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Teaching Enhancement Project Fund Report

Exploring Complex Learning Spaces

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Abstract

This paper reports on a project seeking to understand the complexity of learning spaces which are inhabited by students in higher education institutions. Developing work already carried out by the project leaders on experimental learning spaces within the university, this is a project which aims to gain a better understanding of the 'learning lives' of students beyond the formal learning spaces such as the lecture theatre, laboratory and seminar room. Using a mixed methods approach focusing on survey and photo-ethnographic methods data will be developed from the general to the particular to investigate the other spaces which students use to develop their learning. These spaces include both physical and virtual spaces, as well as on and off campus spaces, including cafes, libraries, study bedrooms as well as virtual learning environments and social networking/Web 2.0 technologies. This research intends to consider the complex interplay of these different spaces in the learning of students and also how they relate to the formal spaces of which we have a clearer understanding. This project will therefore aid academics in better understanding the dynamics of the learning ecologies which underpin the experiences of students within the university.

Keywords: Formal learning spaces, Informal learning spaces, complexity theory, Deleuzean Rhizomatics, Striated/smooth spaces

Introduction

Modern universities are increasingly complex places, which no longer rely on a simplistic process of lectures and tutorials as the only, or major, medium of learning and discourse. At the same time there is a growing interest in many countries concerning the design of formal learning spaces to ensure the development of places which are geared towards the diverse learning needs of students (JISC, 2006; Jamieson et al., 2000; Oblinger, 2006; Johnson & Lomas, 2005). It is within this context that the present researchers undertook some small-scale research into the utility of three experimental formal learning spaces based on the perceptions of various stakeholder groups (2010). Based on our results and analysis we proposed an initial framework or model for understanding and evaluating formal learning spaces which we named the DEEP model due to its main elements (Dynamic, Engaging, Ecological, Participatory). During the course of the research it became apparent that the formal learning spaces used by students was only one element of a much wider series of spaces which they made use of in their learning. These observations were further developed through an exercise which was undertaken with a group of students following an MA in International Education, focusing on their use of space for learning, and which formed the methodological basis for part of the present project. The informal insights which emerged from this exercise were strongly suggestive of an 'ecology' of spaces, interacting suites of spaces which together create the wider learning environment of students. The present paper summarises our initial attempts to capture and understand complex and emergent patterns of learning space use, and offers a theoretical framework as a basis for analysing and understanding the data which has been collected.

Complex spaces of learning in higher education – complexity thinking and smooth/striated spaces

Williams et al. (2011) highlight the impact that technology has had on the media through which students learn, and argue that this has led to more complex processes of learning at HE level. They suggest that these more complex processes are leading to blurred boundaries, increasingly resulting in 'emergent learning', which they define as,

> …learning which arises out of the interaction between a number of people and resources, in which the learners organise and determine both the process and to some extent the learning destinations, both of which are unpredictable. The interaction is in many senses self-organised, but it nevertheless requires some constraint and structure. It may include virtual or physical networks, or both. (p.41)

This definition emphasises the varied processes involved in learning in the modern HE sector, and as such can be seen as associated to complexity theory, a theoretical framework which Williams et al themselves identify as significant in their thinking. Complexity theory was initially developed within the physical sciences as a way of describing and explaining systems which are too complex to understand through linear modelling, and which cannot be accurately predicted into the future, but which nevertheless demonstrate underlying patterns. Many such systems exist in the natural world, such as ant hills (Johnson, 2001) and convection cells, and are characterised by activity where individual actions appear almost random, but which show coherent characteristics at the level of the whole population.

Having established a position within the physical sciences, complexity theory has also become increasingly used to describe and analyse social settings, which themselves can be seen as complex systems which demonstrate coherent patterns, but which are not linear. Early examples of work in the social sciences included research on cities (Johnson, 2001), and the processes and patterns of organisations (Stacey, 2001; Fonseca, 2002). The developing interest in complexity thinking at this time led to an emerging interest in educational research. Fullan (1999) was an early adopter of complexity thinking within education, basing his ideas on the work of Stacey (1996) in management and business studies. Fullan saw the importance of complexity thinking in its ability to explain the adaption of organisations to rapidly changing environments and also in its claim that cause, effect relationships are rarely linear with change emerging out of coherent, but diverse and complex processes. Morrison (2002) further developed the use of complexity theory as a lens for understanding school leadership, taking further the arguments of Fullan (1999) that schools are complex, non-linear systems which have a level of unpredictability.

Davis and Sumara (2006) offer a summary of the factors which together create complex systems within an educational context. Emergence is described as a central element of complexity thinking as it is the interaction of systems and sub-systems which leads to change and the development of new ideas and ways of working. It is the complex interaction of agents and systems at a number of scales which emerge in different ways, leading to unexpected and novel outcomes, and where change in one area or sub-system can have disproportionate impact elsewhere within the organisation, and vice-versa. For emergence to occur, there is the need for:

- internal diversity
- internal redundancy
- neighbour interactions
- distributed control
- randomness
- coherence

Diversity highlights the need for any complex system to have a natural variability so as to allow the opportunity for different actions or behaviours to occur and develop. This is allied to the concept of redundancy, as in any system which allows for diversity it has to be accepted that both duplications and excesses will occur, leading to what would traditionally be seen as superfluous resources, and inefficiency. However, it is by encouraging diversity and allowing a degree of redundancy that systems can evolve, change and emerge. In the case of learning spaces, this suggests that a wide variety of spaces (both physical and virtual) should be encouraged and trialled so that students have the opportunity to organise their spatial needs from the bottom up, and through organic experience or trial and error. This means that there may be some redundancy in the spaces provided, perceived ‘inefficient’ uses of space, but as students’ preferences and activities change over time, this redundancy effect may well shift from space to space and change in magnitude over time. Therefore, having a level of diversity and redundancy in the system may actually be a positive factor in increasing student satisfaction as well as facilitating varied ways of working.

Complex systems are trans-level phenomena. In the case of learning, Davis and Sumara (2006) argue that: "…for a social collective to expand its repertoire of possibilities, the individuals that comprise it must themselves learn and adapt" (p.142)

Individual and group interests need not compete for space, and in learning, creating spaces where neighbours are encouraged and enabled to interact, enrich the process of learning. Davis and Sumara (2006) emphasise that in talking about neighbours, it is ideas and other forms of representation which need to be given the opportunity to interact, moving beyond a mere consideration of people as physical organisms. Therefore, spaces that allow for both individual study, and collective sharing of ideas are important, as learning is not always an individual process; it occurs at a number of different levels depending on the focus, intentions and processes involved. In turn, this leads to the importance of distributed control. Distributed control includes the idea of sharing, and hence, a belief that control in learning becomes a matter for all rather than as an activity controlled by an 'authority' figure, leading to notions of consensual working. Nested levels of activity and distributed control have a ready overlap with the development of 'ecologies' of learning spaces as students need the opportunity to work both individually and interactively – again, in both physical and virtual space. This requires a spectrum of spaces and opportunities for learning to allow for the diverse and personal preferences students have for their learning environments.

Finally, complexity theory focuses on the need to have both coherence and randomness/freedom. For a system to operate successfully it cannot be chaotic, it needs a level of consistency or order. However, if the level of system coherence is too restrictive, it limits the possibilities and diversity in emergent activity. In the case of learning spaces, coherence can be argued to emerge from the formal, timetabled learning opportunities, and 'official' structured online materials which are central to learning within a university course. Learning as an activity becomes structured, and therefore to retain the diversity and distributed nature of an emergent complex system, it is important that other learning spaces and opportunities are less structured and allow freedom for students to find their own emergent behaviours and preferences in terms of media content and locations for learning.

As a complex system, learning and the spaces it takes place within are emergent and constantly changing, but at the level of the population of students may appear coherent and stable. The creation of a number of different spaces and associated learning opportunities are crucial for providing such healthy, emergent systems.

One way in which we can consider how architectural/learning space configurations can bring the coherent freedom suggestive of complexity theory, is to use the concept of 'Rhizomatics' developed by Deleuze and Guattari (1987). They describe a theory of relations which allows for connection and heterogeneity, with no hierarchical structure, as opposed to traditional hierarchical spatial frameworks. They associate these relational distinctions with two forms of cultural space, 'striated' and 'smooth'. Striated spaces are those which are stratified and managed cultural spaces, such as activities in formal learning spaces, which act to contain and direct. Smooth spaces are those which are rhizomatic in nature, which are spaces of possibility, fluid spaces of opportunity which allow for creative and original expression. Movements from striated, hierarchical spaces to smooth, rhizomatic spaces are described as lines of flight, allowing us to act and think differently (Avalos & Winslade, 2010). Allied to differentiated cultural space is the concept of territorialisation and

deterritorialisation. Territorialisation occurs where there is spatial and cultural stability, as in striated space, and is the process through which social and spatial boundaries and identities are created. Therefore, lecture theatres may be deemed as spaces of territorialisation as they have not only spatial boundaries, but encourage the creation of stable identities. The pursuit of a line of flight into smooth spaces beyond that of the formal learning space is described as a process of deterritorialisation as boundaries are broken down and fluid movement and cultural heterogeneity emerges. This can present issues, as Savin-Baden (2007) states:

> The contrast between smooth and striated learning spaces introduces questions about the role and identity of universities and academics in terms of what counts as a legitimate learning space and who makes such decisions of legitimacy (p.14).

However, if we see the interplay of striated and smooth spaces, territorialisation and deterritorialisation, as a positive process rather than inherently problematic, adding to diversity and opportunity for learning, territorialisation and deterritorialisation can be seen as creative juxtapositions. As Dovey (2010) states in using Deleuze and Guattari to understand issues of architecture, identity and power:

> The concept of territory here is broad enough to encompass everything from the rhythms of the urinating dog to nationalism; yet for Deleuze and Guattari (1987: chapter 11) territoriality is creative rather than defensive, a form of becoming at home in the world (p.17).

So what does the introduction of the theoretical work of Deleuze and Guattari add to a complexity view of learning spaces? We argue that the emphasis on striated and smooth spaces gives a context for understanding the emergence of complex systems through diversity, redundancy, freedom and coherence. The utility offered through lines of flight and the exploration of smooth spaces and deterritorialisation, ensures that learning spaces, both cultural and physical, are diverse in nature and offer distributed control, thus allowing the emergence of both individual and group interactions with(in) space. It is in the creation and enactment of discourses both within and between striated and smooth space which provide the contexts in which emergence can occur.

In conclusion, complexity theory and Deleuzean discourses of spatial interaction and power can be brought together to demonstrate that to be generative, learning spaces need to be diverse in both physical and cultural terms, allowing students to negotiate their learning in the most positive way possible, as they move between and negotiate their use of spaces as the context for their learning.

Methodology

To capture perceptions and experiences of students concerning their preferences and use of learning spaces, we used two methods. An online survey was used to gain an overview of a series of spaces related issues. The main categories of questions were based around:

- Learning approaches preferences
- Views on formal learning spaces such as lecture theatres and laboratories
- Views on informal learning spaces such as cafes and the library

- Students' use of technology
- Student views on the need for green spaces
- Student views regarding their vision of the 'perfect' university of the future

In each section there was a mixture of Likert Scale questions based on a 5 level categorisation, and open questions which allowed students to give short explanations of their views.

A link to the online survey was sent to the Students' Union organisation at the university, as well as the environment team for distribution to university students, and was also posted to the university's e-newsletter. This would have given a widespread exposure for the survey. The results were then collated and used to gain simple descriptive patterns from the data.

To support the results from the survey, a photo-ethnographic method was used which had been developed a year earlier in a small pilot study. The method focuses on capturing the spaces students use for learning over the course of a week by asking them to take a photograph of each space. At the end of the week, students are asked to bring thumb-nail copies of their photos to a workshop. At the workshop, they are asked to place the photos on an A3 piece of paper (example given in Figure 1), and next to each write some short notes about their emotions whilst using the spaces, who, if anyone, they use the space with, and the types of technology they use there, if any. They are also invited to link the photos if they feel that the spaces relate to each other.

This exercise was intended to be used across six academic departments, one from each of the six colleges at the University of Leicester. Unfortunately, the contact at the Students' Union who was to broker the workshops left his post before they were organised. As a result, we collected data from teacher trainees and international Masters students in the School of Education. In total, the technique was used with 35 students which was the same as the intended sample, but from a more restricted spectrum of students. This restricts the breadth of the study compared to its original design, but still offers some interesting insights.

The photo summaries were analysed by considering the types of space present, the extent to which students saw links between spaces, the patterns of use made of technologies, and their emotions concerning the spaces.

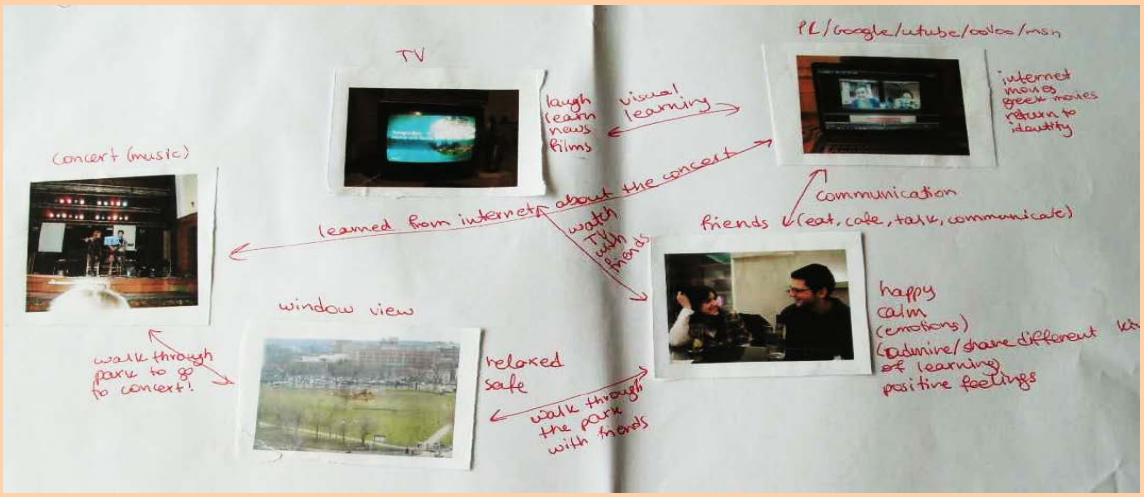

Figure 1: Example of a photo summary of spaces used during the course of a week

Results

The survey only returned a total of 97 responses, which is relatively small, but none the less gives an impression of a variety of views from a wide spectrum of students. Of those responding, 77% were female and 23% male, with 78% in the 18-25 age range, with roughly equal percentages in increasing ages, with the oldest respondents being in the 45+ category (7%).

Table 1: Breakdown by percentage of the five largest respondent courses.

Course	Percentage of Respondents
Biological Sciences	20
Education	14
Geography	10
Maths	6
Geology	3

Thirty nine courses were represented (Table 1), showing that there was a spread of views, although not statistically representative of the university.

There was also a broad spectrum of course types amongst the respondents, shown in Table 2, with the greatest group studying for BSc, followed by BA, PGCE and PhD.

Table 2: Breakdown by percentage of the five largest respondent degree levels.

Course	Percentage of Respondents
Bachelor of Sciences	20
Bachelor of Arts	14
Post Graduate Certificate in Education	10
PhD	6
Master of Sciences	3

Whilst the survey return was small, there was a wide spectrum of respondents, with a number of different experiences. The results are small-scale and therefore in a sense impressionistic, but give some interesting insights into patterns of learning and the use of learning spaces.

Learning preferences (Table 3) show that there are a wide number of learning activities which students enjoy. Preferred learning activities include finding information through using the internet (84% agree), and informal discussion with friends (83%). Other activities are less well received, including lectures and note taking (51% agree) and the use of simulations and roleplay (29%). Reading for understanding (60%) and small group discussion through the use of tutorials (64%) falls somewhere in between. The

results suggest that students find a spectrum of different learning opportunities useful, but seem to value more informal learning activities more than formal.

Formal Learning Spaces

Table 3: Percentage responses to questions relating to learning preferences.

	Strongly agree	Agree	Sometimes agree, sometimes disagree	Disagree	Strongly disagree
I like teaching approaches which focus on facts and content	24	54	21	1	0
I like teaching approaches which focus on discussion	19	41	34	6	0
I like teaching approaches which focus on lectures and notetaking	9	42	36	12	1
I like teaching approaches which focus on problem-solving and decision-making	24	42	28	6	0
I like teaching approaches which focus on simulations and/or role-play	6	23	39	22	0
I like to learn by myself	15	34	41	9	1
I like to learn with others	13	33	47	5	2
I like to read books and journal articles to develop my understanding	27	33	25	14	1
I like to use the internet to find information sources	36	48	12	3	1
I like to discuss ideas informally with friends to help me learn	39	44	14	2	1
I like tutorials	23	41	26	7	3

Views about the 'formal' learning spaces within the university are generally positive (Table 4). 58% agree that they like these learning spaces, although the results for specific spaces are lower, with the lecture theatres (40%), seminar rooms (42%) and laboratories (41%) all scoring below 50%.

Table 4: Percentage responses of views concerning formal learning spaces within the university.

	Strongly agree	Agree	Sometimes agree, sometimes disagree	Disagree	Strongly disagree	Not applicable
I like formal learning settings (such as lecture theatres and seminar rooms)	16	42	29	13	0	0
I like the lecture theatres in our university	7	33	42	7	0	11
I like the seminar rooms in our university	5	37	34	7	1	15
I like the laboratories in our university	15	26	5	1	0	53

Some formal spaces are not always perceived as appropriate for the task, or are seen as needing refurbishment. For example two typical responses were:

> Some of them are outdated and old, some of them lack in space and facilities but others are more appropriate in terms of facilities and modernity.

> The Fraser Noble Hall is often cold, badly lit and has poor acoustics.

However, the more modern stock of lecture theatres is more positively received, for example:

> They are modern so are comfortable and you can easily see the board/overhead projector from all areas in the room. The advanced computer systems also mean the sound system is good-quality so we can watch videos etc. easily.

These responses suggest the importance of retaining a high quality of maintenance in formal spaces so that the learning environment remains conducive for learning.

A number of other formal spaces are identified by students, most of which are specific spaces within departments, and in all cases, even though the numbers of students identifying the spaces are small, they are very positive about them. This might be due to the specialist design of these rooms which fits with the needs of specific courses, for example, a comment on a computer room by a computer sciences student:

> plenty of computers well spaced out and with excellent seating. raised platform at the front makes lecturers easy to see.

The students spend a varied amount of time in formal learning spaces, which will reflect the type of degree being followed. The overall breakdown across respondents is shown in Figure 2. 54% of respondents spend 10 hours or less a week in formal spaces with only 15% spending more than 20 hours. Therefore, formal learning spaces are not used for long periods of time by most individuals in any typical week, suggesting that more time is spent in informal spaces.

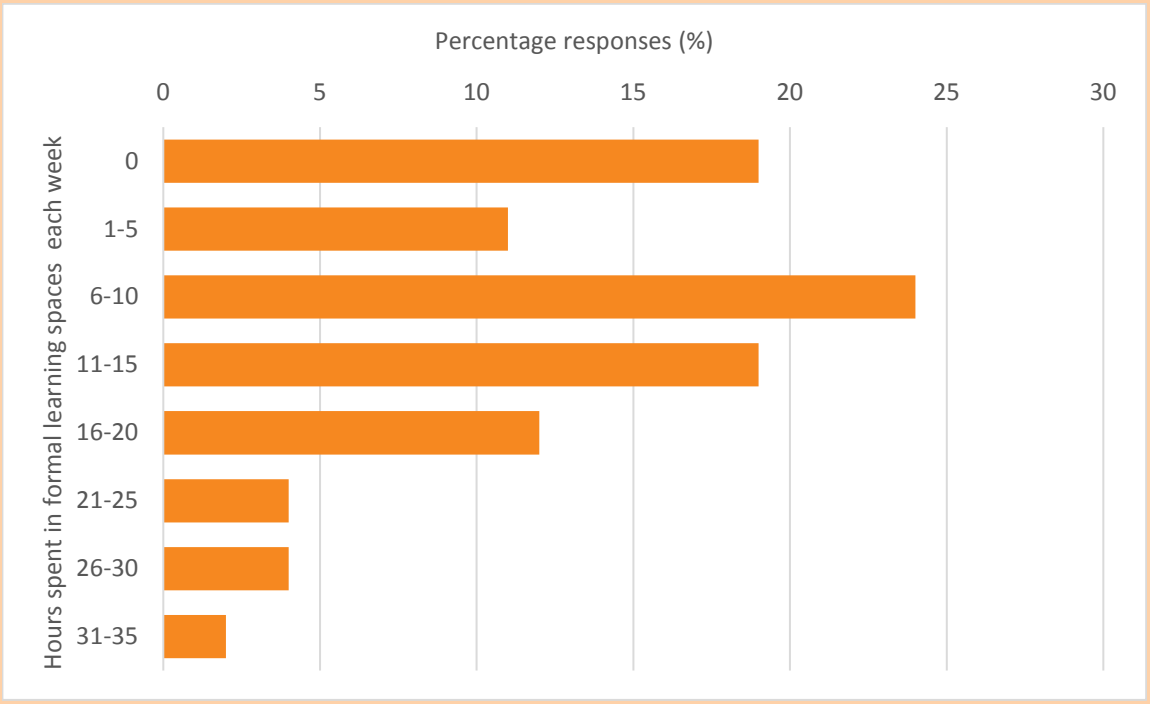

Figure 2: Percentage responses to the number of hours spent in formal learning spaces each week

Informal Learning Spaces

Four main informal spaces were identified within the survey, domestic spaces such as home and study bedrooms in university accommodation (77 respondents), university libraries (67), cafes (22), and public spaces (17) such as parks and public transport. The amount of time spent in these spaces varies (Figure 3), with more shared spaces such as cafes and public spaces being used for small numbers of hours each week. However, they are clearly useful collaborative spaces for learning, for example:

> This is a good space [café] for discussion with other students and provides a more relaxed atmosphere which makes people feel able to chat and contribute ideas which can sometimes be difficult in other spaces.

> Cafés on the main campus. These are accessed before or after library visits. Sometimes there are on an individual basis but are often a group space where i meet other students and discuss progress and problem areas of work. I like this area as it is a social event as well as a learning space. Informal and relaxed but with stimulating conversation and a meeting point when on the main campus.

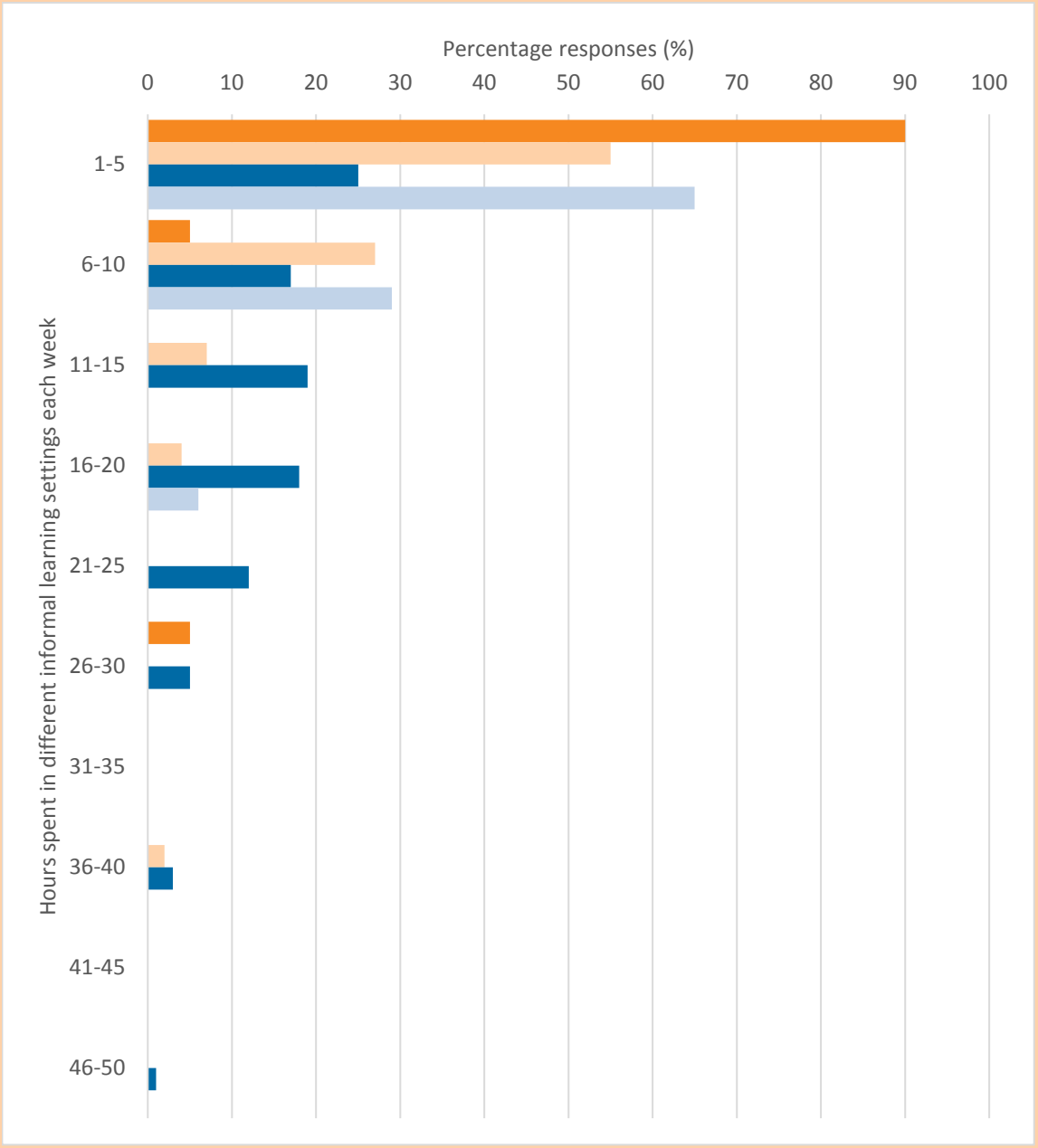

Figure 3: Distribution of time spent in different informal learning settings by percentage.
Key: dark orange – café; light orange – libraries; dark blue – domestic spaces; light blue – public spaces

Fourteen (from twenty-two) of those saying they use the cafés, do so most often as part of a group. This suggest that the cafés are sometimes used as individual spaces, but more often as social learning spaces. Domestic spaces are used for longer hours on average with more than half of respondents using these spaces for 11 hours or more each week. Domestic spaces are predominantly used as individual, reflective spaces where quiet and freedom are highlighted as positive factors. 86% of respondents who listed these spaces use them for individual study only. Typical views expressed are exemplified below:

> It is quiet and I have all my notes and books at hand. I can control the temperature and light in the room. If I need to take a break I don't have to worry about my belongings from being stolen. I can bring my food to my desk and keep working. I can adjust how I am seated and change my workspace every so often to keep comfortable.
>
> Has all of the resources and equipment I need in it. More relaxed atmosphere than the library or seminar rooms. Easy to switch between work and leisure activities.

The library is also seen as a very positive space for learning, and due to a recent refurbishment and extension, is a modern and well-designed learning space. The majority of respondents only use the library for 5 hours or less per week, and whilst 64% state that they use it for individual study, 36% state that they like to use it for group work, including the use of the group work rooms designed for informal group work beyond lecturer led learning. Examples of comments made by respondents which reflect their opinions of the library are:

> The library is fantastic for studying because of the group-study, quiet and silent areas. Although it can be difficult to access a computer, but working in the silent zone is a great way to improve work efficiency.
>
> quiet studious atmosphere, comfy chair, internet access, large amount of reading material close by, away from distractions (limited mobile signal), sofas for reading and lovely toilet facilities.

Students were also asked about their use of web based applications to gauge the degree to which technology is an important element of their learning space (Table 5). The use of both email and the internet are almost ubiquitous, with 94% and 97% of respondents respectively making daily use of these applications. This links to the strong preference in using the internet for learning through searches for useful information. Facebook is also popular, although 13% of respondents do not make use of it. Blackboard is used regularly, with 60% of respondents using it daily.

Table 5: Percentage response to use of web-based technology.

	Not at all	Daily	Two or three times a week	Once a week	Once every two weeks	Once a month
Blogs	74	11	2	2	4	7
Wikis	44	14	12	15	4	11
e-mail	0	94	4	0	1	1
Facebook	13	76	3	3	0	5
Internet	0	97	2	1	0	0
Blackboard or other	1	60	19	10	5	5

However, both blogs and wikis are used much less, and suggests that many of the respondents are consumers of information from the internet, but are not producers, but make daily use of technology in their learning.

Students were also asked to give their views on the importance of ecological and sustainability issues in relation to the learning spaces they use (Table 6).

Table 6: Percentage of responses to questions concerning the environmental sustainability of learning spaces.

	Strongly agree	Agree	Sometimes agree, sometimes disagree	Disagree	Strongly disagree
It is important to me that my learning spaces include natural elements such as plants and natural light	42	40	15	3	0
It is important to me that my learning spaces are sustainable giving attention to fair procurement and careful resource use	21	44	26	9	0
It is important to me that my learning spaces are sustainable giving attention to the opportunity to recycle	28	49	16	7	0

Students agree (82%) that learning spaces which include elements such as natural light and plants are important in creating a positive and conducive environment. They also believe the opportunity to recycle is important (77%), whilst a majority also think fair procurement and careful resource use are important (65%). In general this strongly indicates that environmental consideration is important in the design and upkeep of learning spaces.

Thoughts for an ideal future

Finally, students were asked to think into the future, and consider what their 'perfect' university would be like. To begin with, they were asked to list five words which would best describe their perfect university (Figure 4). The results are shown as a word cloud, with the most often mentioned words being the largest in the diagram. The most often used words are linked to the environmental qualities of the university, such as comfort, light, access, quiet, relaxed and spacious.

Figure 4: Summary word cloud of the words used by respondents to describe their 'perfect' university

In addition to a list of words, students were also invited to write a short description, of up to 100 words which would describe their university. Of the 97 respondents, 15 took this opportunity. Responses stress the need for space, natural environments, flexible learning and working approaches, and extended use of technology. Two examples which exemplify the predominant views are given in full below:

> My ideal university would have spaces which are accessible for all and interact with each other. Faculties would not work in isolation. Spaces would be interchangeable and adapt to current needs. Moving walls/screens would enable rooms to be changed. Spaces would be layered and visible by others with transition spaces interesting and useful. Sustainability would be paramount. Latest technology would be available with opportunities for sharing facilities and resources, linking to other universities worldwide (joint sessions). Innovative design of furniture and environments.

> My ideal university would have a wide range of different types of learning rooms because people learn differently and some people might want individual spaces whereas others might need group learning spaces. Ideally these should all be; well lit, clean, accessible from accommodation / near lecture halls and have a computer station.

Photo-ethnographic outputs

Having gained a general picture of the uses of extended learning space across and beyond the university, we then carried out the photo-ethnographic workshop to sample in greater depth the use made of learning spaces by students. The variability in the 'spaces-boards' which resulted was surprisingly large, as was the variety in the ways students decided to categorise and locate the spaces they use.

Figure 5 shows a response from a student on the MA in International Education, School of Education. This student identifies six different learning spaces. On the formal side of the board, two classrooms are identified where the level of interaction with others depends on the activities which are completed, and emotions vary from keen interest to boredom depending on the topic being covered. Laptops are used in these sessions. The spaces are seen as interrelated as the learning which goes on in them support each other. The domestic informal spaces identified (bed and bath) are both more reflective and individual in nature and technology plays no part, but the process of learning is more informal, for example, the student's children do come into the bathroom to discuss their learning. These spaces are also identified with happiness and contentment. The last two spaces are a cafe in the School of Education and the student's car. The café is a place to discuss and debate issues covered in formal learning sessions with other students. Technology is only occasionally used here, and again, the debate and informality of the space make it positive emotionally. The student links this space with the classrooms in that the café is used within and after formal learning sessions and therefore acts as an opportunity to fix and deepen understanding covered in the formal sessions. Finally, the student's car is identified. The use of this space for learning depends on whether the student is giving a lift to other students or not. When other students are in the car, it is another space for debate and discussion, similar to the café. However, when alone, the student uses the time to 'unpack sessions/workshops', developing thinking processes, and again this is a positive space for the student emotionally.

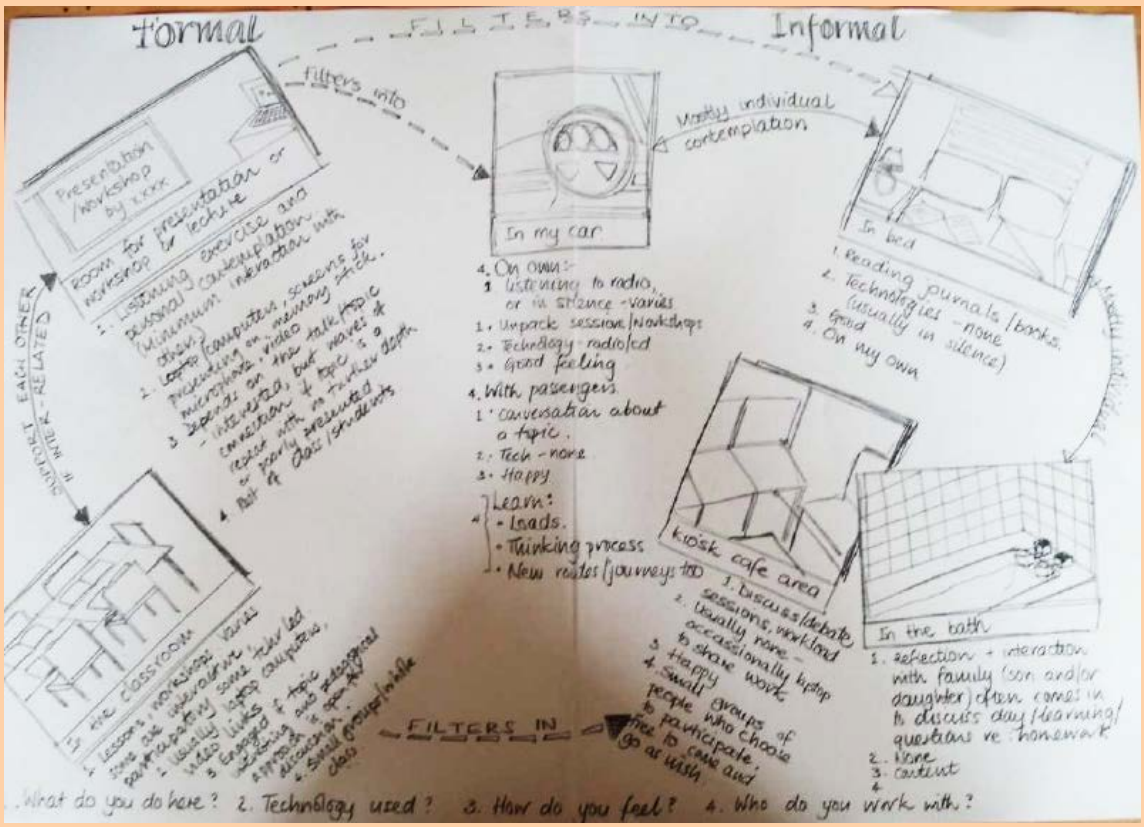

Figure 5: 'Spaces-board' for student on MA International Education course, School of Education

Figure 6 shows the summary for a student from the Postgraduate Certificate in Education course. This student decided not to include photographs, but again, links suites of spaces into wider networks of

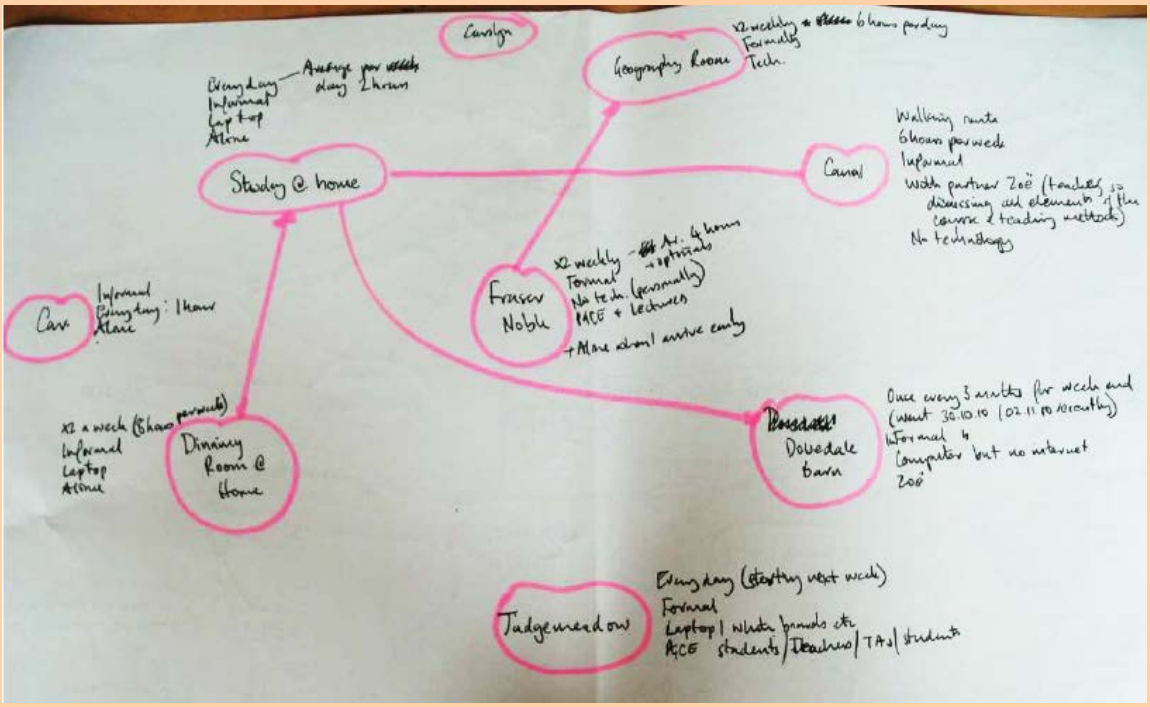

Figure 6: 'Spaces-board' for student on Postgraduate Certificate in Education course, School of Education

space for learning. Domestic spaces are again important, but here, a study and dining room are highlighted. In both cases, learning is individual and use is made of a laptop. However, linked to this is a space identified as 'canal' and is a route regularly walked by the student with her partner. Her partner is already a teacher, and they discuss issues arising from the course, and methods for classroom teaching. Two rooms at the School of Education are also identified, a lecture theatre (Fraser Noble Hall), and a small seminar room used for specialist subject sessions. These are linked in the mind of the student, and are more group orientated with use again of technology. As with the first student, a car is used by this student and is again highlighted as a space for learning and reflection.

The student spaces-board in **Figure 7** is one created by another PGCE student. Again, a number of spaces are represented. In this case, domestic spaces are important, and are positioned centrally in the 'spaces-board'. Some of these spaces are encountered in relation to others, such as the dining room and living room, both of which are seen as resulting in 'communal learning' through discussion with family members, in some cases in reaction to the television. Learning space extends out to a local reservoir where the student jogs by themselves resulting in a lot of reflective thinking, but at other times, with parents, again leading to discussion.

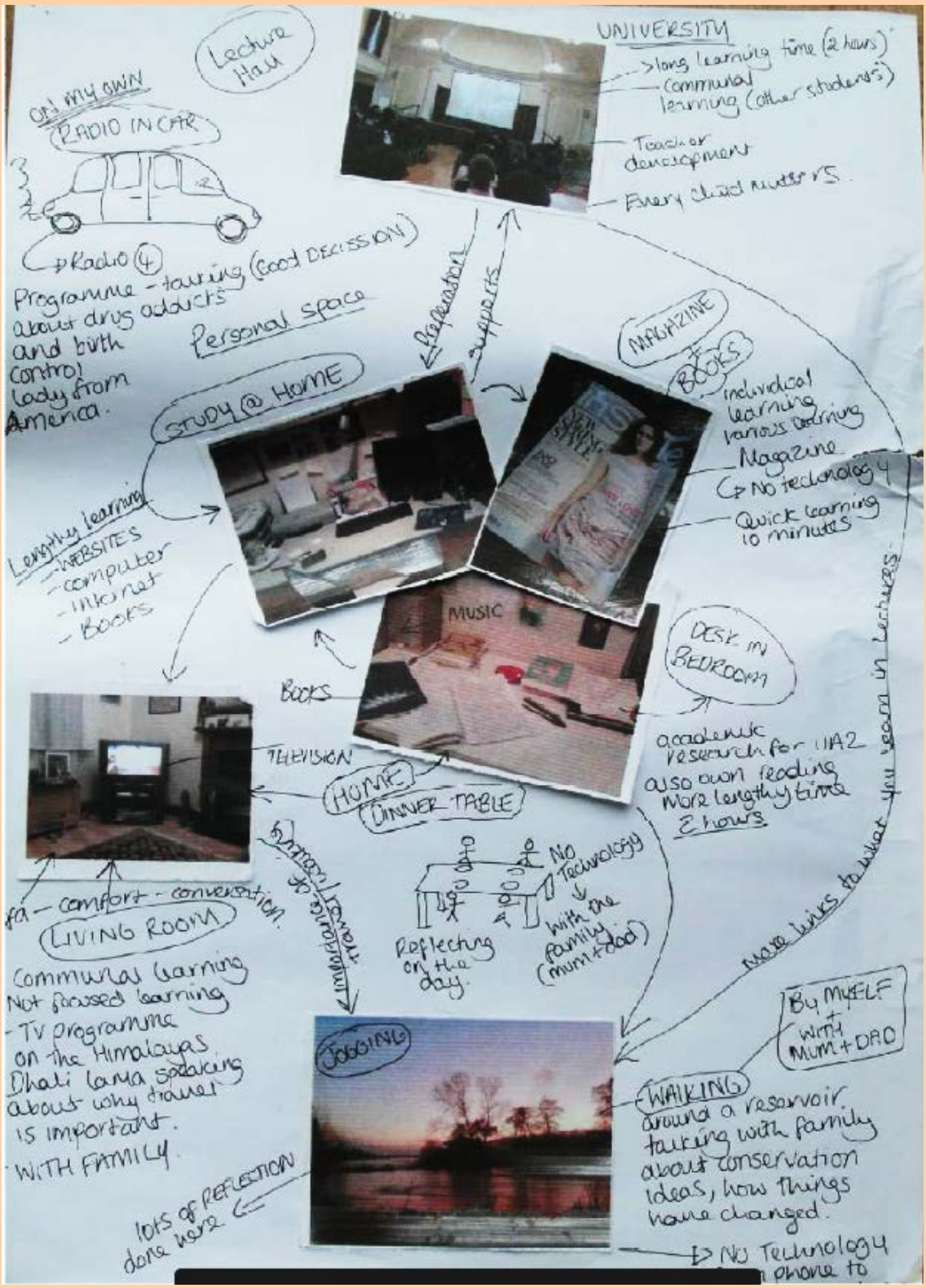

Figure 7: 'Spaces-board' for student on Postgraduate Certificate in Education course, School of Education

Further spaces within the home are solitary spaces, and may include a greater use of technology, including a study which is identified as the location for 'lengthy learning' as well as a desk in a bedroom. University spaces are actually only represented in one element of the 'spaces-board' and highlights a lecture hall which again is identified as communal learning with other students. Finally, one again, a car is included and listening to a radio is highlighted as the main media for learning. This particular student foregrounds personal and family spaces in domestic settings far more than the other two students, but also demonstrates a wide range of learning activities within these spaces.

These examples are illustrative of the wide spectrum of spaces used by the students who completed 'spaces-boards'. As such, whilst the spaces students use can be classified into a small number of 'categories' the lived experience, and links between spaces and learning are highly complex and particular to each individual, depending on location of home, social habits, such as smoking, and preferences in terms of uses of technology and emotional responses to particular learning spaces.

The results from the study show a number of patterns in relation to preferences in the wider spaces used for learning. The survey, whilst relatively small in terms of responses, does capture a number of views from across the university, and give a clear view of the trends of use and opinion at the level of the 'population'. However, when we begin to look at individuals, there is a wide range of experiences, demonstrating that learning space use and dynamics are very complex at the individual level.

Discussion

The results from this study demonstrate that students' learning and the locations in which it occurs are extremely varied. In terms of learning preferences, students appear to prefer more informal approaches, all be it building on the foundations of formal learning opportunities. They make use of a wide range of spaces, but again prefer informal settings such as the cafes, library and domestic spaces whilst appreciating and understanding the importance of formal learning spaces and activities. Given this pattern of results, the learning space s which exist within the University of Leicester have many of the features of a complex emergent system. There is a great deal of diversity in the available spaces, and the spaces that students choose to utilise. The three students' 'spaces-boards' described in the last section show that they use different spaces within and beyond the university, whilst none of them use the library on a consistent basis, many others who took part in the workshops do; this is an example of the complex factors which are present in personal choices of spaces use. It is possible in this case that there is a distance-decay effect as all three live some distance from the university and travel by car. Others who are based in locations close to the campus more regularly talk of their use of the library and overwhelmingly do so in positive terms.

Given the diversity of spaces, individuals will preferentially use some but not others finding them redundant for their use. However, overall the spaces throughout the university seem well used and whilst any redundancy might be taken as a mark of inefficiency, the related diversity means that students have the opportunity to experiment with and find spaces which suit them as individuals when undertaking various learning activities. There is evidence that the mixed formats of space, such as a café and library being located together, allow for a range of interactions where individuals and groups need not compete for space, but where spaces allow for generative associations of group and

individual learning to occur. Many students talk about cafés as places to discuss and debate ideas, sometimes as a 'break' from individual study in the adjacent library space.

Taking learning dynamics together with domestic spaces, for many students there appears to be a high level of distributed control in their learning activities, with lectures and seminars setting the context and conveying core understanding before allowing students to develop their work in whatever way they see fit. For many students this includes a lot of time in domestic spaces such as study bedrooms in halls of residence, or in dining rooms, studies, kitchens and bedrooms at home. These spaces are central to personal, reflective processes and hence for consolidation and extension of learning.

Finally, the learning spaces and the activities which fill them have a clear level of coherence, through 'structured' coherence, i.e. course frameworks, suggested reading, and timetabled periods of learning which are determined by academic departments and central room booking services, and through 'emergent' coherence. This is the developing coherence of study and the spaces in which it occurs, determined by the individual student's spatial and learning preferences. Beyond 'structured' coherence there is an inherent level of freedom/randomness when and where students are able to create their own identities and approaches as 'emergent' learners.

The results of the study are therefore in keeping with the features of a complex system, with variety, interaction, distributed control and elements of coherence and freedom all giving rise to self-organisation by students which in turn leads to emergent, complex systems of learning and utilisation of space.

The striated spaces of lectures and seminars give the students the coherent basis for their learning, and are therefore of paramount importance. As Dovey (2010) highlights, the territorialised spaces of the lecture theatre are creative and positive in that they are a form of becoming and identity. The lines of flight which students then follow in inhabiting smoother, informal spaces form a positive juxtaposition where they can personalise their learning, and find generative and creative approaches which suit them in taking their learning further. The 'spaces-boards' of the three students shown in the results section demonstrate that such lights of flight are different for each individual, as they follow their own journeys of becoming. This critique offers a more positive reading of the roles of striated and smooth spaces than that offered by Savin-Baden (2008), as it is founded in a belief that emergence is only possible through a generative relationship between the two types of space.

In our initial research on innovative formal spaces (Wood et al., 2010), we developed the DEEP model of learning spaces **(Figure 8)** based on designing and evaluating formal spaces. We argued that learning spaces should be considered as dynamic and changing in space and time.

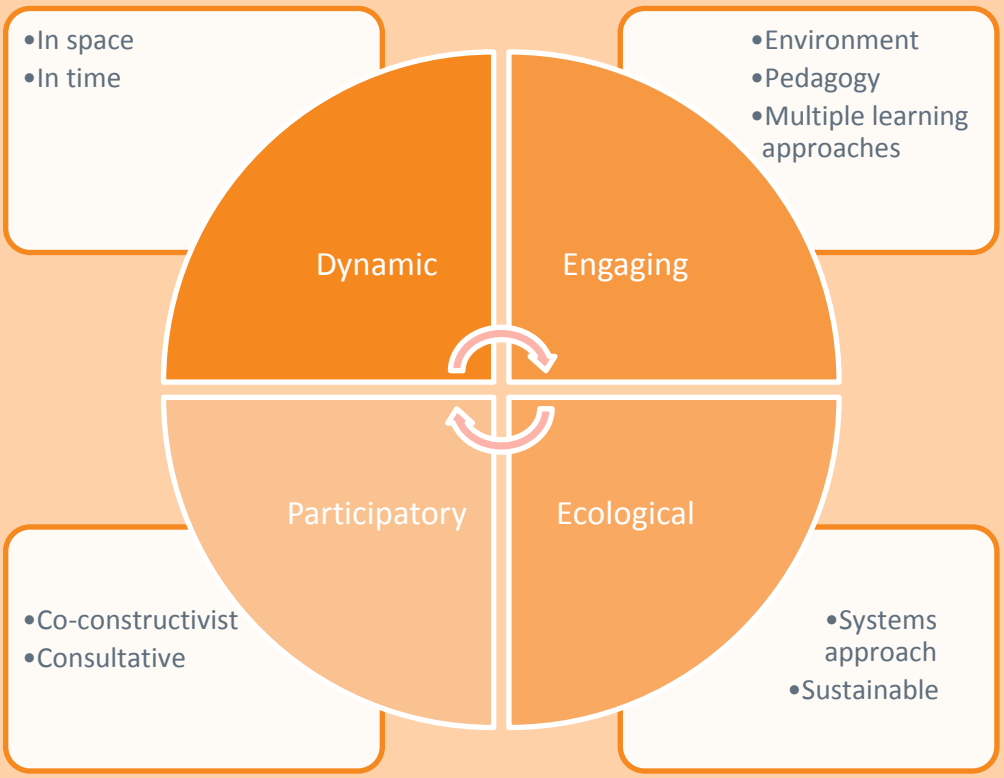

Figure 8: Original DEEP model (Wood *et al.* 2010)

In addition we argued that learning spaces should be engaging in terms of their physical appearance (environment), and pedagogies, that they should be ecological in that they should be sustainable, but also be seen as a wider ecology of learning (systems approach), and that they should be participatory, actively involving all participants.

In light of the research we have reported in the present research project, we believe that the original DEEP model needs to be extended **(Figure 9)**. The dynamic element of the model now needs to take account of the activities and processes beyond formal settings, and must allow for the fluid and emergent nature of the learning of students, over both space and time. The 'Engaging' element of the model must also take account of the results presented here, as it is not only a case of making a formal space pedagogically and engaging. Extending these characteristics across and beyond the university campus account of the multiple learning spaces students utilise. In the ecological aspect of the model, we now make the process of emergent complexity explicit, relating to the dynamic and extended nature of the system. Finally the participatory element of the model still stresses the co-constructivist nature of formal learning spaces, but extends this to other spaces as an element of distributed control, leading to a more holistic notion of participation across a spectrum of spaces and activities, both formal and informal.

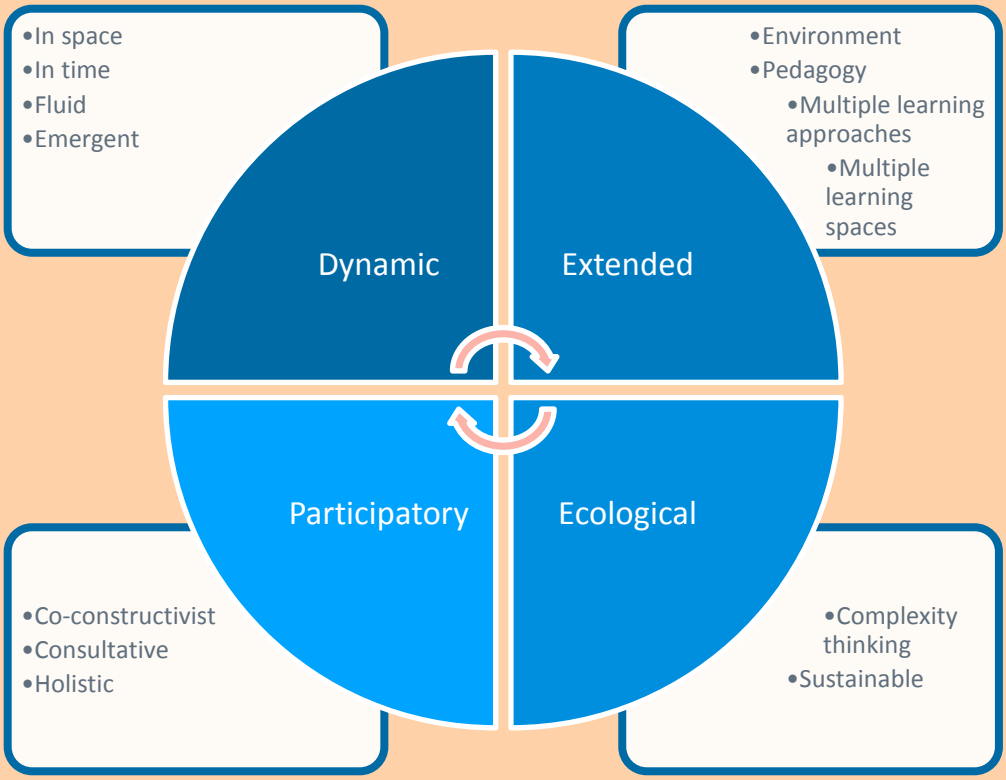

Figure 9: Updated DEEP model

Conclusions

The results of this study, whilst based on a relatively small sample, give us the confidence to develop the DEEP model of learning spaces to reflect the evidence of the emergent, complex nature of both learning spaces and the learning activities and processes which occur within them. Based on this, the use of complexity theory and Deleuzean rhizomatics appears to help us to gain a critical understanding of space and its relationship with learning. A level of coherence and stability at the level of the population is underlain by diversity, difference and self-organisation at the level of the individual. As universities move towards the future, we suggest that several points need to be considered and developed if the diversity of student needs is to be successfully met:

- Planners and users need to consider the juxtaposition of striated and smooth spaces and the lines of flight which link them. How spaces are to be designed which allow for coherence and at the same time allow for diversity and generative lines of flight?

- In a similar way, there needs to be the facilitation of emergence and change in design. This again relies on diversity in the design and nature of physical spaces, but also requires careful consideration of virtual spaces, resources, and the forms of pedagogy proposed for courses.

- Continued integration of technology to add to diversity and self-organisation as well as creating virtual smooth spaces.

- A consideration of how to encourage and understand personal lines of flight in relation to learning, especially given the diverse background and personal circumstances and preferences of individuals.

- A research interest in characterising and understanding the rich spectrum of learning spaces which students utilise beyond the university, especially those in domestic settings. For many of the students in this study, a greater amount of time is spent learning away from the university campus than within it. We still know precious little about the activities and affordances such spaces may afford.

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