# A conceptual framework to identify spatial implications of new ways of learning in higher education

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**DOI**
10.1108/F-02-2013-0013

**Publication date**
2015

**Document Version**
Accepted author manuscript

**Published in**
Facilities

Beckers, Ronald, Van der Voordt, Theo & Dewulf, Geert (2015), A conceptual framework to identify spatial implications of new ways of learning in higher education. *Facilities* 33 no. 1/2, 2-19. DOI 10.1108/F-02-2013-0013

# A conceptual framework to identify spatial implications of new ways of learning in higher education

## Abstract

**Purpose** - The purpose of this paper is to explore the spatial implications of new learning theories and the use of Information and Communication Technologies (ICT) in higher education.

**Design/methodology/approach** - Based on a review of literature, a theoretical framework has been developed that visualizes the spatial implications of developments in higher education. In order to further explore spatial configurations that support changes in education, a comparative floor plan analysis was carried out at four Dutch institutes of higher education.

**Findings** - The findings show that traditional classroom space is progressively being replaced by a variety of learning settings to support contemporary learning activities.

**Practical implications** - The research findings contribute to a better understanding of the alignment of learning space to the evolving needs that come from new ways of learning, supported by advanced ICT, and can be used to support space planning in higher education.

**Originality/value** – This paper builds on findings from different disciplines: Facilities Management and Corporate Real Estate Management (suitability of floor plans) and Theory of Education (the pedagogical approaches and pedagogical assumptions those floor plans convey).

**Keywords** Space management, learning spaces, comparative floor plan analysis, new ways of learning, higher education

**Paper type** Research paper

## Introduction

In the literature and the practice of facility management, there has been an increasing interest in the educational sector (Amaratunga and Baldry, 2000; Price, Matzdorf, Smith and Agahi, 2003; Dunyar, 2011; Kok, Mobach and Omta, 2011). The last few decades the educational sector has undergone substantial changes (Collis and Van der Wende, 2002; Johnson, Smith, Willis, Levine and Haywood, 2011). Developments in learning, educational theories and Information and Communication Technologies (ICT) have resulted in new ways of teaching and learning – anytime, anyhow, and anywhere (Simons, Van der Linden and Duffy, 2000; Punie, 2007; Beckers and Van der Voordt, 2013). Despite the growing attention for the educational sector, Temple (2007) draws attention to the limited research investigating the relationship between teaching, learning, and physical space in higher education. Learning spaces in higher education are still an under-researched topic (Temple, 2008; Boddington and Boys, 2011). Marmot (2012) highlights that there is a need to understand how new learning spaces are used to support an effective pedagogical transition. Boddingtong and Boys (2011, xviii) conclude that there must be a shift in the way we think about learning spaces "from solution to illumination". "We need both better conceptual frameworks and more appropriate methods and tools that reveal, assist and inform rather than dictate and fix the management and construction of learning spaces, whether physical, digital or intellectual". (Boddingtong and Boys, 2011, xviii).

This present research aims to contribute to the understanding of the alignment of learning spaces to the changing educational context. The paper first outlines a conceptual framework which links learning space to learning theories and educational processes. This framework builds on the 'purpose-process-place' framework of Duffy, Graig and Gillen (2011) which was developed to analyse the interaction between organisations and the use of the physical environment (figure 1). Purpose-process-place refer to 'why, how and where' in

a specific context of 'what'. Duffy *et al*. used case studies to explore the framework in office environments. They concluded that spatial arrangements and adjacencies ('place') must be deployed in such a way that working practices ('processes') can contribute to enhance the goals of the organisation ('purpose'), see figure 1.


**Figure 1.** Purpose-process-place framework (visualised after Duffy *et al*., 2011)

After the theoretical elaboration of the purpose-process-place framework in the context of higher education, an empirical study will be presented to explore whether shifts in ways of learning are represented in new buildings in Dutch higher education. Finally the findings will be discussed in connection to practical implications.

## Purpose, process and place in higher education

### *Purpose*

According to Merriam-Websters dictionary, a school can be defined as a place of instruction and teaching. This traditional perception fits with the purpose of schools as formulated by the American educational reformer Dewey at the start of the 20th century. Dewey's vision on the purpose of schools, was to transfer knowledge and preparing young people to participate in America's democratic society (Rodgers, 2002). In the 20th century the ideas about knowledge transfer in education were mainly based on traditional learning theories such as behaviourism, cognitive theory and constructivism (Merriam, Caffarella and Baumgartner, 2007). The application of behaviourism in education was focussed on predicting and controlling behaviour (Ashworth *et al*, 2004). Learning was manifested by a change in behaviour, with an emphasis on a connection between a stimulus and a response. In the middle of the 20th century, the emerging knowledge about processing and storage of information in someone's

brain led to the cognitive learning theory. Cognitivism is concerned with how learners learn: how information is received, organised, stored and retrieved by the mind (Illeris, 2007; Merriam *et al*, 2007). For education this meant that the emphasis moved from the reproduction of learning to meta-cognition (Ashworth *et al*, 2004).

Based on Vygotsky's work at the end of the 20th century, understanding of learning shifted from a quite inactive role of the student, to learning as constructing knowledge and understanding in interaction with the social environment (Ashworth *et al*, 2002). This social constructivist theory of learning stresses the need for collaboration and social interaction between learners, in contrast to traditional competitive approaches (Foster, 2008). Education shifts from an industrial model of transmission to an inquiry model of transaction and from a purpose of conformity to the purpose of critical thinking (Leland and Kasten, 2002).

In the last two decades the growing opportunities of ICT in the educational context (Collis and Van der Wende, 2002; SFC, 2006) have led to a new learning theory: connectivism (Siemens, 2005; Kop and Hill, 2008; Marais, 2011). Connectivism argues that knowledge is distributed across a network of connections, and that learning consists of the ability to construct and traverse those networks (Downes, 2007). Developments in ICT have prepared a paradigm shift by anticipating opportunities to learn in ways that were not possible without ICT facilities (Siemens, 2005).

To conclude, the purpose of teaching and learning has shifted from 'school' as a place of instruction in the 19$^{th}$ century to a place to produce learning in the late 20$^{th}$ century (Barr and Tagg, 1995), and to a place to construct knowledge in the 21$^{st}$ century (Siemens, 2008). Yet, the above-mentioned learning theories all have their own merits. Ashworth *et al* (2004, 10) emphasises that "it would be more advantageous for educators of the future to take a more eclectic approach where learning theory is concerned, as more than one theory could accommodate the needs of the self-directed, experimental and lifelong learners of the future".

*Process*

The four described learning theories are reflected in different educational processes with a different power distribution between student and teacher. Trigwell, Prosser and Taylor (1999) formulated three approaches founded on two extremities of the student-teacher spectrum: a teacher-focussed strategy, a student-focussed strategy and a teacher/student interaction strategy in between. Illeris (2007) mentions three similar interactions between students and teachers and calls these 'teaching directions' from a teacher perspective, teaching directions from a student perspective and a teaching direction in which both teachers and students are involved.

The traditional teacher-centred way of teaching is based on behaviourism (Freiberg and Lamb, 2009). Behaviourist learning theory has had a substantial influence on education, for example leading to programmed instructional approaches (Jones and Brader-Araje, 2002). Behaviourism in schools placed the responsibility for learning directly on the shoulders of the teachers (Jones and Brader-Araje, 2002) and with fixed rewards for positive student behaviour (Freiberg and Lamb, 2009). Shreeve (2008) described this didactic form as lecture-based learning (LBL), where learning is derived from the instructor imparting what is known about a subject and thus hopefully resulting in knowledge transfer.

"Cognitivism meant a shift away from teacher-centred methods of course delivery and more freedom for students to choose the type of learning that suits them best." (Ashwordt *et al*., 2004, 7). Such students must be self-regulated learners. "They personally initiate and direct their own efforts to acquire knowledge and skills rather than relying on teachers, parents, or other agents of instruction." (Zimmerman, 1989, 329).

The impact of social constructivist theories in education can be seen in the focus on working in small groups (Jones and Brader-Araje, 2002). The emphasis is on having students working together, while sharing ideas and challenging each other's perspectives. "Crucial to

social constructivism is the idea that knowledge and understanding are constructed when individuals engage socially and communicate with each other, through shared problems and tasks. Most social constructivist models therefore stress the need for collaboration among learners" (Foster, 2008, 93). Social constructivism literature mentions different didactic forms, like problem-based learning (PBL), collaborative learning, and cooperative learning (Foster, 2008). A characteristic of all educational processes that fit the social constructivist theory is the shift in the teacher's role from "the sage on the stage to the guide on the side" (Martin *et al*., 2007, 13).

New learning processes in connectivism are based on network learning (McLaughlin and Mills, 2008). In network learning everyone is a node in a collaborative learning process. According to Siemens (2008) the difference between connectivism and the previously mentioned social constructivism, is that constructivists suppose that knowledge transfer occurs by socialization, and connectivists are connecting nodes involving both people and other sources. Hence, while a constructivist would likely see the network solely as a social medium for interaction, a connectivist additionally sees the network as an extension of the mind (Siemens, 2005). Wang (2008) described the learner-interface interaction as an important component of a technology-based interactive learning environment. This has led to virtual education which can be characterised as a form of asynchronous tuition (Shabha, 2004). "Learners might move away from classroom groups and a tutor to online networks and important nodes on these networks" and the role of the teacher will further decrease (Kop and Hill, 2008, 9).

*Place*

Traditional school environments focus on accommodating the transmission of knowledge rather than on learning objectives and learning outcomes which can be achieved in different ways (Punie, 2007). "The design of classrooms optimizes instructor transmission. In the traditional

classroom floor plan, students receive content packaged and presented with a 'one size fits all' approach, regardless of the learners' unique needs or styles" (Brown and Long, 2006, 9.3).

The increase of self-regulated learning in education implies a shift in the role of the physical learning environment. "In order to self-regulate, learners must be able to control their attention. Often this process entails clearing the mind of distracting thoughts, as well as seeking suitable environments that are conductive to learning (e.g. quiet areas without substantial noise)" (Winne, 1995 as cited in Zumbrunn *et al* 2011, 11).

Influenced by social constructivist theories in education, formal teaching spaces for large groups, like traditional classrooms, are becoming less common than smaller, less formal settings where students can learn from one another as well as from their appointed teachers (Marmot, 2005). This leads to the need for project rooms and small group settings which support project-based learning and other forms of active learning (Fisher, 2005).

For new ways of learning students need more informal areas where they can meet face-to-face and have contact with their virtual network sources (Foster, 2008). Watson (2007) mentions 'third places' as a striking development in new university buildings. Originally third places were public settings where people gathered to meet, such as coffee houses, cafés, restaurants, public outdoor space and virtually ('cyberspace') (Oldenburg, 2001). Based on the idea of third places, Oldenburg defined the social learning space as a physical and/or virtual area that is not predominantly identified with either social or work/study perspectives, but transcends both (Oldenburg, 1991 as cited in Wiliamson and Nodder, 2002). New university buildings have progressively shown such environments, for instance Techno Cafés (Foster, 2008), which include high quality services and technology to facilitate individual and group work.

To conclude, the relation between the physical learning environment and learning activities had been explained in frameworks before (Beard and Wilson, 2006). Developments in learning theories generate opportunities to give students more freedom to decide *what* they are supposed to learn, *when* they want to learn, *how* they learn and *with whom* (Rudd, Gifford,

Morrison and Facer, 2006). Schools have to facilitate the needs of the students regarding these choices by offering the right spaces, so students can also decide *where* to learn. In their Learning Combination Lock, Beard and Wilson (2006) show those principles by defining several learning environments as the '*where*' of learning and linking these to learning activities as the '*what*' of learning. Learning spaces should not focus exclusively on the reproduction of knowledge. They should also be sufficient flexible to facilitate different learning modes and styles, depending on the learning object, the learner, the teacher, the environment, etc. "In some cases, the learning mode could be more traditional (…) and in others, it could be more personalised (…). Then again, it could be group work (…) or face-to-face (bilateral) interactions" (Punie, 2007, 193).

## Conceptual framework

The development of the above mentioned four learning theories can be characterised by two shifts in ways of learning. First, the development from behaviourism to cognitivism implies an increase of self-regulation in learning (Zimmerman, 1989; Chen, 2002). "Self-regulated learning emphasizes autonomy and control by the individual who monitors, directs, and regulates actions towards goals of information acquisition, expanding expertise, and self-improvement" (Paris and Paris, 2001, 89). Second, in contrast to behaviourism and cognitivism, social constructivism and connectivism emphasise social interaction (Siemens, 2005; Van der Zanden, 2010). Where social constructivism is to some extent associated with self-regulation (Paris and Paris, 2001), connectivism is strongly related to self-regulated learning (Türker and Zingel, 2008) and the learner's autonomy (Kop and Hill, 2008). The four learning theories can be placed in a two-by-two matrix with 'self-regulation in learning' on the horizontal axis and 'social interaction in learning' on the vertical axis (see the left box of figure 2).

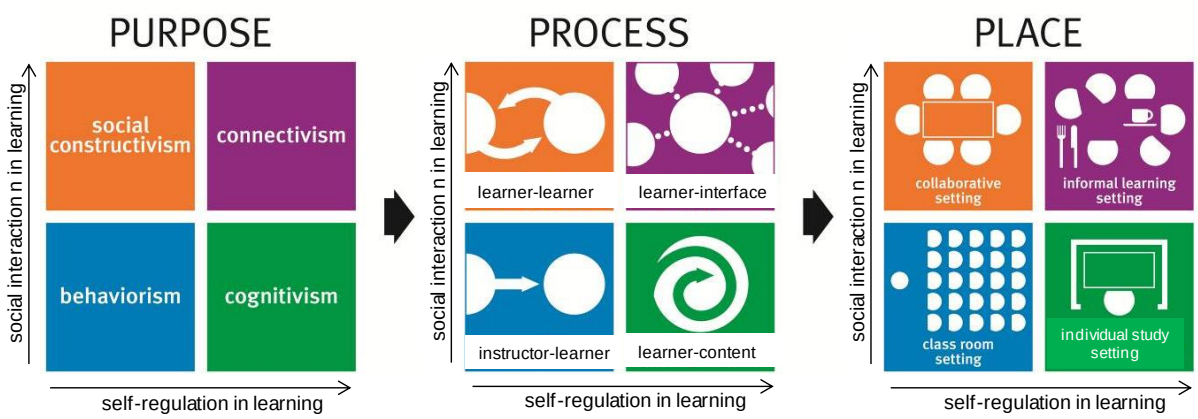



**Figure 2.** Purpose-process-place framework for education

The impact of the four described learning theories on educational processes can also be mapped in a matrix with the same axes (see the middle box of figure 2). The designations of the four process quadrants in the matrix are derived from Wang (2008) and Moore (1989). The conventional behaviourist educational instruction model was described by Moore (1989) as a relationship between the instructor and the learner. He characterised the self-regulated (cognitive) learner in relation to the content and the social constructivist learner in relation to other learners. In connection to ICT developments in education Wang (2008) added the relation between the learner and the interface. The four fields are not mutually exclusive. They are all valuable and complementary and a curriculum is usually composed from a pallet of different teaching and learning processes (Kolb, 1984).

The right hand box of figure 2 represents the physical learning environment. Here the matrix builds on relevant learning space classifications in literature (e.g. Fisher, 2003, 2005b; Marmot, 2005; Beard and Wilson, 2007; Watson, 2007). Fisher (2003) presented a 'learning environments matrix' showing a clear overview of learning settings with different levels of self-regulated spaces and/or collaborative spaces. He distinguished four edges of the learning space spectrum: the classroom setting, project space, personal study space and the internet café. The four edges correspond with Fisher's typology of four learning settings from 2005.

Analogous to Fisher's work, we also defined four categories of learning spaces in the right hand box of the conceptual framework using the same axes as in the other two matrices (see figure 2):

- Classroom setting: types of spaces that support large groups for the benefit of presentations and lectures.
- Collaborative setting: types of spaces that support small groups for the benefit of face-to-face collaborative and cooperative learning activities.
- Individual study setting: types of spaces that support individuals for the benefit of self-study activities.
- Informal learning setting: types of spaces - scattered across the campus or building in corridors, atria or cafeteria and restaurants, that support individuals and small groups for the benefit of either social or study activities, both in the real world and in the virtual world.

This completes the conceptual purpose, process, place framework for education as shown in figure 2.

**Explorative study at Dutch higher education institutes**

Changes in the purpose and process of learning are expected to be reflected i.e. the shift in learning theories and a growing use of ICT, will be reflected in learning space design in practice. More particularly that a shift might be expected to occur in the ratio between different types of learning settings, with less traditional classroom space and more space for interaction and informal learning. To test this proposition, a comparative floor plan analysis was conducted at four buildings of Dutch higher (professional) education institutes (HEIs), also indicated as Universities of Applied Sciences. The Netherlands has 39 of such institutes with a total number of 421,560 students (2012). The ten largest institutes together represent

73% of all students. In the period 2010-2011 six of these ten institutes constructed new school buildings. In order to explore spatial reflections of developments in learning and teaching three new buildings were selected and compared with an older school building.

*Research method*

For this study a three-tier analysis procedure is followed. First, the study compared a building in Arnhem (building A) of the economics faculty of HAN University of Applied Sciences (HAN) built 14 years ago (1998) with a new economics faculty building in Nijmegen from 2011 (building B), also part of HAN. Both buildings accommodate the same kind of students and nearly identical educational processes, and as such the comparison provides a good insight into changes in learning space design over time. Second, the new building B in Nijmegen was compared with a new building of Windesheim University of Applied Sciences in Zwolle from 2011 (building C) and a new building of HU University of Applied Sciences (HU) in Amersfoort from 2010 (building D), in order to look for similarities and differences regarding the way new school buildings facilitate educational processes of the 21st century. Buildings C and D also accommodate economics educational disciplines and are in that respect comparable with the target group of the buildings A and B. Third, all buildings (that is, A, B, C and D) were compared.

Based on Yin (2009) the four cases were selected partly for homogeneity and partly for heterogeneity regarding age of the building and type of academy. The characteristics are shown in table I.

| **Homogeneity of the cases** | **Heterogeneity of the cases** |
|---|---|
| All school buildings for Dutch HEIs | Three different Dutch HEIs |
| New building B, C and D (2010-2011) | An older building A (1998) |
| All buildings used by economics students | |
| Two buildings (A and B) of the same Economics Faculty | |

**Table I.** Case characteristics

In order to compare the four buildings the Comparative Floor plan Analysis (CFA) method has been used (Van Hoogdalem, Van der Voordt and Van Wegen, 1985; Van der Voordt, Vrielink and Van Wegen, 1997). On the one hand CFA studies search for similarities and differences between floor plans of the same organisation over time, and of different organisations in the same period. On the other hand CFA studies explain different spatial-functional configurations. A similar method was used by Fisher (2005b), who linked pedagogy and space in several case studies in Australian school floor plans. Besides the analysis of floor plans, document analysis of annual reports (2010/2011) and building walk-throughs were included in the research design as well.

## Results

*Building A (1998), Arnhem*

Building A has 16,360 square meters gross floor area on 5 floors and accommodates 4,544 students of the faculty of economics. A particular characteristic of the building is the narrow, 150 meters long central atrium, surrounded by classrooms and offices. At the time building A in Arnhem was built (1998), educational processes were still mainly based on the transfer learning model, supplemented by emerging interactive learning based on social-constructivism, in which students work together on assignments. ICT had not yet been

incorporated in education in 1998. Figure 3 shows the plan of the first floor of building A. The floor plan is characterised by a large proportion of classrooms. There are hardly any collaborative settings / project rooms in the building. Most small rooms on the plan are staff offices. The main places that supports group work or individual study activities, are the study landscape situated in the library or the canteen on the ground floor (see the pictures in figure 4).

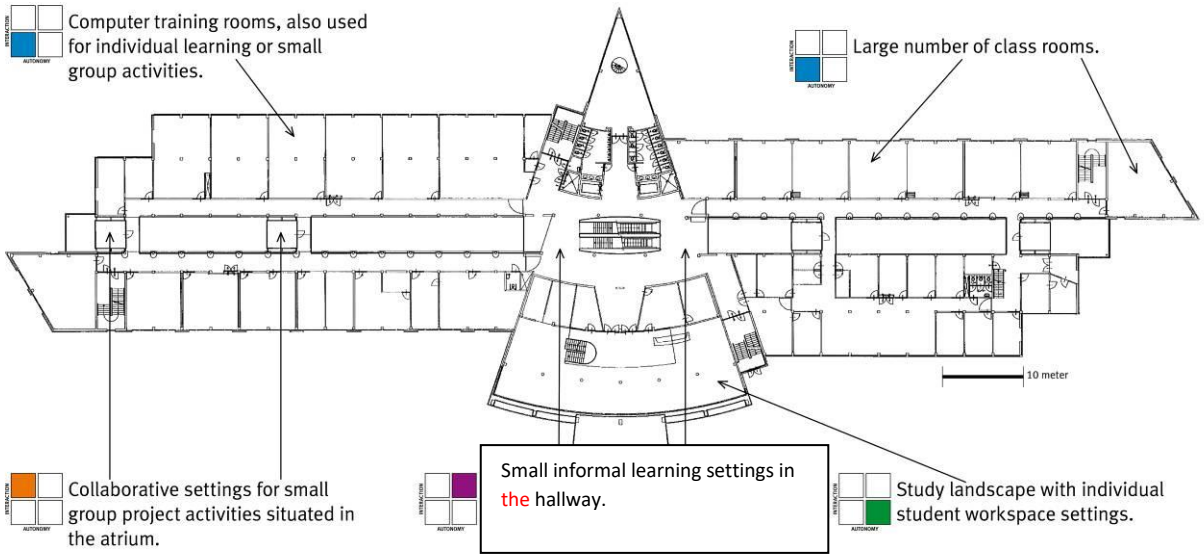



**Figure 3.** Floor plan of building A


**Figure 4.** Pictures of building A

*Building B (2011), Nijmegen*

The floor space of building B is 13,998 square meters gross floor area, divided over three floors, and accommodates 3,794 students of the faculty of economics. The floor plan reflects the educational concept of HAN which was changed to competency-based learning and teaching in 2005. The main principles of this concept are: stimulating vocational orientation, autonomy in learning, and creating opportunities for a personal interpretation of the education by the student. All activities are supported by a digital learning environment called Scholar that gives students online access to teaching materials and project data. Figure 5 shows the first floor of the building that is typical because it has two atria. Despite the developments in education, there are still many classrooms that facilitate a traditional teaching approach. In the building many informal and collaborative settings are scattered across the wide corridors, in and around the atria. Central in the building, on the ground floor, is a large restaurant that is also used for informal learning (see the pictures in figure 6).

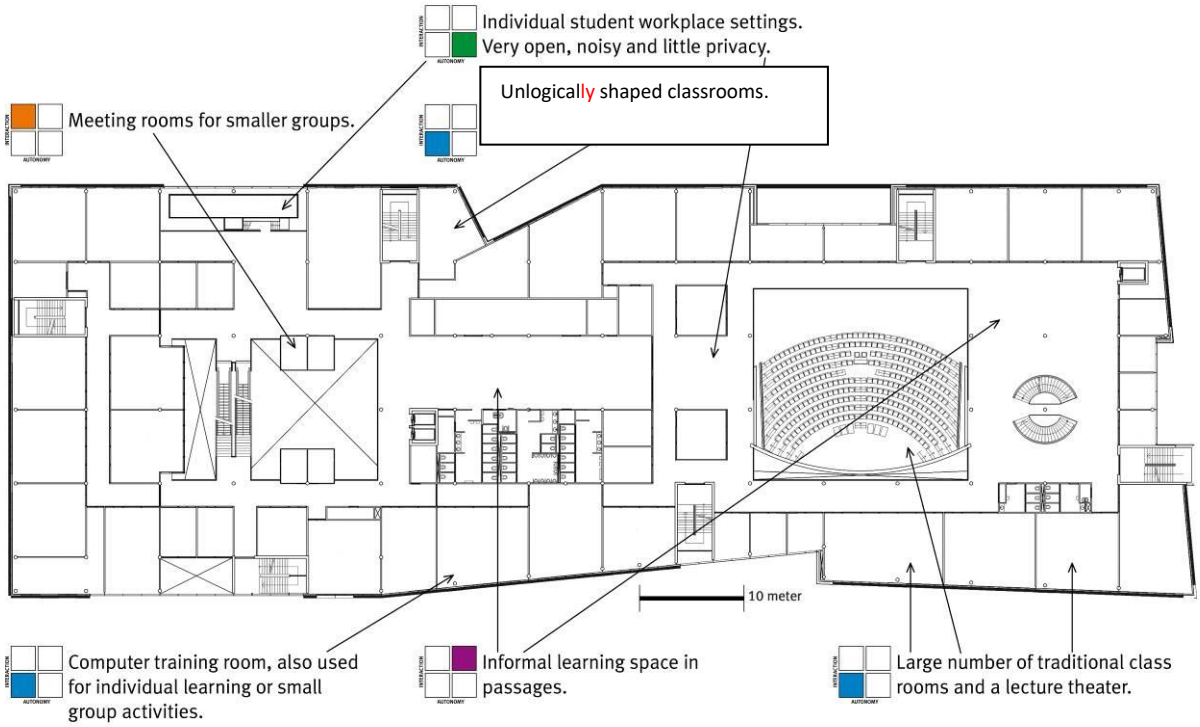



**Figure 5.** Floor plan of building B

Individual student workspace.

Cafetaria with informal learning space.

Restaurant used as informal learning space.

**Figure 6.** Pictures of building B

*Building C (2011), Zwolle*

Building C of Windesheim University of Applied Sciences in Zwolle was finished in 2011. It accommodates 4,602 students of the School of Business and Economics, and the School of Media on 11 floors with a total of 16,852 square meters gross floor area. The educational process of Windesheim is characterised by competence-based learning in which students work together in projects. Classroom learning is shifting to demand-driven learning with more attention to the individual student and a digital learning environment which makes learning flexible. The change in education methods is visible in the building which includes many informal learning spaces and study landscapes. Figure 7 illustrates this concept on the eighth and ninth floor. The interior of the building is characterised by a large atrium that splits the building into two parts with split level floors on both sides (see figure 8). On each floor learning settings are mixed to stimulate circulation of students and teachers in the building so they can easily meet. Catering facilities are concentrated on the ground floor in a large restaurant.

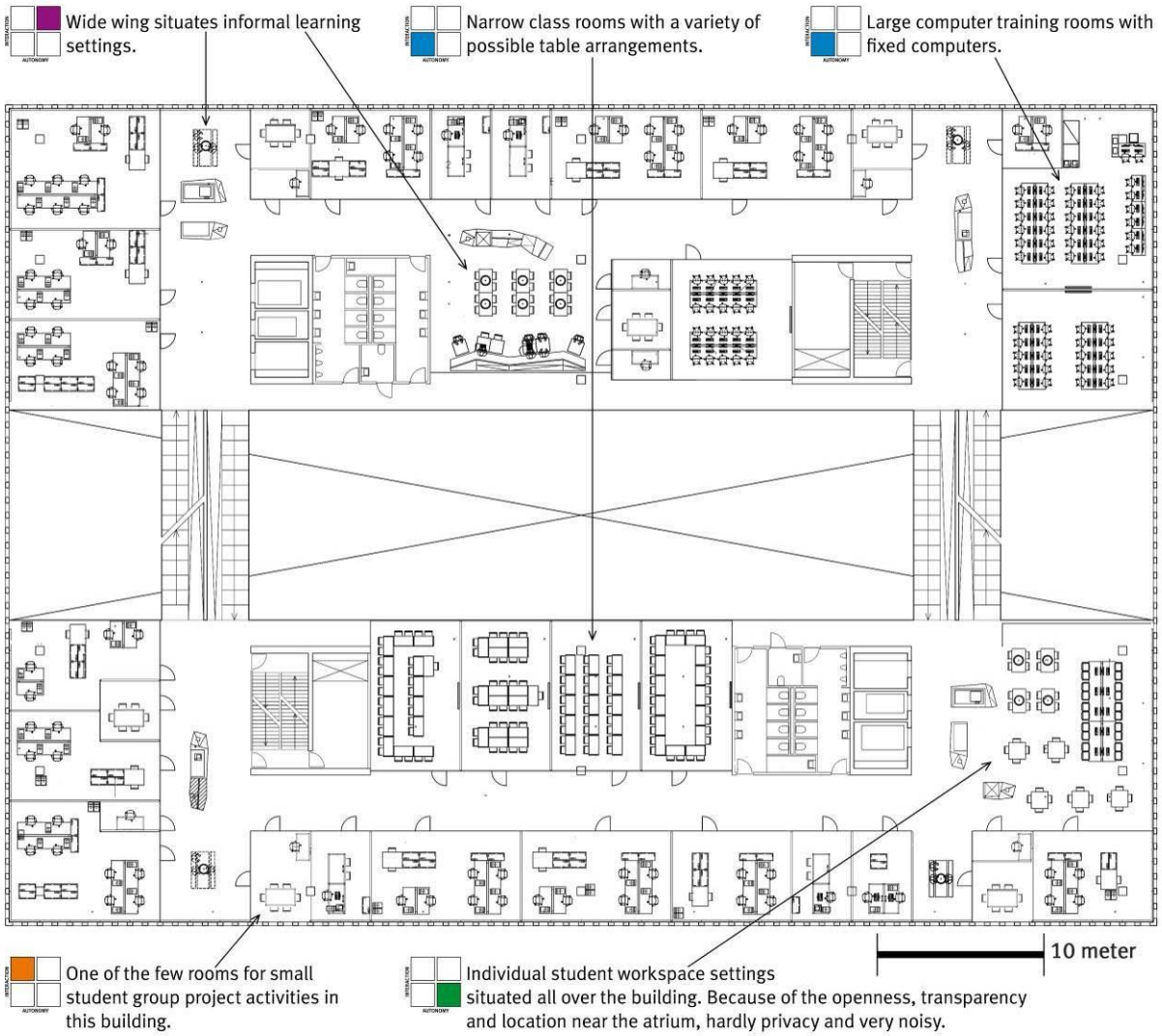



**Figure 7.** Floor plan of building C


**Figure 8.** Pictures of building C

*Building D (2010), Amersfoort*

Building D of HU University of Applied Sciences (HU) is located in Amersfoort and has 14,000 square meters gross floor area over 7 floors. It has a total length of 151 meters and consists of a short and a long wing. The building has been occupied since 2010 and accommodates 4,000 students of the Faculties of Economics and Management, Education, and Society and Law. The educational process is aimed at creating learning communities to stimulate students to meet face-to-face, as much as possible because for HU 'learning is meeting'. The accommodation concept is meant to support meeting, connecting and knowledge sharing. The building is characterized by large voids inside and open spaces. A mix of learning settings is present on each floor. A large part of the ground floor accommodates the restaurant and meeting space. Figure 9 shows the second floor which gives a good picture of the way learning space is arranged throughout the building.

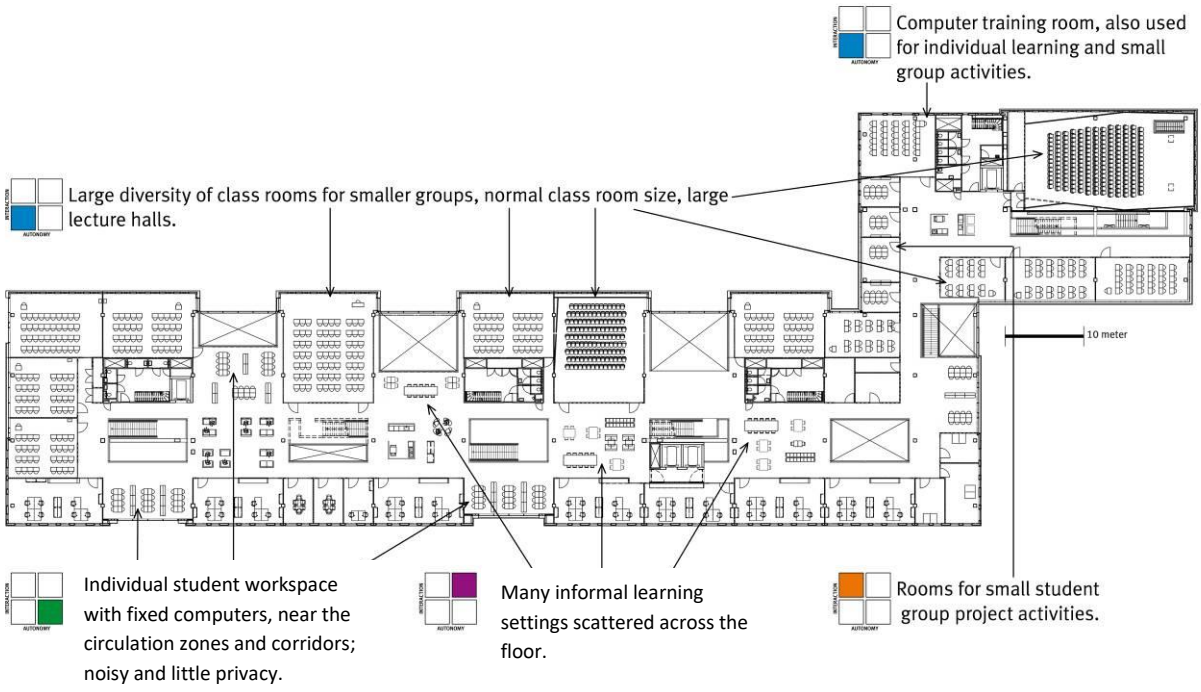



**Figure 9.** Floor plan of building D

Individual learning settings direct near corridors.


Small cockpits for concentrated individual learning.

Informal learning settings.

**Figure 10.** Pictures of building D

*Comparison of the four buildings*

The floor plans were analysed using the typology of learning settings in the conceptual framework of figure 2. Table II shows the ratio of various learning settings in percentages of total square meters gross floor area learning space for each building.

The comparison of the four buildings shows a shift from a high proportion of classroom space in the fifteen year old building A, towards less classroom space and a growing percentage of individual workspaces for students, and informal learning space in the new buildings B, C and D. In these buildings informal learning space is much more scattered throughout the whole building and especially designed for the purpose of informal learning using ICT. The new buildings have wide corridor areas which are also used as meeting spaces and for informal learning activities. The older Arnhem building is characterised by long narrow corridors that only serve circulation. All four buildings are primarily designed to support the transfer learning approach.

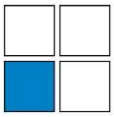
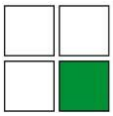
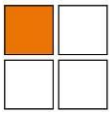
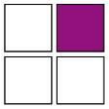
| | **Learning settings** | **Building A, Arnhem** | **Building B, Nijmegen** | **Building C, Zwolle** | **Building D, Amersfoort** |
|---|---|---|---|---|---|
|  | *Classroom setting* (incl computer training rooms) | 70.8% | 61.8% | 54.5% | 50.1% |
|  | *Individual study setting* | 4.9% | 10.7% | 13.9% | 13.7% |
|  | *Collaborative setting* (project rooms) | 5.0% | 11.8% | 1.7% | 9.6% |
|  | *Informal learning setting* (general) | 1.1% | 3.9% | 12.6% | 23.5% |
| | *Informal learning setting* (restaurant) | 18.2% | 11.8% | 17.2% | 3.1% |
| | Total | 100% | 100% | 100% | 100% |

**Table II.** Comparison of learning settings in percentages of total square meters gross floor area.

Other remarkable findings are the limited percentage of collaborative learning spaces in building C (1.7%), the low percentage of informal learning spaces in combination with lunch facilities in building D (3.1%) and the relatively low percentage of informal learning spaces in building B (3.9%). Walkthrough observations in the four buildings showed that students use informal learning spaces like restaurants and cafeterias for project activities too. The older building A does not contain deliberately designed informal learning spaces. However, due to the wireless network, students nowadays use the large canteen for informal learning activities too. Individual study spaces like in libraries are used for project activities. Using informal learning spaces for collaborative activities fits to the connectivist philosophy,

but using individual learning spaces for project group activities is interfering with peacefulness and quietness of individual use of these workspaces. Since the study did not involve an analysis of the curricula of the education in the buildings, it is difficult to conclude that the shift in learning settings can be fully attributed to developments in educational purpose and processes. Yet, it is interesting to see that the ratios between learning settings in HAN's building B in Nijmegen exactly correspond with the ratios formulated for first year student learning activities in the annual report 2011 of the HAN. HAN indicates that the preferred ratio between instruction and students activities without supervision of a teacher (self-study and project work) for first year students is 62% - 38%.

**Discussion**

The present study shows that in modern school buildings, developments in education are expressed in a lower proportion of classroom space and a higher proportion of space for informal learning, self-study and collaborative learning in small groups. This finding is consistent with experiences from The Saltire Centre case (Watson, 2007) and other research in seven higher education institutions in the UK that concluded that institutions need to remodel their existing space to cope with new teaching and learning methods, the use of new technologies and new social expectations (SMG, 2006). Our study shows that despite the apparent shift in learning settings the floor plans of the new school buildings in Dutch higher education are still characterised by a large number of classrooms. The development towards modern learning centres, as presented in the guide for 21st century learning space design (Joint Information Systems Committee [JISC] (2006), in the design patterns of Nair and Fielding (2005), and the visions on learning environments of Marmot (2005), go well beyond the studied higher education buildings. A justified question is what is needed for further developments in learning space design. Jessop *et al.* (2012) state that the push to make

fundamentally or radically different choices concerning learning and teaching spaces in universities must come from students.

Our study shows that HEIs with new school buildings can anticipate on developments in education. Yet, the change in education is much faster than the buildings can accommodate. Buildings are a long term investment, and most universities have to learn to live with their architectural legacies (Temple, 2007). Diverse studies argue for flexible learning environments (Jamieson *et al*, 2000; JISC, 2006; Marmot, 2006). Adaptable furniture and equipment, movable walls and flexibility in building technology make it easier to deal with that legacy and facilitate multi-functional uses of space by different users and for different purposes.

The cross-case comparison confirmed the expected changes in the floor plans of new school buildings in Dutch higher education. However, the number of studied buildings is limited. Besides, the empirical study only focused on a comparative floor plan analysis. A systematical post-occupancy evaluation and data-collection on the use of space were not included. The presented conceptual framework showing a typology of four learning theories, four learning processes, and four types of learning space may suggest that each type of learning is exclusively associated with one particular type of space. In practice much space is used in a more flexible and multi-functional way, to stimulate efficient use of space. The implementation of ICT in education makes it possible to arrange contact ‘anytime, anywhere’, independent of time and location (Jamieson *et al*., 2000; Punie, 2007). In addition to measures to support technical spatial adaptability, the opportunity to have access to information and networks always and everywhere, leads to space that can and will be used in more flexible ways (JISC, 2006). The walkthrough observations indicate that students progressively work on projects in informal learning settings, coffee corners and restaurant settings. Watson (2007, 258) noticed a similar situation in The Saltire Centre-case: “for the student, finding a place to

undertake interactive group work is not straightforward (…) many students end up working in the refectory". Students also use classrooms that are not scheduled for classes, for small project group work, or even for one-on-one peer feedback sessions with a tutor. As a consequence, the conceptual framework should be used as a discussion tool to deliver conceptual input to the planning of learning spaces, like Duffy (2000) did in the framework for the planning of new ways of working in offices.

## Concluding remarks

The 'purpose-process-place' framework was shown to be useful for linking learning settings to learning theories and educational processes, and the Comparative Floor plan Analysis was shown to be a useful method to explore the relationship between purpose, process and place. The combination of the conceptual framework and CFA contributes to a better understanding of how different learning theories may influence the physical learning setting, but does not explain completely yet the use of those spaces to a full length. Other research methods are needed as well to understand the motivations of students to use certain types of space.

The studied floor plans of the new school buildings in Dutch higher education show a trend towards less classroom space and an increasing proportion of other learning settings. Yet, the studied buildings are quite conservative in learning space developments. Developments in learning and teaching apparently do not go at such pace that one might speak of a revolutionary change in learning space design. In current Dutch higher education all four types of learning settings are still needed to support learning processes. They are complementary and not mutually exclusive. The total demise of the formal lecture and the classroom as a learning setting that has been suggested in literature, will not be reality in the foreseeable future of Dutch higher education.

Of course a selection of four cases is too limited to generalise these conclusions to all institutes of higher education. Further research is needed to test if the established trends are visible in other new school buildings as well. Another topic for further research is the quantification of the most desired ratios between different types of learning settings, and how this knowledge is or could be incorporated in decision making on the design and the management of learning spaces.

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