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The Influence of Hierarchy and Layout Geometry in the Design of Learning Spaces

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For a number of years, higher education has moved away from didactic teaching toward collaborative and self-directed learning. This paper discusses how the configuration and spatial geometry of learning spaces influences engagement and interaction, with a particular focus on hierarchies between people within the space. Layouts, presented as diagrams, are analysed in terms of teacher-to-student and student-to-student power dynamics and against an established set of Principles for Designing Teaching and Learning Spaces. The paper observes that some arrangements have underlying hierarchies which subtly reinforce traditional teacher-centred power dynamics and concludes that spatial geometry and hierarchy should be considered key parameters in learning space design

Introduction

Increasing student engagement and self-direction has been the subject of much research and innovation in higher education teaching over the last decade or more. More recently, studies on the relationship between teaching spaces and learning have also emerged (Beckers, van der Voordt, & Dewulf, 2016; Boys, 2011; Chiu & Cheng, 2017; Ellis & Goodyear, 2016; Granito & Santana, 2016; McArthur, 2015; Neary & Saunders, 2011; Temple, 2008). Architectural space influences the way people behave both consciously and subconsciously. Consequently both teachers and students are likely to adopt the mode of teaching and learning signalled by the room (JISC, 2006; Long & Holeton, 2009), and will be significantly influenced – perhaps unknowingly – by the context of each individual learning space.

Contemporary pedagogic methods therefore demand a critical rethinking of the spatial environments in which they take place. This paper discusses how the configuration of learning spaces – and in particular the geometry of their arrangement – affects the spatial hierarchy within that place, and how that in turn impacts on the relationships between people in the room. This is significant because that power dynamic influences student engagement and interaction, both with their teacher and with their peers. The aim of this paper is to contribute to a way of thinking about space that helps achieve the desired balance of ownership and power within it.

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The Value of Diagrams in Space Design

There are many variables that contribute to the contextual differences between learning spaces. In design terms these include: the scale of the space, daylight, artificial lighting, sensory stimuli (such as colour and textures), temperature and acoustics, as well as spatial arrangement (Gee, 2006; Granito & Santana, 2016). Architects use diagrams as a means of focusing on the essence of an idea, helping provide clarity in the process of exploring one key issue or variable at a time.

A variety of different layouts for learning spaces are presented and discussed as *parti* diagrams, chosen because they succinctly describe the central idea or concept of a space independently of the other factors (Frederick, 2007). Each *parti* diagram focuses on spatial hierarchy and its impact on the interrelationships between students, the teacher, and the orientation of focus within the space. These are presented as diagrams – as opposed to photos of existing teaching spaces – for several reasons. Firstly, the absence of irrelevant features ensures the key principles under consideration are clear. Secondly, for the same reason, the diagrams can be compared more easily and effectively. Thirdly, a diagram's inherent principles can be adopted at different scales and to different contexts which means they can be readily applied when designing new, or refurbishing existing, spaces. Fourthly, in plan diagrams – as opposed to photographs or interior perspective drawings – the relationships (positioning and adjacencies, for example) between all the elements (students, teacher, seating, projection surfaces etc.) within each arrangement can be seen more clearly.

The diagrams are analysed in terms of the teacher-to-student and student-to-student hierarchies generated by the underlying axes, symmetry and orientation within each configuration. This process reveals the impact spatial geometry – and the hierarchies it creates – has on learning and proposes they become key considerations in learning space design. However, these concepts are not commonly discussed in the literature.

The Current Context of Pedagogic Thinking and Learning Spaces

It is widely acknowledged that best practice in higher education focuses on approaches that foster student inquiry, independent learning, collaborative working, active engagement, interaction – both student-to-teacher and student-to-student – and self-direction (Biggs, 2003; Chickering & Gamson, 1987; Prosser & Trigwell, 2001; Ramsden, 2003). Brown and Long (2006) argue that the design of teaching spaces should flow from these principles of learning, facilitating social and active teaching strategies.

Learning spaces play a key role in determining the quantity and quality of engagement and the potential of that engagement as an effective learning experience (Gee, 2006; Jamieson, Fisher, Gilding, Taylor & Trevitt, 2000). For example, the configuration of a space will affect the extent to which students can interact with each other and work in self-directed ways (Granito & Santana, 2016; Oblinger, 2005). A comparison of traditional and non-traditional learning spaces by Brooks (2012) found that the configuration of the space had a significant impact on: the activities undertaken, teacher behaviour, delivery methods and student behaviour. He argues that more attention should be paid to how learning spaces serve as indirect causal agents that affect the *actors* in the room.

This paper explores how features such as the geometry of the layout, underlying axes created by the arrangement of furniture or projection, the presence or absence of symmetry and the orientation of the space affect the hierarchy between students and students, and between students and the teacher, in different learning space configurations. Geometry is spatial order defined through the measure and relationship of forms (Lawlor, 1982). In architectural composition, an axis is a powerful regulating device, which can define conditions of symmetry; the principle of hierarchy in design implies the degree of importance given to the different elements within a composition (Ching, 1979). It is a widely-accepted principle in architectural design that qualities such as axes and symmetry can influence hierarchy and orientation. As Boys (2011) observed, it is not just how terms such as *front* or *back* describe characteristics of a given space but also the meanings of such relationships to different participants in a given situation. This is significant because, as mentioned above, both the students and the teacher will respond to the mode of learning and the degree of interaction that is signalled to them (subconscious) and facilitated by (conscious) the space.

Traditional Learning Spaces

Many argue that the lecture theatre mode of learning is in decline (Coulson, Roberts & Taylor, 2015; Parr, 2014; Ramsden, 2003). Kandiko and Mawer (2013) found the traditional formal lecture to be students' least favoured format, with a preference instead for more interactive learning. Nevertheless, general teaching spaces are still largely dominated by a tutor-focused, one-way configuration (JISC, 2006), as illustrated by Figure 1. The learning environments of last century still perpetuate (Ferrell, 2016).

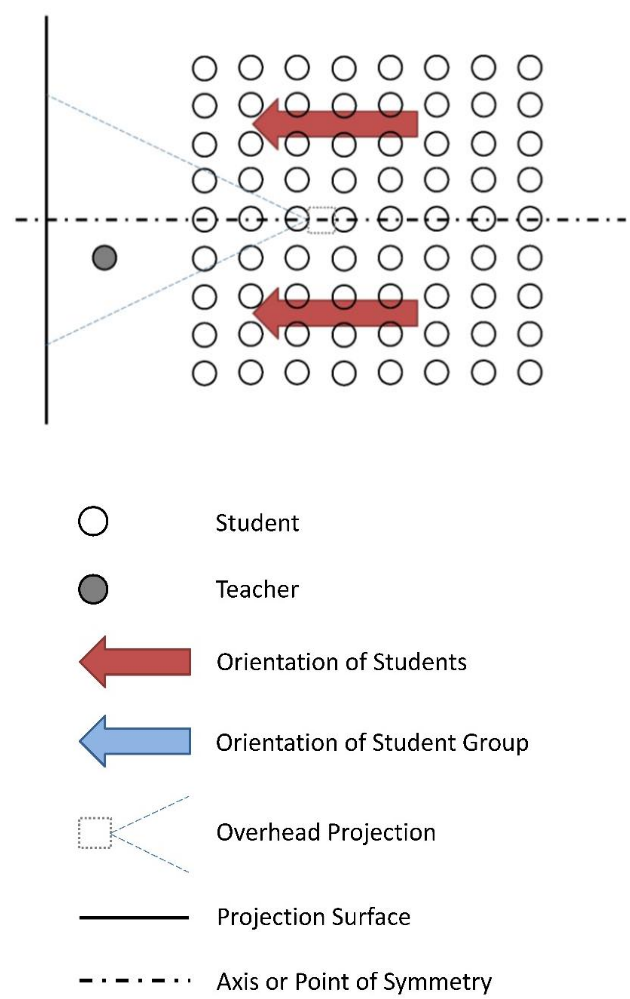

Figure 1. The predominant general learning space configuration (with key)

Neary and Saunders (2011) found the most compelling learning spaces are those contextualised within progressive pedagogic theory. Thomas, Jones and Ottaway (2015) argue that spaces should be configured to reinforce the inter-relational dynamics of collaborative and active approaches such as flipped lectures, group work and peer learning. The flipped class, for example, is a model in which class time is transformed into sessions where students interact with both the content and each other (EDUCAUSE, 2012). Likewise, in collaborative group work – such as problem-based learning – students must be able to easily engage with each other (Hmelo-Silver, 2004).

In both examples, learning is dependent on interaction – dialogue and debate, both student-to-teacher and, increasingly, student-to-student. In contrast, Figure 1 is characterised by a single axis of strong bilateral symmetry and a hierarchy where the teacher holds court over the space, and it is clear that this configuration does not encourage interaction both with either the teacher or other students.

Alternatives to the Traditional Model

In order for students to become more engaged and influential in their learning (Ramsden, 2003), they must be empowered to do so. In his study of methods employed by the best teachers, Bain (2004) highlights that trust in students depends in part on the teacher's rejection of power over them; similarly, Neary (2014) argues that the academic as a point of power within the room should be designed out. Lange, Reynolds and White (2016) highlight both that student and teacher behaviours are formulated around the traditionally accepted hierarchy between them and implicit responses to power, and how difficult it is to remove that power element from a learning space; they point to the need to actively disrupt the traditional environment of a teaching space if equitable discourse or co-production of knowledge are desired. Such a dramatic re-alignment of the traditional student-tutor power dynamic demands a significant re-conceptualisation of traditional teaching environments. It challenges, for example, the orientation of the room and whether there need be an identifiable front to the space.

Figure 2 represents an alternative to the traditional forward-facing configuration of Figure 1, which might be characterized as teaching in the round. As well as looking toward the teacher, students also face each other, which reduces the teacher's power in the hierarchy. However, by incorporating two axes of bilateral symmetry, there is still a strong underlying order and a focal point the teacher can occupy to assert power. This arrangement would support debate across the cohort but the potential for peer-to-peer student discussion is still minimal. It could also create issues for projection although at the Collaborative Teaching and Learning Centre, University of Queensland, multi-directional orientation has been facilitated by projection onto several surfaces within the space (Long & Holeton, 2009). Interestingly, research by Granito and Santana (2016) suggested that students experience improved learning in spaces with multiple projectors.

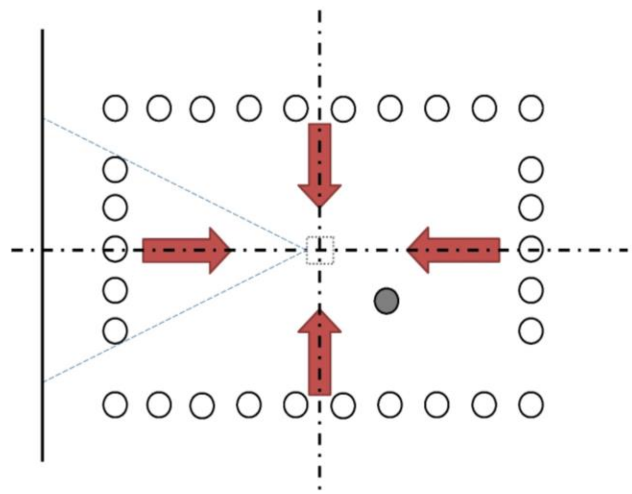

Figure 2. ***Teaching in the round*****, with students facing each other as well as the teacher**

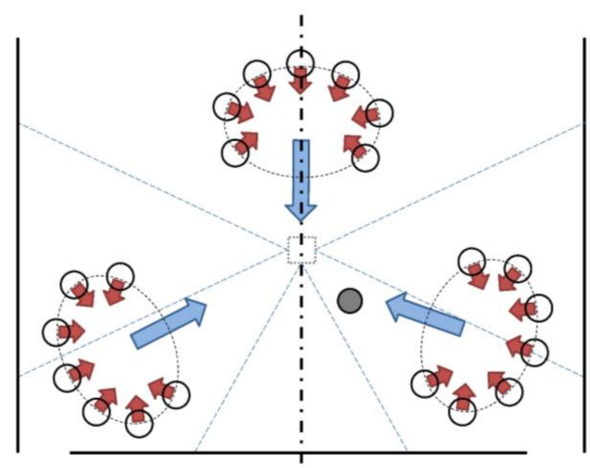

Figure 3. **Multiple projection, with students in clusters**

Figure 3 also has multiple directions of spatial orientation, but unlike Figure 2 students are clustered in groups to facilitate peer-to-peer interaction. The configuration of the seating signals the nature of engagement that is intended – a circle of students encourages collaboration and communication (Gee, 2006). Here the arrangement further diminishes the teacher's position in the hierarchy in favour of the students. With a single axis of bilateral symmetry, there is still an underlying order structuring the space but it is less prominent than in Figure 2. Also, a central focal point within the space still remains, which the teacher can occupy to assert power.

The cluster arrangement has been shown to be highly conducive to communicative exchanges for both student-student and student-teacher interactions (Brooks, 2012), fostering a more collaborative environment through face-to-face contact between participants. This effect could also be achieved (though to a lesser degree) in a *cabaret* configuration as shown in Figure 4. Clustering students enables them to engage in discussion, but the underlying orientation in one direction – towards the stage, as it were – with one axis of bilateral symmetry is less flexible. This configuration maintains a focus on a *front* of the space, and consequently conveys some of the traditional orientation and hierarchy of the lecture room. Students seated toward the *back of the room* may feel less able to engage with the teacher, unless she or he makes a deliberate effort to move around the space – although this is facilitated more with students arranged in clusters as opposed to rows.

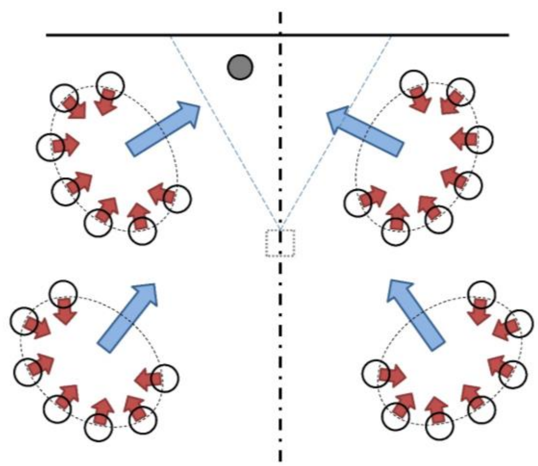

***Figure 4.* A *cabaret* configuration**

Schön (1985) argues that many disciplines could learn a great deal from the design studio because it is a place where competencies are acquired through learning-by-doing and the subtle and complex interactions between students learning from and with one another. The design studio is an instructive example of student-directed learning environments; one that encourages high levels of engagement and interaction. Figure 5a shows a typical design studio teaching session, in which students are orientated towards each other – strongly reinforcing peer-to-peer interaction. Furthermore, the teacher is positioned outside the circle of students, but is still available to engage with them. Significantly, in the design studio the teacher has no desk or podium and instead sits at the students' tables, promoting more intimate teacher-student interactions.

This configuration, represented as a diagram in Figure 5b, places even greater emphasis on student-to-student engagement, moving the hierarchy further toward them, although there is limited potential for engagement between the clusters. The teacher is positioned outside of each group, as each cluster has tightened inwards, but can move easily between them. The layout has symmetry, but it is rotational as opposed to axial and the absence of an axis within the space reduces directional orientation. The centre-point of the rotation means that there is a subtle focal point that the teacher can occupy, but the students do not face towards it. This arrangement aligns well with problem-based learning – the basis for most design studio coursework – where responsibility for learning is strongly orientated toward the student group. Lopez and Gee (2006) describe a learning studio space similar to this but which includes a mobile teaching station. In the design studio there is no dedicated point for the teacher, who moves from table to table and sits amongst the students, the result of which is the lack of a tangible focal point and the further erosion of the teacher's point of power within the room's hierarchy. Whilst these approaches have existed for decades in studios for creative programmes, it is only more recently that contemporary pedagogic approaches have proposed such learning methods in other fields.

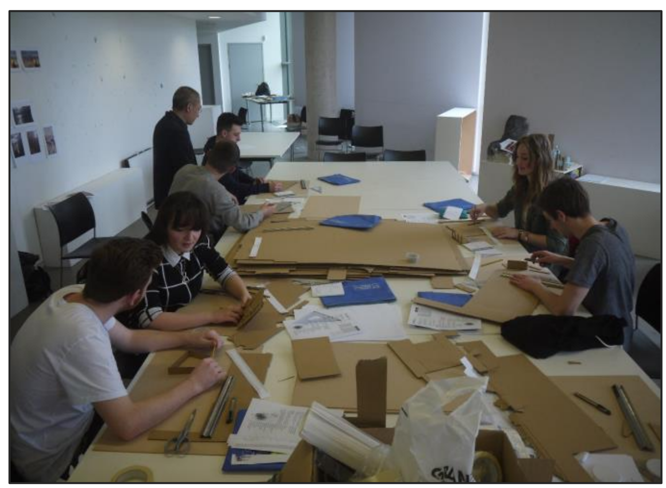

***Figure 5a*. A design studio teaching session (Photo courtesy of Anthony Malone).**

In architectural design there is a causal link between symmetry, order and hierarchy (Ching, 1979); therefore one strategy to minimise teacher-led hierarchy would be to create an arrangement with no symmetry – rotational or axial. This approach, shown in Figure 6, suggests clusters of students with no focal point and minimal, decentralised hierarchy in the space – removing what Neary refers to as the teacher's *point of power*. A significant difference between the configuration in Figure 6 and those of Figures 1 to 5 is the absence of any symmetry whatsoever. As in the design studio model, the teacher is positioned outside of each of the clusters but is free to move between them to provide support and prompt discussion. Furthermore, the student clusters face inward, which encourages eye contact and improves the potential for dialogue between them. This configuration would also be ideally suited to progressive pedagogic approaches such as problem-based learning and flipped lectures.

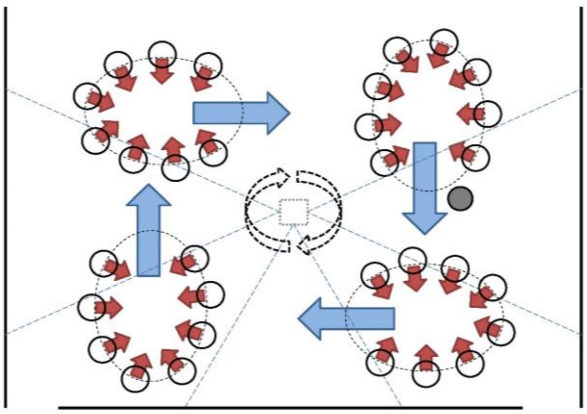

***Figure 5b*. Diagrammatic interpretation of design studio layout, with rotational symmetry**

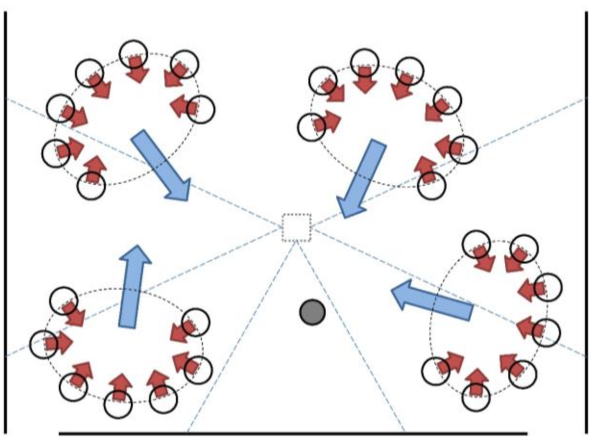

***Figure 6*. Clustered learning areas, with a decentralised hierarchy and no focal point**

Evaluation of the Configurations

Each of the six diagrams have been analysed in terms of the hierarchies they generate through their underlying axes, orientation, focal point and symmetry; this is presented in Table 1. It is argued that this is important because of the way in which these qualities influence and facilitate student and teacher behaviour, both implicitly and explicitly. Each diagram has been critiqued in terms of the strength and direction of power using a four-point comparison scale – from *strongly toward the teacher*, through *toward the teacher* and *toward the student*, to *strongly toward the student*; the rationale for each rating is briefly summarized.

Finkelstein, Ferris, Weston and Winer, (2016, p. 28) proposed a set of "Principles for Designing Teaching and Learning Spaces" which aligned the design of learning environments with student engagement themes as defined by the National Survey of Student Engagement in North America. Table 1 includes an evaluation of each diagram against those Principles using a similar four-point comparison scale – ranging from *very supportive*, through *supportive* and *limited*, to *severely limited*. This deepens the understanding of each configuration by creating a broader analysis of the impact of spatial hierarchy on learning space design. It also facilitates an understanding of Finkelstein et al.'s Principles in the context of spatial hierarchy.

Discussion

Spatial hierarchy directly affects the power dynamic between those using a learning space. So to achieve greater student participation and empowerment an appropriate spatial hierarchy must be adopted within learning space layouts. It is important to understand that some configurations appear quite different to a lecture theatre, and much more student-focused, but – because they include focal points or underlying axes – may in fact reinforce the teacher-focused power dynamic of traditional learning environments. For example, the configuration in Figure 3 includes a focal point within the space where the teacher can occupy a dominant position, reverting to the traditional teacher-focus; the configuration in Figure 4 could reinforce methods associated with the traditional lecture model, due to the single axis of bilateral symmetry and the presence of a *front* to the space. Other layouts, such as that in Figure 6, actively discourage or inhibit those methods because there is no symmetry about an axis or a focal point for the teacher to occupy.

Table 1. An analysis of the diagram configurations against spatial hierarchy and Finkelstein et al.'s "Principles for Designing Teaching and Learning Spaces"

Spatial hierarchy		Principles for Designing Learning Spaces				
		Academic challenge	Learning with peers	Experiences with teacher	Campus environment	High-impact practices
Figure 1	*Strongly toward the teacher*. One axis, with bilateral symmetry; orientation to "front". All students face the teacher only.	*Severely limited*. Reinforces the transmission mode of traditional lecture	*Severely limited*. Peer to peer dialogue is very restricted	*Severely limited*. Restricts interaction with teacher; difficult for teacher to move around the space	*Severely limited*. Layout is very difficult to change due to number of chairs / seats	*Severely limited*. Does not promote different practices; teacher is sole focal point
Figure 2	*Toward the teacher* Two axes, both with bilateral symmetry; strong central focal point. All students face the teacher, and some peers.	*Limited*. Promotes more engagement but may reinforce traditional lecture due to focus towards teacher	*Limited*. Dialogue can take place across part of the cohort, but difficult to work collaboratively	*Supportive*. Opportunity for more students to interact with teacher; strong focal point for teacher	*Supportive*. Flexible furniture can be moved around in the space; single projection restricts options	*Limited*. Likely to reinforce teacher as the traditional focal point of the room
Figure 3	*Toward the teacher* One axis, with bilateral symmetry; central focal point. Students don't all face the teacher; teacher can still occupy focal point.	*Very supportive*. Facilitates multiple modes of teaching	*Very supportive*. Students can work individually and in groups	*Supportive*. Teacher can move easily between individuals and groups; focal point for teacher	*Very supportive*. Easy to move flexible furniture around in the space	*Very supportive*. Space could be used for a variety of student-centred teaching approaches
Figure 4	*Toward the teacher* One axis, with bilateral symmetry; orientation to "front". Students don't all face the teacher; teacher can still occupy the "front" of the room.	*Supportive*. Facilitates multiple modes of teaching, but may reinforce traditional lecture as "front" of room still exists	*Very supportive*. Students can work individually and in groups	*Limited*. Teacher can move easily between individuals and groups, but those toward "the back of the room" will feel less engaged with the teacher	*Supportive*. Easy to move flexible furniture around in the space; single projection restricts options	*Supportive*. Space could be used for a variety of student-centred teaching approaches, but may reinforce traditional lecture
Figure 5b	*Toward the students* Four-fold rotational symmetry; no axis to create directionality. Teacher has no base; can occupy focal point of rotational symmetry.	*Very supportive*. Facilitates multiple modes of teaching	*Supportive*. Students can work individually and in groups, but interaction between the groups is difficult	*Supportive*. Teacher can move easily between individuals and all the student groups; focal point for teacher	*Very supportive*. Easy to move flexible furniture around in the space	*Very supportive*. Space could be used for a variety of student-centred teaching approaches; discourages traditional lecture
Figure 6	*Strongly toward the students* No axes; no bilateral or rotational symmetry; no focal point or orientation. No focal point for teacher to occupy; student clusters face toward each other.	*Very supportive*. Facilitates multiple modes of teaching; discourages traditional lecture as teacher has no focal point	*Very supportive*. Students can work individually and in groups, and clusters face toward each other	*Very supportive*. Teacher has no focal point within the room, and so is encouraged to move between student groups	*Very supportive*. Easy to move flexible furniture around in the space	*Very supportive*. Space could be used for a variety of student-centred teaching approaches; discourages traditional lecture

The configurations most supportive of Finkelstein et al.'s Principles are Figures 3, 5 and 6. In each of these there is no traditional *front* to the arrangement; although this is also true of Figure 2, that configuration has limited capacity for peer-to-peer engagement and two axes of symmetry creating a strong focal point for the teacher to occupy. Figure 6 is very supportive across the Principles. There are no axes of symmetry, and no focal point that enables the teacher to assume control of the room for all or part of a teaching session; without it the teacher is more likely to move around the space, between the clusters, encouraging greater interaction with the students. The absence of a teaching station can easily be facilitated through mobile technologies. Next most supportive is Figure 3, although a central focal point means the teacher could assert power and thereby potentially inhibit interaction.

There is clearly a case for considering the nature of the desired power dynamic in a learning space and how that might be affected – either explicitly or implicitly – by its design. Yet there is also cause for caution. Boys (2011) highlights that in a recognisable space, like a lecture theatre, students make assumptions about their place within it and she suggests that altering traditional arrangements could undermine their sense of confidence. As hierarchy shifts toward students, the increased power and consequent responsibility may diminish both their confidence and their sense of belonging in – and understanding of – that space. What is more, it might affect both student and teacher. To the extent that they disrupt the traditional order and hierarchy, new types of learning spaces will inevitably be unsettling and although this is not necessarily a negative consequence, it does demands consideration when such spaces are being designed and occupied.

It is not the intention of this paper to suggest that any one configuration presented in the diagrams is preferable over any other; different arrangements suit different educational approaches. The objective is to explore how different configurations influence the spatial hierarchy, consider the impact they have on the potential for interaction between those occupying it, and create an understanding of how that might affect different learning experiences within a space. The analysis demonstrates that spatial hierarchy is an important factor to consider in the context of the ownership of power within different learning space configurations, which range from strongly teacher-centred to strongly student-centred. This is significant, given that contemporary pedagogic methods increasingly favour the latter.

Concluding Remarks

The analysis reveals that the geometry of different spatial arrangements affects the hierarchy within them, which in turn affects the psychological ownership of the space for those within it. Some arrangements have underlying hierarchies that subtly reinforce the traditional teacher-centred power dynamic, despite appearing more student focused. It is only when the geometry of the layout of a space suppresses symmetry and underlying axes that power genuinely moves toward the student.

The diagrams in this paper do not represent definitive room layouts per se, but serve to explore how different spatial arrangements influence the hierarchy between students and between teacher and students, which will impact on interaction between them. The configuration of a room has the power to shape the behaviour of everyone who occupies it and affect classroom activity – even subconsciously (Brooks, 2012). Whilst not suggesting that one arrangement is preferable to any other, this paper argues that the hierarchies created by the arrangement of a learning space make a significant contribution to the nature of interaction and learning that will take place.

The American architect Louis Sullivan (1896, 408) wrote, "form ever follows function", and it is logical that learning space arrangements should be determined by the nature of learning that is sought. The traditional teacher-student power dynamic is changing and contemporary pedagogic approaches demand learning spaces that facilitate these new hierarchies; the power dynamic between people occupying a space demands careful consideration of spatial hierarchy. Long and Holeton (2009) highlight the need for a common language to talk about learning spaces. This paper proposes the terms *hierarchy* and *spatial geometry* should be included in that language and considered key design parameters.

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