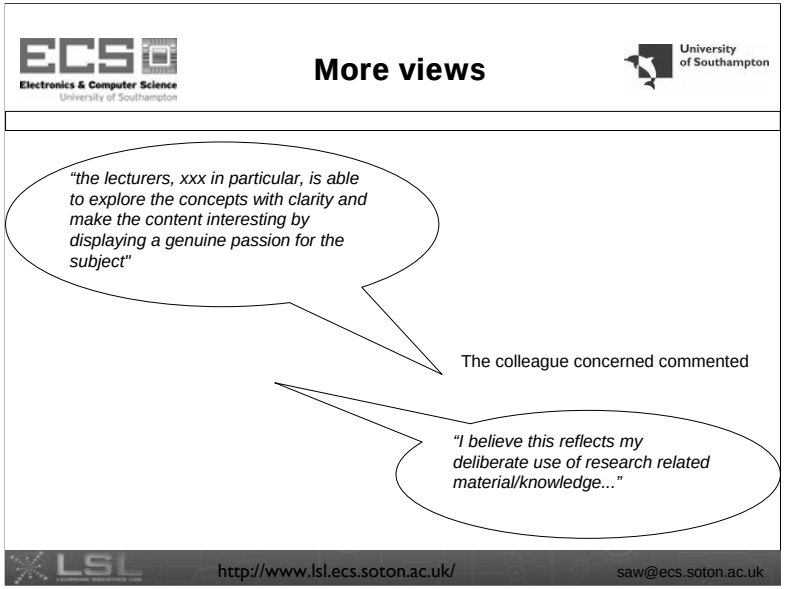
Surveyed colleagues to ask them what they considered to be

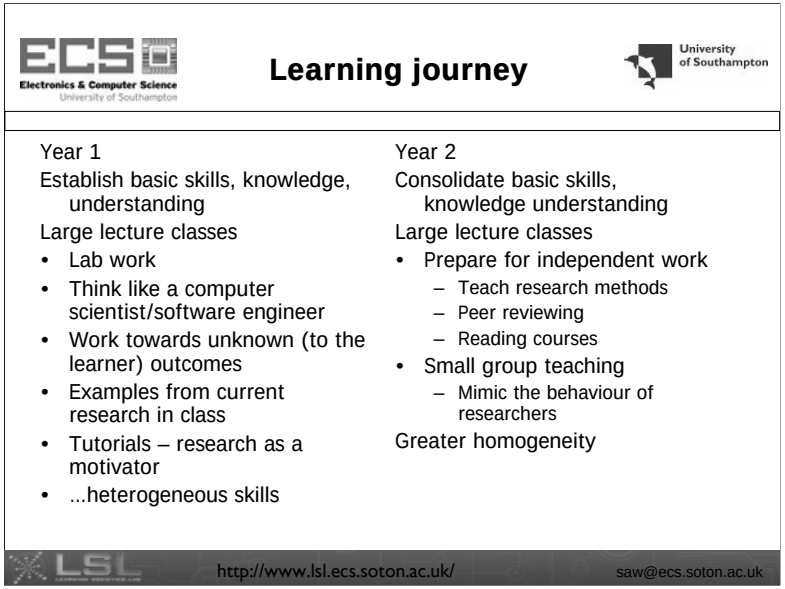
Research tutored, research led, research oriented, research based

Active researchers tended to relate things back to

How they research, what matters to them as researchers, classroom techniques they are proud of

Ref – my freshman year





Many examples were necessarily left out

3.1 First year

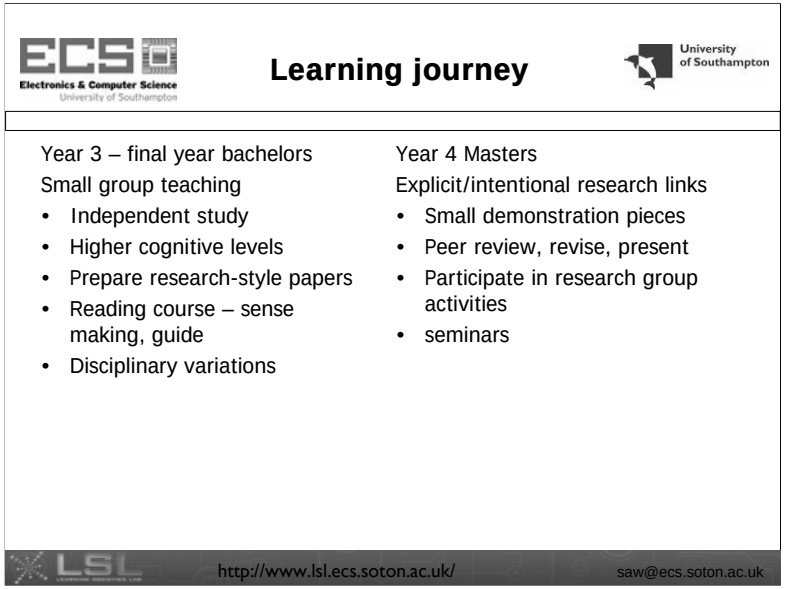
Typically modules are concerned with establishing the basics. Teaching approaches include large lecture classes, with laboratories to learn, practice and master programming. Students may be given problems to solve but they are typically expected to use this stage of their education to master basic skills. However it is possible to view lab work as an introduction to working as an engineer, since students are receiving instruction in a format which is designed (for them) to work towards attaining unknown outcomes. On many degrees there is an element of undergraduates learning how to become computer scientists/software engineer, and part of that education is learning how to think like a computer scientist/software engineer. This aspect of learning how to think and behave is particularly exercised by activities which are open challenges – often goals which may be addressed by students who are demonstrating more advanced levels of achievement in assessment. Many colleagues expressed the view that there are little or no realistic opportunities at this level of study for the students to be actively involved in producing research results, or undertaking activities which were a proxy for research. In many basic modules colleagues considered that there was no realistic opportunity for teaching to be research related. A number of colleagues did however explain that is some courses (for example data-structures and algorithms) they may typically give examples of their own or others cutting edge research in order to demonstrate concepts and make the subjects covered more interesting to students. Such and approach was also used in order to communicate an excitement for the discipline as a whole. In one example, students were given the opportunity to find out about current research as a task within their professional issues course where they work in groups to investigate a topic and then prepare a presentation. Some colleagues also indicated that they used small group tutorials/supervisions as an opportunity to talk to students about topics which they are currently researching as a means of communicating what is new in the discipline and motivating the students to engage in their studies. One way in which there is a difficulty in achieving an uniform integration of perspectives related to research in the teaching for level one students is a consequence of differing skill levels across the cohort – something which is often most prevalent at entry onto programming modules.

3.3 Second Year

At this stage of their studies students are expected to consolidate their basic skills. Content in this year is often large and may be an obstacle to achieving approaches which bring together research and teaching. Typical teaching approaches continue to concentrate on large lecture classes. Again colleagues indicated that they might relate what they were teaching to current topics of their own and other's research by way of example of applications of the theory being presented. Assignment may involve reading research papers and postulating new ideas based on the reading. Most UK students undertake group software projects at this level, and the skills they are required to demonstrate are akin to those of researchers working in teams.

Some teaching at this level can explicitly be designed to develop research skills. One of the universities offered a research methods module which focuses on preparing students for study at final year undergraduate University level and to developing the students' requisite academic skills for completing their studies, in particular research techniques and methods in preparation for final year project and for developing skills in critical analysis and reflection. The other university encourages students to engage with research by getting them to participate in a student conference. Students have to put together an abstract which is peer (and tutor) reviewed, prepare a paper then present at the student conference – an in-house event, but run along the lines of a conference. Students develop their research skills as part of this process.

In smaller optional classes there is a chance for class discussions of directed reading for example *"Artificial Intelligence, for the philosophy of AI part, I give students directed reading, which then forms part of their expected background knowledge for the examination. Sometimes the required reading is classic stuff, like Turing's 1950 paper in Mind, but sometimes it is up-to-the-minute commentary, and so could be counted as `research'"* In such cases students mimic the behaviours of researchers but they do not generate any actual new knowledge. Other examples of reading courses were offered, although large student numbers often precludes effective group discussion which is a necessary accompaniment to this type of educational approach.



At final year bachelor's degree level teaching via large lecture classes is less widespread. A significant part of student learning takes place through the individual project, students take advanced options which are often taught to small groups. Boyer identified this as a capstone experience, consolidating previous taught modules, and enabling the students to develop higher level skills as identified in Bloom's Taxonomy (design, analysis and synthesis). Having already established the basics, students may have an opportunity to engage in research like behaviours and activities. Colleagues who are active researchers often set students topics for their individual project which relate to research problems they or their post graduate students are facing. Optional courses may also be offered which enable students to undertake activities akin to those in which active researchers engage. One such example, described as a "research-led curriculum" was initiated by one of the authors of this paper and has been reported in detail elsewhere [21].

Modules at this level also sometimes take the form of a reading course. In one example a colleague described their teaching as providing a narrative which provided context to assist students in making sense of the academic papers which to provide the basis for coursework and examination assessments. They also observed that expecting students to learn from academic papers can sometimes be an unrealistic objective since there is too much additional knowledge and understanding which is needed to make the information presented in the paper to be accessible. As with some other examples, this may vary according to the field of study under discussion.

3.5 Masters level

At this level students at both universities are often given tasks and study modules which are explicitly research related. In one example students have a compulsory individual research project where they are expected to review existing literature and undertake a small piece of research which they present in a paper written in a standard journal format. Students peer review each other's work, revise their papers, prepare a poster and make a short verbal presentation. This is a more elaborate version of a "research-led curriculum" which is offered at the previous level at the same university. Research is evident in the curriculum in student projects where project topics and problems are normally aligned to staff research interests. At one of the universities students are encouraged to join research groups and participate in the activities of that group with the project and dissertation relating to research group activities.

Disciplinary exemplars

Research-tutored *e.g.: classic tutorial structure – typically small group supervisions in the computing disciplines* Supervision class where students are taken through recent publication(s) and are invited to discuss/debate their understanding of the activity. Possible at each level of study, but for organisational/management reasons may only apply in particular years of study.	Research-based *e.g.: authentic research activities, inquiry/enquiry based learning* Students are given a task which requires them to use and develop skills (practice and understanding) which are equivalent to those used in authentic research. May be practiced at any level of study, but may be more typically found at advanced levels
Research-led *e.g.: curriculum follows current research* Most typically advanced level options Can also be a component of teaching at any level, where students are exposed to state of the art research concepts (e.g. agile programming	Research-oriented *e.g.: teaching processes of knowledge construction* Typically found in capstone courses where students undertake some research activity, individually or as a group. Students at less advanced levels may practice this as part of research based activities

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Tried to fit the responses into the Healey Model

Boyer

Discovery
- Core to enquiry based curriculum
- Natural in lab based courses
- Well aligned to conventional approaches in teaching programming
- Internships
- Final year projects

Application
- Final year options
- Masters curriculum
- Proxy activities in follow on courses – apply previously learnt skills, knowledge, understanding
- Proxy discovery in lab classes
- Internships

Integration
- Capstone modules
- Final year projects/dissertations
- Synoptic assessments
- Design classes

Teaching
- Professional issues
- Skills modules
- Peer instruction
- Small group teaching methods

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Tried to fit the feedback into the Boyer model

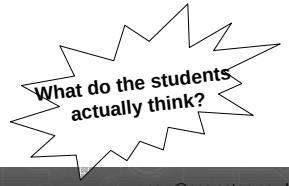
Which was the better fit and why?

Conclusions / reflections

- There is evidence of activities which create a link between research and teaching at each year of study
- Some colleagues have difficulties with the concepts
- Some issues are related to Disciplinary Differences or Engineer/Scientist tensions

- Academics in CS are not social scientists
- Many found it easier to relate to Boyer's explanation than to Healey's

- Probably need a whole curriculum approach
- But not whole institution because of disciplinary preferences?
- I don't think so... but
- For the future we need to consider additionally activities for Millennials



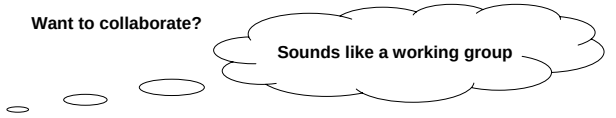
Future work

Looking for more data:

- Evidence of current practice
- Academic perspectives
- Student Perspectives
- Educational approaches
  - Technology based
  - Enquiry based
  - Traditional face to face

Possible Perspectives?

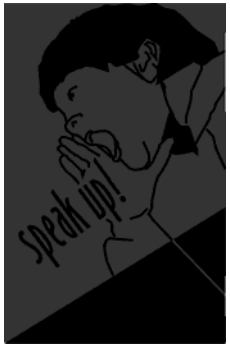
- National
- Curriculum type
- Institution type
- Educational Objectives



Thank You ☺

Acknowledge:
Contributions of colleagues at our respective institutions

Questions?



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Appendix

- Research teaching nexus matrix
- Mindmap
- Survey monkey – to use for online survey
- CPHC Learning Development Group

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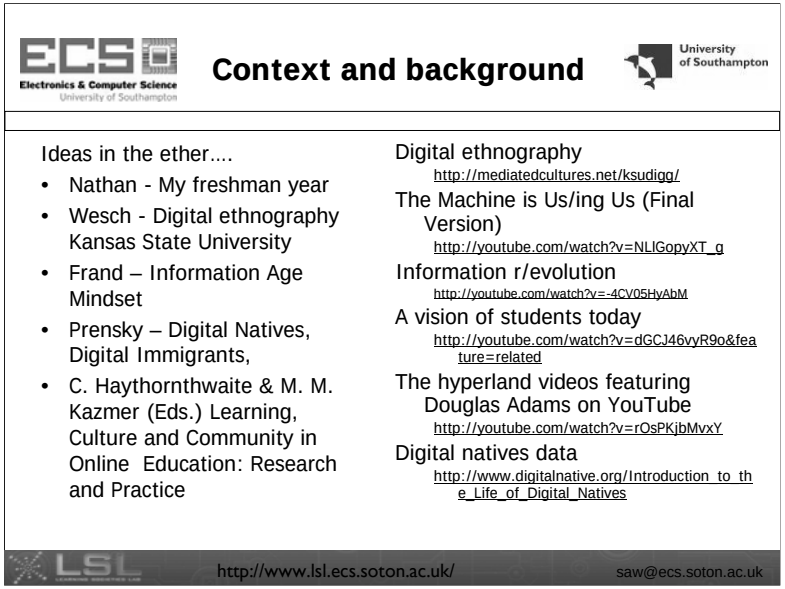
The plan is to complete the matrix (available as word file/pdf direct from saw@ecs.soton.ac.uk)

Recruit partners - institutions

Put the survey up on the web to gather data irrespective of institution

Get backing from CPHC Learning Development Group



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