Evaluating University Learning Spaces

A literature review of recent approaches
Evaluating University Learning Spaces
The interactions between higher education’s built environment and the activities of teaching and learning, and research, taking place within and around it are not well understood. Where connections between the environment and educational activities are made, the basis for doing so tends to be casual observation and anecdote, rather than firm evidence.

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Contents

Introduction ............................................................................................................................................ 7
Theme 1: A recognition of the paucity of thorough, innovative studies ................................................. 7
Theme 2: The complexity of the phenomena under evaluation ............................................................... 8
Theme 3: The role and importance of evaluative frameworks ................................................................. 9
    Assessing Learning Spaces .................................................................................................................. 9
    Summing up: Patterns in Evaluation Frameworks ............................................................................. 11
Theme 4: A variation in emphasis on a particular segment of the cycle ............................................... 11
Theme 5: Sanitised, unproblematic reports of the process of collecting data ...................................... 12
Theme 6: A ubiquity of standard methodologies vs some new directions ............................................. 14
Theme 7: A privileging of space and usage as evaluation targets ......................................................... 15
Theme 8: A conviction that environment and learning are intimately related ...................................... 16
    A word from a material semantic perspective .................................................................................. 16
Reference List ........................................................................................................................................ 19
Appendix 1: Evaluation Frameworks .................................................................................................... 21
Appendix 2: Summary of Research methods Used for Learning Spaces Evaluation ......................... 25
INTRODUCTION

The literature reviewed here spans the period 2000 to 2009. While it addresses a growing awareness of potential relationships between classroom environments, pedagogy and learning (in this case, in IT enhanced classrooms), the focus of this review is what it has to say about evaluation; that is, about how such relationships may be traced and identified.

Such evaluations form either the main substrate or the background to each of the items reviewed here; presented as serving the future of good classroom design and/or good pedagogy, albeit also such administrative goals as justifying spending.

In addressing these studies with the purpose of eliciting a ‘best current practice’ in evaluating classroom spaces, it is possible to find the following recurring themes and moments of interest:

1. A recognition of the paucity of thorough, innovative studies;
2. The complexity of the phenomena under evaluation;
3. The role and importance of evaluative frameworks in approaching this complexity;
4. A variation in emphasis on a particular segment of the cycle: classroom/evaluation design → evaluation → analysis → findings → redesign.
   While some studies focus on the process of designing an evaluative framework others visit a particular classroom and a particular study of chosen relationships within it.
5. Sanitised, unproblematic reports of the process of collecting data:
   While some give a glimpse of actual people at work and the things they do; more often a series of leaps are ‘seamlessly’ linked to represent a process, leaving many unanswered questions re how they got from one point to the next.
6. A ubiquity of standard methodologies and tools vs some new directions and explorations;
7. A privileging of space and usage as evaluation targets;
8. A conviction that environment and learning are intimately related and an optimism re the research task of tracing these relationships.

Each of these themes is addressed in the following sections

THEME 1: A RECOGNITION OF THE PAUCITY OF THOROUGH, INNOVATIVE STUDIES

This theme refers to a lack of thorough studies which link classroom environment to actual outcomes, such as learning. It was taken up by Fisher in response to his review of studies from 1996 to 2005 (Fisher 2005b, p18, quoting Herman Miller Inc, 1994) but can be traced to the end of this series of studies.

The Scottish Funding Council (2006) suggests that despite reviews of learning such as the work by Bransford et al. (2000) identifying learning through reflection, learning by doing, and learning through conversation, there are few empirical studies that link this body of research to the environment in which learning takes place. (Pearshouse, Bligh et al. 2009, p5)
In 2006 also, Bielaczyc reported that while the studies she reviewed

... *highlighted the importance of classroom social structures in learning with technology-based tools and have begun to identify central features ... what is missing is a systematic account of what the critical variables are.* (Bielaczyc 2006, p303)

Further, she says, re the ‘how’ of designing social infrastructure ‘such that a technology-based tool is used in ways that create effective environments for learning,’ the current literature does not help. (ibid. p303)

In a 2007 review of ‘Learning spaces for the 21st century,’ Temple concluded,

*The interactions between higher education’s built environment and the activities of teaching and learning, and research, taking place within and around it are not well understood. Where connections between the environment and educational activities are made, the basis for doing so tends to be casual observation and anecdote, rather than firm evidence.* (Temple 2007, p4)

Even as recently as 2009, in a study which ran from September 2008 to March 2009, and involved a literature review and a survey of UK HE and FE institutions, Pearshouse et al. report a key concern that ‘there is still insufficient qualitative and deep research into the relationship between pedagogy and design of learning environment’. (Pearshouse, Bligh et al. 2009, p10)

**Theme 2: The Complexity of the Phenomena Under Evaluation**

One reason for this paucity of thorough, innovative studies investigating the relationships between classroom environments and actual learning, has to be the complexity of these very settings; another theme which threads these studies. Hunley and Schaller (2006, p. 13), claim that, '[d]irect measures of learning outcomes are the most valid and reliable indicators of academic gains', but they go on to say that such ‘direct measures to determine the impact of learning spaces on learning are fraught with complexity,’ due to the multifarious nature of learning settings .. with courses taught by multiple teachers in multiple sites using multiple means.’

These difficulties are noted in the reviews undertaken by Temple (2007) and Pearshouse et al. (2009):

*The difficulties in designing research that can distinguish inputs to learning from the physical environment from inputs arising from other sources are formidable, and do not appear so far to have been seriously addressed.* (Temple 2007, p7)

*Space, learning and the effectiveness of the university more widely, are intimately connected. Untangling them completely is perhaps impossible, as well as unprofitable. Nevertheless, greater sensitivity to their interactions should be worthwhile: relatively small improvements in space design are likely to be amply rewarded in learning and other institutional benefits.* (ibid. p8, see also p71)
One of the biggest challenges for the JELS research project is the presupposition that architecture can improve learning. There are too many variables involved in any assessment of a learning space to ever assure an intimate relationship between effective learning and any given environment. (Pearshouse, Bligh et al. 2009, p8)

It is noted that these difficulties were ‘noted’ by these authors. The choice of words is deliberate as their references to these difficulties are passing references to a problem which does not appear to daunt any of the researchers. This issue will be taken up again in themes 7 and 8.

**THEME 3: THE ROLE AND IMPORTANCE OF EVALUATIVE FRAMEWORKS**

While appearing undaunted, a number of researchers have nevertheless attempted to address this complexity by constructing generalized models of learning environments and what is happening in them, as part of a process of constructing what they call an ‘evaluative framework’.

These authors have examined the complex settings of the classrooms they are interested in, in the light of current theories of good pedagogy, and attempted to find meaningful places to which they can (or would like to be able to) attach ‘tracer points’. Invariably these points have then been classified and organised into schemas .. schemas which tend to reflect the origins of the authors work in either design or pedagogy. Four such evaluative frameworks are outlined in the reviewed papers, but are introduced here by way of a more general discussion of evaluative frameworks, by Hunley and Schaller.

**ASSESSING LEARNING SPACES**

Hunley and Schaller (2006, 2009) spell out the challenge associated with wanting to assess learning spaces for their impact on learning: that is, you will be dealing with multifaceted phenomena.

You will be dealing with variables, say Hunley and Schaller, associated with the environment, time, content and structure; that is, with spatial things, temporalities, what is being taught, as in course contents, as well as pedagogical issues to do with how the teaching/learning setting is structured

Previous studies (e.g. Strange and Banning, 2001) suggest the settings (for these variables) which are predicted to enhance learning impact on theories of learning environment influence which in turn influence the design of a particular Learning Environment in which learning is then experienced/influenced, and is in turn assessed via, eg:

- learning outcomes (in measured, institutional terms)
- engagement

These findings, as assessed, are then correlated with the particular features of the Learning Environment. The results are used to make judgments about the ‘success’ of the Learning Environment in influencing Learning, which is in turn used to progress this reiterative cycle of design and assessment.
The authors also make the following points about the process of assessing a learning space:

**With respect to an Assessment Framework** (for learning spaces)

Three issues must be addressed in the assessment design:

1. It must be clear whether assessment focuses on teaching or learning. As these will influence the means for evaluation;
2. The audience(s) for the assessment information must be identified. E.g., an external audience for accreditation or an internal audience for development.
3. Assessment of learning space must take into account the fact that learning and instruction are no longer confined to the classroom. This will involve
   - environmental settings which may be both physical and virtual;
   - time settings which may be formally scheduled or self-selected;
   - **abc and VIR** content & structure settings which may be formal, informal or self-directed.

**With respect to the Assessment Targets** (for tracing learning/change)

Institutions should determine assessment targets based on their own goals and culture, (but, they suggest) the following models suggest relevant targets:

1. A general model using university-wide targets to determine student growth. (Pascarella and Terenzini 2005)
2. The person-environment interaction. (Strange and Banning 2001)
3. Learning outcomes as a direct measure of learning. (Huba and Freed 2000)

However, as the authors take up each of these models in turn, they suggest that 'engagement' is inherent in all (see p.13.4-14.5). For example, while claiming that, '[d]irect measures of learning outcomes are the most valid and reliable indicators of academic gains', they go on to say that such 'direct measures to determine the impact of learning spaces on learning are fraught with complexity.' (Due to the multifarious nature of learning settings .. with courses taught by multiple teachers in multiple sites using multiple means.) They go on to claim that, 'One alternative measure for student learning is student engagement.' p.13.5 They quote Astin’s theory of involvement: 'students learn by becoming involved', and call on a 'general consensus in the literature'.

Although this discussion of how an evaluative framework is constructed is presented as a general discussion, it has nevertheless been specific in the way it has organized the variables it is setting us up to watch, i.e. as variables of space, time, structure and content. It is useful to now look at several other frameworks presented in the literature reviewed here, and see how variously they are organized.

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1 They do this without references except for 'research based on the National Survey of Student Engagement ([http://nsse.iub.edu/index.cfm])'.

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Four frameworks have been summarized in Appendix 1. They are

1. the Social Infrastructure Framework, (Bielaczyc 2006)
2. the User’s Environmental Interaction Framework, (Scott-Webber, Marini et al. 2000)
3. the Theory of Change Framework, (Levy 2009)

**SUMMING UP: PATTERNS IN EVALUATION FRAMEWORKS**

Table 1 compares these schemas of variable dimensions, proposed as frameworks to guide the design of evaluations of classroom settings. While Hunley and Schaller’s framework represents the most general categories, others take a more explicit perspective: Bielaczyc’s SIF targets what she calls social dimensions; the Theory of Change is interested in process and impact. And while Hunley and Schaller take the most general stand, the JISC project (FELS) attempts to assemble the widest net, or rather, to list as many ‘tracable spots’ as possible. (See Table 1 in Appendix 1.) It is an ambitious proposal and the JISC team themselves appeal for users to test their schema on ‘live cases’. (Pearshouse, Bligh et al. 2009, p4)

|------------------------------|--------------------------------------|-----------------------------------------------|---------------------------------|-----------------------------------------------|
| Evaluation Frameworks in general | • Environment  
• Time  
• Content  
• Structure | • Cultural beliefs  
• Practices  
• Socio-techno-spatial relations  
• Interactions with the outside world | • Environment  
• Values  
• Internal responses  
• Behavioural responses | • Intentions  
• Context  
• Practice  
• Design  
• Procedures |

**TABLE 1 - DIMENSIONS FOR CONSIDERATION AS PROPOSED IN FIVE ACCOUNTS OF AN EVALUATION FRAMEWORK**

**THEME 4: A VARIATION IN EMPHASIS ON A PARTICULAR SEGMENT OF THE CYCLE**

While these authors hesitate at the classroom door in their attempt to create more and more efficient and ‘fool proof’ lists to guide the design of classroom environment evaluations, others have no such compunction. They take us to specific classrooms and learning spaces, old and new, and they use well known evaluation tools - interviews, questionnaires and usage statistics - to attempt to show that the setting is or isn’t working as it was designed to do.

These approaches can be seen as variations in emphasis on a particular segment of the cycle:

classroom/evaluation design→evaluation→analysis→findings→redesign.

That is, while some studies focus on the process of designing an evaluative framework, others visit a particular classroom and a particular study of chosen relationships within it. (See for example, Dori,
Belcher et al. 2003; Dori and Belcher 2005; Alexander, Cohen et al. 2008). These variations can be mapped onto the cycle in Figure 2. Again, other studies illustrate the full cycle. See for example Scott-Webber et al. (2000)

In this article we get to see an example of each of the steps in this cycle. We see theories of education and design being gathered together into an evaluation framework; we get a glimpse of a methodology, and the tools it needs to answer some specific research questions, emerging from this framework. We see the tools at work gathering data. We see something of the evaluation targets - the classrooms and people using them - and the process of analyzing the data. Then in more detail we see the findings which emerge; findings which can potentially feed back into the theories of good design and teaching with which the cycle began.

**THEME 5: SANITISED, UNPROBLEMATIC REPORTS OF THE PROCESS OF COLLECTING DATA**

Reports like this by Scott-Webber et al. give us an insight into the role evaluation frameworks and assessment processes play in a larger reiterative cycle of design, use and evaluation. Other reports focus on several links in the chain of events. However they all leave a great deal to the imagination .. especially as to how researchers move from their evaluation frameworks to their assessment instruments. The JISC report sums this up in a comment they make while reviewing the work of Bielaczyc. They tell us that, ‘Difficulties with formulating contextually relevant questions in response to the design considerations are mentioned briefly.’ (Pearshouse, Bligh et al. 2009, p18.8)

The same report highlights some of these ‘difficulties’ as noted by Tom et al. (2008). They suggest that positive assessments too often reveal assertions, rather than quantifiable evidence, given the number of changing variables in say a comparison of two classes. They are also concerned that collaborative work is often uncritically equated with learning.
A literature review of recent approaches

Theories of Learning and the role of the Classroom Environment

Evaluation Framework

- Choose Targets & Criteria
- Create/Choose Instruments

Assessment Instruments

- Conduct the Evaluation

Classroom

- Teachers
- Students

Design/Build a Classroom

- Teachers design a Teaching Program
- Teachers and students use the Classroom

Findings

- Examine relationships
- Gather the data

FIGURE 1 - A CLASSROOM ENVIRONMENT DESIGN/EVALUATION CYCLE
Other authors note reservations due to:

- the difficulty of collecting data due to the flexible nature of certain environments: e.g. when students who are free to move around;
- the realization that evaluation should distinguish between differences arising out of novelty and differences that might be a feature of learning under new arrangements, once established. (Roberts and Weaver 2006)

But while some authors at least acknowledge these challenges, and while some give a glimpse of actual people at work and the things they do (e.g. Case Study 2 in Pearshouse et al. (2009, p58)); more often a series of leaps are ‘seamlessly’ linked to represent a process, leaving many unanswered questions re how they got from one point to the next. For example, in one report on using the Theory of Change evaluation framework, we are told, ‘Once the Theory of Change and the EPO indicators have been established, evaluation questions are drawn from them and data collection methods are designed.’ (Pearshouse, Bligh et al. 2009, p17) Even visiting the extensive report of the use of ToC in the CILASS Centre at Sheffield University, does not throw light on this process.²

**THEME 6: A UBICITY OF STANDARD METHODOLOGIES VS SOME NEW DIRECTIONS**

Questionnaires, surveys, interviews and focus groups, sometimes combined with observations, student test results and space usage data, are the recurring instruments reported in this literature. The JISC study also reported this ‘emphasis on standard evaluation techniques’ in the literature they reviewed and the interviews they conducted with HE and FE institutions in the UK. From the interviews they report the most frequently used tools were surveys (60%), focus groups (50%) and observation (45%), often justified pragmatically. Few used control groups, or strategic sampling. (Pearshouse, Bligh et al. 2009, p10-12) Less than a third used baseline data.

However some new directions are emerging, especially explorations of multimedia and the new possibilities associated with web 2 tools. The JISC review reported that 20% of interviewees reported some use of such tools. For example, Tom et al, used faculty and student blogs to collect impressions and reflections on the use of the space they were studying. (Tom, Voss et al. 2008) Another study placed video equipment in 10 booths being used in an innovative classroom, and report being somewhat overwhelmed by the amount of data recorded. (Pearshouse, Bligh et al. 2009, pp12, 56) But in general we learn very little about these new media experiments.


CILASS - Centre for Inquiry-based Learning in the Arts and Social Sciences. This site provides a detailed account of the Theory of Change as it was developed for this project, and evidence of the questions used in the questionnaire, but no discussion of the relationship between them.
The range of methods reported in the literature surveyed here are collected in Table 1, in Appendix 2, prompting two comments:

1. While the ubiquity of standard methods is obvious in this table, there is no suggestion that these studies and these methods are necessarily therefore under a shadow. It may be that the extensive use of these tools represents a time-honoured validity. Fraser (2002) uses the term ‘validated’ to refer to the four widely used questionnaires he discusses, without any apparent need to justify this comment. While the resolution of this issue is beyond the scope of this review, there is nevertheless a hint of dissatisfaction, in eg. such comments as, ‘The lead evaluator … rejected traditional surveys and focus groups as less useful beyond the planning stage of a learning space …’. (Pearshouse, Bligh et al. 2009, p12) This dissatisfaction is also evident in the experimentation with new methods and the recognition of the need for multiple methods.

2. This frequent use of multiple methods is in turn a response to a recognition of the complexity of the settings studied, and the inadequacy of single tools in such settings. [quote, ref]

**THEME 7: A PRIVILEGING OF SPACE AND USAGE AS EVALUATION TARGETS**

This was a key finding of the JISC study. They describe an ‘emphasis on enabling new teaching and learning scenarios’. (Pearshouse, Bligh et al. 2009, p12-13) This emphasis is encouraged by, for example, social constructivist theories of learning. The provision and use of these enabling spaces, is then used as a measure of (assumed) learning. This trend can be seen in the study by Scott-Webber et al. (2000):

In this paper the authors give us a glimpse of a chain of actors, as they see them, at work; a suggested sequence:

*The design of settings for learning can have a direct impact on motivation, concentration, and performance by affecting comfort, control, attention, access, and enjoyment. (Scott-Webber, Marini et al. 2000, p18, quoting Herman Miller Inc 1994)*

Here the design of a setting (A) leads to motivation, concentration and performance (C) through comfort, control, attention, access, and enjoyment (B). The authors have previously told us that A is a representative for an institution’s values and priorities. The implication is that the elements of C (motivation, concentration and performance) are all precursors of something else, presumably ‘learning’. [Having interpolated A, B and C, I’ll call it D.] So here is a sequence in which the values and priorities of an institution, as expressed in design of settings, can affect learning; how A can influence to D.

They remind us that while a particular kind of setting may be advocated, as in a ‘paradigm shift’ from teacher centred to student centred learning, the range of teaching/learning styles needs to be supported. (quoting Barr and Tagg 1995) Thus, they say, ‘it becomes apparent that using appropriate learning environments, that are designed to support the appropriate collaboration and self-direction, is key to promoting learning within any school or organization.’ (Scott-Webber, Marini et al. 2000, p19, emphasis supplied)
Note my emphasis. Is this an example of what Pearshouse et al called a privileging of space and usage as data? (2009, p13). Having spelt out the links through which space can influence learning, the message seems to be, Have Space (and Use Space), and you Have Learning. And, if you want to evaluate D, measure a new variable, use of A.3

A similar argument is taken up by Hunley and Schaller, who justify measures of engagement as measures of learning. For example, while claiming that ‘direct measures of learning outcomes are the most valid and reliable indicators of academic gains’, they point out that such ‘direct measures to determine the impact of learning spaces on learning are fraught with complexity.’ They go on to claim that, ‘One alternative measure for student learning is student engagement.’ (Hunley and Schaller 2006, p13.5)

**THEME 8: A CONVICTION THAT ENVIRONMENT AND LEARNING ARE INTIMATELY RELATED**
In all of the studies reviewed here, none doubted the value of the relationships they were pursuing. As the JISC report put it,

> One of the biggest challenges for the JELS research project is the presupposition that architecture can improve learning. There are too many variables involved in any assessment of a learning space to ever assure an intimate relationship between effective learning and any given environment. And yet we have an instinct that tells us that the quality of space we inhabit will affect our ability to concentrate, to solve problems and to be creative.

> We inhabit spaces and we have learnt through our experience; we know that certain spatial arrangements, qualities, facilities and technologies will help our work processes. (Pearshouse, Bligh et al. 2009, p8-9)

It is the how, which is the elusive question. How can space ‘facilitate different learning behaviours and respond to the needs of individuals?’ (ibid. p9)

This is what they have enthusiastically set about to answer, as have so many others.

**A WORD FROM A MATERIAL SEMANTIC PERSPECTIVE**
The articles reviewed here definitely don’t indulge in phenomenological speculation or procedure, or the language of such approaches as, say, Actor Network Theory. However they are all acknowledging and investigating the activity of a heterogeneous cast of actors, both human and non-human, material and immaterial, and are acutely interested in the agency of things. They are therefore temping sites to examine from a material semiotic perspective. Take for instance the study by Tom et al. (2008)

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3 But note also that this study was designed to measure the difference between student and faculty perceptions of classroom settings, not learning outcomes per se.
Of interest is the extensive use of language in this article, which allows the classroom and various aspects of the environment to own activity. The following are all from page 48, but many other examples occur throughout the article.

*The room encourages instructors to ‘give up the podium’;*

*New types of learning spaces ... create new patterns of social and intellectual interaction,*

*the facilities and technology ... made her think about doing things not possible otherwise,*

*(the room) makes me reinvent myself,*

*the presence of the technology forced the instructor to ‘learn how to use it all’.*

At the outset, the authors show us how their Evaluation Framework is based on (what they want to demonstrate is) a firm foundation in peer reviewed research. They appeal to Steele to make the first assumption underlying this research: that 'the physical setting is a very important aspect of the climate that 'stimulates people to develop new skills, abilities, knowledge, and understanding so that they grow in confidence'. (ibid. p18) They tell us Steele is an organizational development specialist. They are doing what Latour has told us to expect: making links to strengthen the network of actors which will constitute this knowledge claim. (Latour 1987)

They also do something else Actor Network Theory has told us to expect: they appoint a 'spokesperson', a representative. Something accessible to stand for something less accessible. (Callon 1986a) They quote Herman Miller, Inc, to say

*‘The physical setting is only one component of an organisation’s cultural climate that affects both work and learning. However, it is perhaps the most obvious expression of the values and priorities of that organisation.’* (ibid. p17-18)

They then give us the glimpse of a chain of actors, as they see them, at work, and as we saw in Paragraph 7, above.

We had already seen these processes of appointing ‘spokespersons’ by extending networks, at work in Paragraph 3.1. In invoking ‘engagement’ to represent learning, Hunley and Schaller appoint a representative which can speak for the complexity they want to approach. They strengthen this claim by linking into larger networks .. in this case via the work of Astin. (Astin 1985; Hunley and Schaller 2006)

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4 Callon calls this ‘mobilisation’: reducing groups to successful spokespersons; rendering entities mobile which were not so before. He also uses the term ‘concentration’ - a group has been reduced to a spokesman. This has happened through a series of displacements/transformations. eg scallops become graphs, diverse populations become spokespeople in a conference room. Callon, M. (1986a). Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Briec Bay. *Power, Action and Belief: A New Sociology of Knowledge?* J. Law. London, Boston, Routledge & Kegan Paul: 196-233.
Given the amount of work which is now being directed towards finding new ways to map the relationships between classroom environments and the learning which happens in them, it is perhaps surprising that there is not more overlap between these fields of research. One factor which may be working against such a fellowship, however, is the marked difference in the language which constitutes these approaches. While ANT works hard to avoid such foundational dichotomies as the social vs the technical, the literature reviewed here spends a lot of its time actually searching for such categorical distinctions, in order to trace, where possible, the relationships between them.
A literature review of recent approaches

REFERENCE LIST


Wolff, S. (2002). Design Features for Project-Based Learning, Oregon State University.
APPENDIX 1: EVALUATION FRAMEWORKS

A number of evaluation frameworks have been identified in the literature.

1 A Social Infrastructure Framework (Bielaczyc 2006)

Bielaczyc has a thorough goal in mind in creating this framework:

*Only by understanding the critical variables involved is it possible to develop a deep understanding of how and why things work.* (Bielaczyc 2006, p302)

*Whether or not they are conscious of how their actions and decisions impact the construction of classroom social structures, developers and teachers engage in making design decisions that affect social infrastructure. I have developed the Social Infrastructure Framework to make such decisions explicit and to organize them into a systematic framework that highlights the critical design factors.* (ibid. p302)

Bielaczyc claims that four critical (interdependent) dimensions of classroom structures that are amenable to design, emerge from the literature.

- The *cultural beliefs dimension* - the mindset that shapes the way of life of the classroom, eg, belief that knowledge is owned by the teacher.

  This mindset influences ethos which is favorable or unfavorable to scientific enquiry.

- The *practices dimension* - the ways in which teachers/students engage in online/offline learning activities, eg, individually, in groups .. and the roles the teacher assumes.

  These variables influence the level of engagement, sense of autonomy, and ability to transfer knowledge within the classroom.

- The *socio-techno-spatial relations dimension* - the organization of physical space and cyberspace as they relate to the teacher and student interactions with technology-based tools, eg, fixed or wireless/mobile.

  These variables influence accessibility, connectivity, and communication among students and teachers. Designers have new challenges as wireless mobility, virtual forums and avatars enter the scene.

- The *interaction with the “outside world” dimension* - the ways in which students interact, online and offline, with people outside of their immediate classroom context;

  This can influence motivation, and presentation/communication skills.

Bielaczyc is explicit that the Social Infrastructure Framework focuses on classroom *social structures* that impact the type of learning environment created with technology-based tools, ie. that this is her specific focus. She tells us,
... the current literature does not help us to answer the question of how to design social infrastructure such that a technology-based tool is used in ways that create effective environments for learning. Classroom social structures are not fixed. We need to go beyond understanding the impact of a given classroom social infrastructure on the integration of a technology-based tool and begin to systematically identify and analyze the aspects of social infrastructure that are amenable to design. (ibid. p303)

2 The User's Environmental Interaction Framework (Scott-Webber, Marini et al. 2000)

Scott-Webber et al also propose a multifactor framework for guiding the design of an evaluation. In their diagrammatic representation of their framework (p20) they invoke the symmetry of quadrants to present the potential influence of

- Environmental Dimensions: ie. physical factors including ambient conditions, space layout and functions, and wayfinding artifacts;
- Value Dimensions: ie. the yardsticks and filters people use for making decisions, and which are a product of cultural training; both corporate and personal;
- Internal Responses: ie. derivatives of 'fight or flight'; cognitive, emotional and physiological; and
- Behavioural responses: ie. derivatives of approach and avoidance reactions amounting to 'social interaction'.

As well as these four quadrants they invoke the idea of proxemics (distances between actors influencing a reaction) and of interactions between all these influences.

3 The 'Theory of Change' for impact evaluation

The 'Theory of Change' (ToC) learning spaces evaluation methodology used by the CILASS project at Sheffield University (Levy 2009)

This framework focuses on development 'in that it is concerned with generating understanding of why and how educational impact occurs rather than simply monitoring or auditing educational outcomes.' (Pearshouse, Bligh et al. 2009, p16)

[It is] based on the assumption that all change initiatives have an underlying 'informal theory' of how desired outcomes will be achieved; that is, how change will happen. This informal theory is introduced at the outset of the change initiative in order to identify indicators for an evaluation that will focus not only on whether or not outcomes have been achieved, but also on how they have been achieved ...' (Pearshouse, Bligh et al. 2009, p16)

Implementing a ToC Framework involves creating a document which summarizes a change initiative - across five distinct areas - using a narrative framework:

- the current situation that precedes an intervention,
- enabling factors (designated E) that define the structures and support which will be needed to produce the desired outcomes;
- process (P) indicators that define what needs to happen in order to achieve the desired outcomes;
• outcome (O) indicators that define the intermediate or longer-term outcomes and
• the overall impact desired for the project.

Through backward mapping a causal narrative or ‘theory’ is established ... Once [this] Theory of
Change and the EPO indicators have been established, evaluation questions are drawn from them
and data collection methods are designed.' (Pearshouse, Bligh et al. 2009, p17)

4    FELS: a conceptual Framework for Evaluation of Learning Spaces

This framework is the outcome of a study which ran from September 2008 to March 2009, and
involved a literature review and a survey of UK HE and FE institutions. It is intended to address, in
part, the concern that ‘there is still insufficient qualitative and deep research into the relationship
between pedagogy and design of learning environment’ (Pearshouse, Bligh et al. 2009, p10), through
providing:

• a common vocabulary to standardise evaluations,
• a checklist of issues to be considered by individual practitioners and evaluators, and
• a structure to describe the nature and character of evaluations completed to date.

It is based on the interplay of five key factors, prompting the following questions:

• intentions: Why is the evaluation taking place?
• context, practice and design: What is being evaluated? And,
• procedures: How will the evaluation be constructed?

See Table 1 for their diagrammatic presentation of FELS, in which each dimension is further analyzed
for its constituent aspects.

The authors suggest a ‘plausible approach’ for using the framework, ie, traversing ‘each dimension
systematically, gradually constructing an evaluation design document to which further detail can be
added with repeat iterations through the framework.’ p20
### Why?
- Purpose
- Users
- Policymakers
- Policy

### What?
- Context
  - Interactions
  - Design gestures
  - Curriculum
    - Maths
    - ICT
  - Non-specific
  - Process
    - Scripted
    - Open

### How?
- Procedures
  - Timescale
    - Longitudinal
    - Quick gain
  - Initiated
    - Internal
    - External
  - Conducted
    - Internal
    - External
  - Feedback
    - Summative
    - Formative
  - Measurement Methods
    - Quantitative
    - Qualitative
  - Research Methods
    - Practitioner research
    - Academic research
    - Service level evaluation
  - Operation
    - Technical
    - Human
    - Top-down
    - Bottom-up
  - Tracking
    - Use of space
    - Journey of learner

### TABLE 2 - FELS, A CONCEPTUAL FRAMEWORK FOR THE EVALUATION OF LEARNING SPACES, REPRODUCED FROM PEARSHOUSE ET AL. (2009, P21)
APPENDIX 2: SUMMARY OF RESEARCH METHODS USED FOR LEARNING SPACES EVALUATION

(Note that no quoted material in this summary is delineated or referenced. To quote, refer to original papers.)

<table>
<thead>
<tr>
<th>Date/Place /Type</th>
<th>Authors (EndNote link)</th>
<th>Method used or discussed</th>
<th>Variables/Criteria chosen</th>
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</table>
| 1996 Studies referenced by (Fisher 2005b) | (Earthman and Lemasters 1996) (Fisher 2000) | Quantitative | • Test scores  
• Behaviour criteria and Building Condition criteria not stated in reference. |
| 2000 Study | (Scott-Webber, Marini et al. 2000) | Qualitative 48 question survey Observations | Step 1: The questions included:  
• semantic differentials - to evaluate environmental conditions, eg. noisy/quiet, poorly kept up/well kept up, quality air/poor quality air, inflexible/flexible arrangements, inadequate/adequate equipment;  
• alternate choice (yes/no) questions and an opportunity to explain - to evaluate value dimensions and internal responses, eg. - Do you have a sense that the space facilitates social interactions: between students, and between faculty/students? Explain.  
• Do you feel that there is adequate physical fit with respect to seating, room layout, equipment?  
• a combination of semantic differentials and alternative choice questions, to evaluate behavioural responses, eg.  
• Would you say that knowing you are going to be in this classroom your mood is: inspired/non inspired, anticipatory/non anticipatory, happy/sad, etc.  
Step 2: Observations using a behavioural mapping technique, to study the proxemic behaviour and the pedagogical interactions of the users. Four observations were conducted on each classroom. |
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</table>
| 2000 UK Study reviewed by (Fisher 2005b) | (PriceWaterHous eCoopers 2000) | Qualitative | • Student Performance  
• Schools Capital Investment  
Designs were based on a deliberate policy of building in  
• improvements to circulation to cut down on movement and contrary traffic flows  
• a wider range of teaching strategies, especially in ‘difficult’ subject areas. |
| 2000 Study reviewed by (Fisher 2005b) | (Dudeck 2000) Book Review by Lackney see [http://thunder1.cudenver.edu/cye_journal/review.pl?n=43](http://thunder1.cudenver.edu/cye_journal/review.pl?n=43) | Qualitative | Reading Development  
Space/place |
| 2001 UK Referenced by (Fisher 2005b) | (Lackney 2001) | Performance measures are often associated with the practice of post occupancy evaluations. | |
| 2001 Awards reviewed by (Fisher 2005b) | OECD PEB (Programme on Educational Buildings) See [www.oecd.org/e du/facilities/com pendium](http://www.oecd.org/edu/facilities/compendium) for further information about the OECD PEB’s Compendium of Exemplary Educational Facilities. | Qualitative 6 categories, 2 focus on learning environments: | • How does the design stimulate children’s early teaching and learning experiences.  
• How is the facility adapted to new forms of learning and research or use ICT to optimize capital planning or property management. |
<table>
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| 2001 Awards reviewed by (Fisher 2005b) | DesignShare Awards www.designshare.com | Qualitative 6 award categories, 1 focuses on learning environments: Enhance teaching and learning and accommodate the needs of all learners. | Designs  
- follow the research in the learning sciences;  
- students doing not just receiving;  
- creating not just re-creating;  
- problem-solving, - cooperative, - project based;  
- interdisciplinary;  
- emphasis on learning styles, multiple intelligences and special needs;  
- accelerate research on the impact of the physical environment on student achievement. |
| 2001 USA Study reviewed by (Fisher 2005b) | (Sanoff 2001) See later paper, and website: http://www4.ncsu.edu/unity/users/s/sanoff/www/schooldesign/assessment.html | Qualitative Classroom Rating Scale using six visual models, assessed according to 11 criteria:  
- students have some opportunity to move around  
- students can engage in activities, manipulating objects & materials  
- seating arrangements vary, incl small groups, pairs, individuals, total groups  
- individuals and small groups can chose from alternative learning activities  
- small groups can work independently on projects or assignments  
- a variety of teaching methods can be used  
- team teaching facilitated  
- teachers can make quick, easy transitions between activities  
- teachers can move around interacting with individuals/groups  
- students .. sense of identity and belonging [facilitated]  
- circulation is minimized  
Also uses the scale:  
- interesting/boring  
- unpleasant/pleasant  
- friendly/unfriendly  
- dislike/like  
- dynamic/static  
- repelling/inviting  
- novel/common |
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| 2002 PhD reviewed by (Fisher 2005b) | Wolff 2002 See paper | Qualitative See diagram of Wolff’s Problem Solving Model | 32 design features that support collaborative, project based learning, including that learning settings should:  
- be variably sized with individual workspace;  
  - have presentation space and ‘cave’ space;  
  - have spaces with access to food and beverage;  
- include process galleries, studios, labs, a collaboration incubator, get away spaces or niches; display spaces and  
- have good access to technology. |
| 2002 Review | Fraser 2002 See paper | Reviews Qualitative and Quantitative work using: Standard Questionnaires:  
- QTI, SLEI, CLES, WIHIC  
Student Outcomes, Interviews, Observations | See article for the variables targeted in each questionnaire |
<p>| 2003 Study | Dori, Belcher et al. 2003 See paper | Questionnaires | Student perceptions re how aspects of the course (in the TEAL physics lab) contributed to their understanding |</p>
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<td>2004 Study</td>
<td>(Ching, Levin et al. 2004) See paper</td>
<td>Qualitative Video case studies and interaction analysis</td>
<td>This study videoed eight cases of university teaching and used the principles of Interaction Analysis to create a detailed log of each session, describing 1. the structure of the event; 2. the temporal organization of the event; 3. the spatial organization of the activity; 4. participation structures; 5. problems and problem-solving; and 6. artifacts and documents. A grounded-theory framework was created as a first step toward describing the various artifacts and technologies and some pedagogical purposes toward which they are used. One case study was then analysed in further detail. The study created what it considers ‘a relatively comprehensive taxonomy of classroom artifacts’. It builds on existing research by including inscriptions, gestures and tools, but broadens it by including objects such as furniture, specific electronic technologies and ambient artifacts such as sound and temperature. In this taxonomy, artifact types are ‘organized according to their relationships to meaning and knowledge in the classroom’, ie, their relationship to pedagogical goals in higher ed. p226. The categories chosen are:  concrete carriers (eg furniture)  concrete conveyors (eg computers, projectors, VCRs)  inscriptions (eg graphs, charts, tables, equations, diagrams)</td>
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<p>| 2004 Study       | (ACNielson 2004) See paper and PPP | Qualitative &amp; Quantitative 1. in-depth face to face interviews 2. pilot phase, semi-quantitative survey using  • self completion methodology for school audiences  • telephone interviews for design consultants. Target audiences: teachers (yr 5-13), principals, boards of trustees and design agencies. | Classroom criteria included:  • spaciousness,  • adaptability,  • layout control,  • natural/artificial lighting/temp control,  • size and arrangement,  • access to support spaces. |</p>
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| 2005 Study      | (Brett and Nagra 2005) See paper | Qualitative and Quantitative Questionnaire Interviews Observation | Questionnaire: Students responded to 22 statements on a 5-point Likert scale. The statements aimed to elicit:  
  - did the students work alone or with others;  
  - what types of uses did the students make of the room;  
  - did the environment facilitate collaborative study;  
  - did the environment affect the students’ concentration;  
  - why did the students choose to study in this room?  
  Also three open-ended questions re likes, dislikes, and suggested changes for the room.  
Interviews: Variables as above.  
Observations: Types of main use were assessed as:  
  - mainly for individual study;  
  - only for individual social use;  
  - mainly for collaborative study;  
  - only for group social use; or  
  - computer not being used.  
Further observations of the traditional computer room sought only to ascertain whether or not, despite these restrictions, collaboration was taking place. |
| 2005 Study      | (Dori and Belcher 2005) See paper | Quantitative Pre and post- tests | Student conceptions (of subject matter taught in the TEAL lab) |
## Variables/Criteria chosen

1. Criteria underpinning the pedagogy in this study included student competencies such as:
   - a positive attitude towards learning and self-expression;
   - success across all areas;
   - a high level of personal, communication and social competencies; etc.
   
   See article for full list.

   The Curriculum Standards Framework was also used as a basis for analysis, e.g. the learning environment/program:
   - is supportive/productive;
   - promotes independence; etc.

2. **Achievement data records**
   
   Alternative possible performance measures:
   - student retention rates,
   - tracer studies on entrance to further education,
   - vandalism and absenteeism,
   - behaviour (detentions), etc.,
   - test scores,
   - OECD PISA data.

### Table: Literature Review of Recent Approaches

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</table>
1. Review of international and national case studies
2.1 Post occupancy evaluation of the refurbishment program
2.2 Evaluation of achievement data records held by DET | 1. The *cultural beliefs dimension*
- the mindset that shapes the way of life of the classroom
2. The *practices dimension*
- the ways in which teachers/students engage in online/offline learning activities
3. The *socio-techno-spatial relations dimension*
- the organization of physical space and cyberspace as they relate to the teacher and student interactions with technology-based tools
4. The *interaction with the “outside world” dimension*
- the ways in which students interact, online and offline, with people outside of their immediate classroom context; |
| 2006 Theory | (Bielaczyc 2006) See paper | A Social Infrastructure Framework | 1. The *cultural beliefs dimension*
- the mindset that shapes the way of life of the classroom
2. The *practices dimension*
- the ways in which teachers/students engage in online/offline learning activities
3. The *socio-techno-spatial relations dimension*
- the organization of physical space and cyberspace as they relate to the teacher and student interactions with technology-based tools
4. The *interaction with the “outside world” dimension*
- the ways in which students interact, online and offline, with people outside of their immediate classroom context; |
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</table>
| 2006 Theory    | (Hunley and Schaller 2006) See chapter | Evaluation Frameworks | A potential Learning Environment, can be described using variables associated with:  
  - Environment \( \text{what, where? xyz} \)  
  - Time \( \text{when? t} \)  
  - Content \( \text{what? abc} \)  
  - Structure \( \text{how? VIR} \)  
  ie. the physical and pedagogical variables which may constitute the learning environment. Learning is experienced/influenced in this setting, and is in turn assessed via, eg:  
  - learning outcomes (in measured, institutional terms)  
  - engagement |
| 2006 Study     | (Roberts and Weaver 2006) See paper | Quantitative electronic people counter laptop loan figures head counts room booking figures Qualitative Interviews, focus groups, questionnaire, photography Analysis of environmental benchmarks and whole life cost Participant observation by staff, eg, keeping a daily log of activities, personal reflection, construction of ‘learning scenarios’ to test the pedagogical principles under scrutiny, sweeps of the spaces | Variables include:  
  - Room and laptop usage,  
  - Occupancy rates  
  Variables assessed via questionnaires, interviews, etc not stated (?) |
| 2008 Study     | (Beichner 2008) See paper | - Conceptual Learning Assessment, using nationally-recognized instruments for pre- and post-testing.  
  - Focus groups,  
  - Student interviews,  
  - Classroom video and audio records,  
  - Collection of student portfolios. | - Concept learning,  
  - Long-term concept retention,  
  - Skill development,  
  - Attendance rates,  
  - Retention rates,  
  - Student performance in later courses, and  
  - Affective outcomes (eg. student/instructor ‘preferences’, ‘enjoyment’, ‘values’). |
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<tr>
<td>2008 Study</td>
<td>(Alexander, Cohen et al. 2008) See paper</td>
<td>Qualitative Questionnaires Pre- and post-course instructor Interviews Class observations</td>
<td>Question 1: Instructor Attitudes and Expectations What are faculty attitudes and expectations for the new learning spaces as they start the semester? Do their attitudes and expectations change over the term, and are they fulfilled? Question 2: Student Perceptions How do students perceive the new spaces? Are they comfortable in the new arrangements? How do the new spaces affect their relations with their classmates? With their instructors? Question 3: Learning Technologies How are the technologies used, both from faculty and student perspectives? What teaching/learning strategies were used, and how did the rooms facilitate or inhibit those strategies? Question 4: Physical Features In what ways did the physical features, such as seating, sightlines, lighting, ventilation, acoustics, and power affect teaching and learning? Were any adjustments made by faculty in their teaching approach specifically in light of room design/function? If so,</td>
</tr>
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| 2008 Study       | (Tom, Voss et al. 2008) See paper | Qualitative  
  - Faculty observations, using student behaviour (difference from traditional settings) as a criteria;  
  - Faculty and Student Blogs, recording impressions and reflections on how the space affected their teaching and learning;  
  - Video observations;  
  - Surveys; and  
  - a Faculty debriefing meeting. | Not explicitly stated but implied in the following: The authors report an impressive, positive response on the part of staff and students, expressed via:  
  - demand for access to the studio,  
  - levels of student engagement,  
  - enthusiastic descriptions of personal experiences: 'a sense of responsibility to use the room well', 'a special place', a 'privilege', a 'refreshing change ..'  
  - staff accounts of support for change in their teaching,  
  - ease of use by and level of support for students with disabilities.  
[for full account see article] |
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| 2009 Study       | (Hunley and Schaller 2009) See paper | Quantitative and Qualitative Data was collected via multiple methods, ie. student and faculty focus groups, interviews, surveys, photograhic observations, observations, rate of use data, as well as self-created, self-administered assessments cultivated in a two year project undertaken with faculty, including activities such as ‘Active Visioning’ and Goal Attainment Scaling. Data was also generated by what the authors call a ‘quasi-experimental’ approach, in which they rotated four classes through four different classrooms throughout a semester. | Criteria were chosen to identify relevant measurable factors, arguing that:  
- key characteristics of learning spaces and relationships had to be identified in order to lay a foundation for ongoing measurement;  
- [and] student and faculty focus groups, interviews, and surveys can provide these data.  
- given that the link between pedagogy/programming and learning is well researched in the literature, in this study the former will be measured via student learning preferences;  
- learning can be assessed through measures of engagement, eg via the NSSE and photographic studies;  
- the learning space should be redefined to consist of the content to be learned, as well as the environment in which the learning occurs.  
Relationships examined, between:  
- space and pedagogy, programming and engagement;  
- space, faculty, students and learning outcomes, and  
- innovative pedagogy and learning spaces. |
| 2009 Review      | (Pearhouse, Bligh et al. 2009) Report on a number of innovative studies in Centres for Excellence in Teaching & learning (CETL) | 1. University of Durham, Liz Burd: Ten booths with AV recording Electronic data collection, eg. online resource access | A rich volume of data was generated examining varying facets of the learning and teaching experience, from physical spaces to temporal issues and usage patterns of surfaces, with both learners and teachers a focus of the evaluation.  
Most of the evaluation appears to have thus far examined usage patterns over time, providing answers for questions surrounding the enablement of new scenarios, and how resources and space are being used. Issues of learning may be addressed more fully in time .. |
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<td>See paper</td>
<td>2. Loughborough &amp; Coventry Unis: Focus groups, feedback forms, swipecard data</td>
<td>Researchers interested in how undergraduate maths students’ “mathematical identities” changed with exposure to university teaching.</td>
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<td>• Why do many students become alienated from mathematics even though they have chosen to study it at university?</td>
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<td>• How space facilitates interaction between tutors and students, and facilitates student-student peer support.</td>
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<td>• Can the provision of such space reduce alienation, improve engagement?</td>
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<td>Swipe card data is analysed to produce results about the identity of student visitors, their repeat visit patterns, their associated departments and how usage from different departments has varied compared to previous years.</td>
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<td>3. Uni of Warwick &amp; Oxford Brookes: Ethnographic study, using action research; a single class and teacher observed in a number of different environments over 2 terms, 2 (out of 3) researchers present at each session.</td>
<td>The researchers … wanted to pilot new evaluation methods. They also wanted to look at the interaction between space, pedagogy and curriculum. Specifically they looked at how the social dynamics of the group, including the teacher, were affected by space and how the orientation to learning and teaching was adopted in that space.</td>
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<td>4. Uni of Nottingham, SPLINT, Gary Priestnall &amp; Nick Mount Small informal focus groups</td>
<td>Open discussion around aspects of the learning space and in particular, the benefits and disadvantages of various technologies used to support specific teaching activities. The students were asked to reflect upon their use of the space – were they working individually? In small pre-allocated groups? Or in ad-hoc groupings? Further questions centred around their use of the technology within the space and any problems or issues they experienced.</td>
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