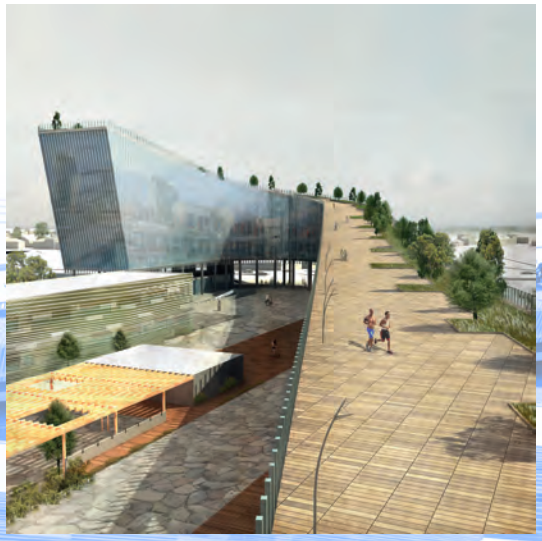
HEALTHY BUILDINGS: INNOVATION, DESIGN & TECHNOLOGY

ICAT 2016

ANTONIO GALIANO GARRIGÓS
TAHAR KOUIDER



CONFERENCE PROCEEDINGS OF THE 6TH INTERNATIONAL CONGRESS OF ARCHITECTURAL TECHNOLOGY UNIVERSITY OF ALICANTE 12-14 MAY 2016

UNIVERSIDAD DE ALICANTE

HEALTHY BUILDINGS: INNOVATION, DESIGN & TECHNOLOGY

ICAT 2016

ANTONIO GALIANO GARRIGÓS
TAHAR KOUIDER

CONFERENCE PROCEEDINGS OF THE 6TH INTERNATIONAL CONGRESS OF ARCHITECTURAL TECHNOLOGY
UNIVERSITY OF ALICANTE 12-14 MAY 2016

UNIVERSIDAD DE ALICANTE

Universidad de Alicante
Campus de San Vicente s/n
03690 San Vicente del Raspeig
Publicaciones@ua.es
http://publicaciones.ua.es
Teléfono: 965903480
Fax: 965909445

Edición de Antonio Galiano Garrigós y Tahar Kouider

ISBN: 978-84-16724-10-9
Depósito legal: A 331-2016

Diseño y maquetación: Roberto T. Yáñez Pacios
Imagen de portada: Galiano Garrigós Arquitectos
Corrección de pruebas: Tahar Kouider
Impresión y encuadernación: Universidad de Alicante

ICAT
INTERNATIONAL CONGRESS OF ARCHITECTURAL TECHNOLOGY

Universitat d'Alacant
Universidad de Alicante
Departament de Construccions Arquitectòniques
Departamento de Construcciones Arquitectónicas

Cátedra MARJAL HEALTHY

International Congress On Architectural Technology

ICAT 2016
12th - 14th May, 2016
Organised by
University of Alicante

Dr. Antonio Galiano Garrigós – Chairman

Roberto T. Yáñez Pacios – Departamento de Construcciones Arquitectónicas

International Marjal Healthy Chair

CONTENTS

THE INFLUENCE OF SPACE LAYOUT, TECHNOLOGY AND TEACHING APPROACH ON STUDENT LEARNING

An Architectural Technology Perspective

DAVID COMISKEY, GARETH ALEXANDER, DIANE HAZLETT, KENNETH MCCARTAN AND LOUISE O'BOYLE
Ulster University, Northern Ireland
da.comiskey@ulster.ac.uk
go.alexander@ulster.ac.uk
de.hazlett@ulster.ac.uk
kg.mccartan@ulster.ac.uk
lm.oboyle@ulster.ac.uk

Abstract. Some would argue that there is a need for the traditional lecture format to be rethought in favour of a more active approach. However, this must form part of a bipartite strategy, considered in conjunction with the layout of any new space to facilitate alternative learning and teaching methods. With this in mind, this paper begins to examine the impact of the learning environment on the student learning experience, specifically focusing on students studying on the Architectural Technology and Management programme at Ulster University. The aim of this study is two-fold: to increase understanding of the impact of learning space layout, by taking a student centered approach; and to gain an appreciation of how technology can impact upon the learning space. The study forms part of a wider project being undertaken at Ulster University known as the Learning Landscape Transition Project, exploring the relationship between learning, teaching and space layout. Data collection was both qualitative and quantitative, with use of a case study supported by a questionnaire based on attitudinal scaling. A focus group was also used to further analyse the key trends resulting from the questionnaire. The initial results suggest that the learning

environment, and the technology within it, can not only play an important part in the overall learning experience of the student, but also assist with preparation for the working environment to be experienced in professional life.

1. Introduction

The traditional teaching model within many Higher Education Institutions has been challenged, and in many cases replaced, with interaction and collaboration. This has led to a new impetus to examine the learning space itself as part of any reworking of the teaching experience. This is true within the built environment sector, with multidisciplinary provision and collaborative working becoming more widely implemented. As the sector move towards this type of educational delivery, is important that the design and layout of the physical environment in which such tasks are taking place is considered (see Comiskey et al. 2015, p.255).

The learning space is no longer a lecture theatre with fixed layouts designed for quiet listening to an academic from behind a lectern. The learning space is now flexible and mobile, incorporating any location from a large classroom to a public space café or a small meeting room. JISC (2006, p.5) outline how, "*a learning space should be able to motivate learners and promote learning as an activity, support collaborative as well as formal practice, provide a personalised and inclusive environment, and be flexible in the face of changing needs*." While this outlines what a learning space should do, Boys (2010, p.160) argued, "*Almost no data exists to help assess the effectiveness of the new and adapted buildings currently being constructed across universities and colleges*". This is an important risk for designers of new learning space as Oblinger (2005, p.14) points out how "*space can either enable - or inhibit - different styles of teaching as well as learning*". What is clear from research is how flexible space capable of enabling a wide range of users to learn in their own way both on their own and in collaboration with their peers is key. Gardner & Eng (2005, cited in Schadl et al. 2015, p.42), highlight that students need

"*space for learning from peers and for integrating technology",* while Schadl et al. (2015) also argue there is no typical student, and thus learning spaces need to facilitate a wide range of preferences from silent areas through to bustling workspaces.

This paper intends to add to the research knowledge by undertaking a study with a two-fold aim, to increase understanding of the impact of learning space layout, by taking a student centered approach; and to gain an appreciation of how technology can impact upon the learning space. The study forms part of a wider project being undertaken at Ulster University known as the Learning Landscape Transition Project, exploring the relationship between learning, teaching and space layout. Whilst this specific project is investigating optimum space layout and technology requirements for a built environment related discipline, it is also using the lessons learnt to provide general feedback which will feed into a wider study aimed at implementing optimum learning space design throughout the new University campus at Ulster University known as the Greater Belfast Development.

2. Literature Review

The change in pedagogic emphasis from teaching to learning has increased the architectural and technical requirements of new learning spaces. This has stemmed from the realisation of how limiting a traditional lecture theatre can be for interaction. It is difficult to encourage a group dynamic when all students are positioned facing the teaching position, in many cases in tiered rows, and unable to speak to people in front or behind with ease. Resultantly, a new spotlight on learning space layouts, aimed towards encouraging collaboration and group work, has led to many institutions creating and maintaining their own suite of active learning spaces. Typically, these spaces incorporate a range of furniture and technologies to facilitate a greater range of learning function.

At Ulster University, the approach to preparing for the changing learning environment in multicampus developments has been to create a range of furniture and technology enhanced active learning classes and studios. Rowley (2014, p.67-68) concluded that teaching in a different physical space encourages academics to review their current curriculum and teaching practices to align with more "technology–rich", social learning spaces to facilitate active, collaborative and blended learning. As outlined by Corcorran (2014), "*Pedagogy, technology and space can and should work in concert to create a synergistic ecosystem that can maximise the effectiveness of great teachers*." That said, Drew & Koppler (2014, p.108) highlight, "*a challenge for teachers as they come to grapple with understanding how learning spaces are created and mediated with technology to engage students with learning activities that effectively assist them towards desired learning outcomes*."

One example of a space where technology and furniture facilitate changed learning approaches is "SCALE-UP" rooms. The term "SCALE-UP" stands for, "The Student-Centred Activities for Large Enrolment Undergraduate Programs" (Beichner et al. 2007), but with increasing use the acronym has changed to incorporate Upside-down Pedagogies (NTU, 2015). A SCALE-UP room combines mobile furniture and linked technologies with problem based learning to create a dynamic where participants are encouraged to collaborate with their peers, questioning and teaching one another (Beichner et al. 2007). To enable the cohort to engage with each other and their topic, they are asked to prepare for their workshops by reading resources and preparing questions and topics for engagement before they come to class each week. Homework helps the group to analyse the resources they use during their seminars. The technologies required to facilitate SCALE-UP learning are designed to enable two-way presentation of content to or from any table within the room. This means the academic can share content to a specific group who can then work on a problem and share their findings with the academic or

other groups within the room. This facilitates opening the engagement to a wider cohort from anywhere within the room.

2.1. TECHNOLOGY AND LEARNING SPACE DESIGN

The use of tablet and mobile technologies has increased in recent years led by interest in Apple iPad and Google Android tablets. As these products continue to grow in terms of their capabilities they can enable a greater range of learning and engagement through Apps designed to encourage interaction both in class and online. Tablets can offer the cohort media rich content, and they can create, share, annotate and change in collaboration with their peers to create their own knowledge resource. Information can be shared without the need for media cables or physical network connections while any information created is stored and shared through cloud storage facilities. As well as tablet devices, there is potential for a range of other technologies to be incorporated within learning sessions for active engagement. The co-authors of this paper have background knowledge in the area of technology enhanced learning; including an award winning initiative to bring construction activities to the students via the use of video (see Comiskey, 2011) and encouraging engagement via the use of iBooks (see Comiskey et al. 2013), and have found that the integration of such technology means the learning experience can be more engaging and a deeper understanding of any concept explored thanks to the creation of a richer learning experience.

Knowledge and experience of technology facilitated via active learning techniques is particularly important at present in built environment education due to the move towards a smarter, technologically driven and collaborative construction sector. There has been the emergence of tablet-based construction Apps, and software allowing for more efficient building design, data capture, management, and communication. This transformation is taking place within a changing office environment, with videoconferencing technologies now frequently used for meetings, and platforms such as FaceTime and Skype, coupled with the rise in the use of

cloud based environments to share information and collaborate, making it easier than ever to instantly connect and work with individuals regardless of location. All of this means that those studying on construction programmes need to be comfortable with technology and working in a more collaborative manner. Therefore, there is an opportunity to integrate this into the learning environment and thus harness a more active learning approach.

Whilst this active learning and technology driven approach has been highlighted as a way of transforming the learning experience, there is recognition that not all academics will be comfortable using such techniques. Therefore, a key aim of this study was to trial a number of technologies and approaches that have the potential to enhance lessons and provide feedback.

3. Research Methodology

Data collection for this study was both qualitative and quantitative, with use of a case study approach supported by a questionnaire based on attitudinal scaling. The design and content of the questionnaire was heavily influenced by similar work from Wood et al. (2010) undertaken at the University of Leicester. A focus group was used to analyse key trends resulting from the questionnaire, helping to triangulate and validate the findings. In terms of academic evaluation, reflective writing was used to record observations witnessed before, during and after the weekly sessions.

4. Case Study

As previously outlined, the case study presented forms part of a wider project being undertaken at Ulster University known as the Learning Landscape Transition Project. This was initiated to increase the awareness of innovative learning and teaching approaches, promoting the importance

of learning space design in future campus developments. As part of this initiative, students designed an experimental Active Learning Space (ALS).

Figure 1. Year 4 ATM Students working in the Active Learning Space

This space included a number of separate zones, one for interaction and collaboration with moveable furniture and both moveable and fixed white boards, and a zone for professional learning which was partly partitioned off from the rest of the space and included moveable desks and seats and a wall mounted TV monitor. Initially, this space was used in an informal manner during the 2014/15 academic year. However, more systematic evaluation was required, and it was decided to analyse the use of the space and gather feedback on a range of topics, including; how it functioned as a learning environment, evaluation of design and layout, and integration of technology. The overarching concept was to learn more about active space design.

Academics belonging to the Architectural Technology and Management (ATM) programme were selected to take part in a pilot evaluation project, using the space as part of their module delivery during semester one of the 2015/16 academic year. Within the ATM programme two distinct student cohorts were identified to provide analysis; Year 1 students due to their ability to draw comparisons with experiences during their secondary or college education, and Year 4 students who had experienced more traditional teaching space layouts during the first two years of their University studies (the third year being spent on a period of industrial

placement). The following case study provides an analysis of the activities undertaken by the Year 4 students and feedback from those involved.

4.1. YEAR 4 GROUP

The Year 4 students involved in the project were studying a module entitled Building Information Modelling, with the content delivered primarily theory based. The ALS was used to deliver the lectures for seven weeks of the semester, with the other five weeks lectures delivered in a more traditional teaching environment (Figure 2). The students also used the space for six weeks for a separate Dissertation module, with the remaining six weeks again delivered in a traditional environment with which they were more familiar.

Figure 2. Year 4 ATM Students working in the traditional teaching space

The two separate spaces were selected to allow some basic comparisons to be made. From the academics perspective, an important aim was to observe student engagement and participation in the more traditional learning space and compare this with the sessions delivered in the ALS.

The lectures delivered in the traditional teaching space all followed a similar format. The material to be delivered was presented in a traditional PowerPoint format, with the lecture broken up via the use of video clips, active and collaborative learning tasks and question and answer sessions. The sessions in the ALS were more varied and employed a range of active and collaborative learning techniques as well as trialling a range of technologies. Microsoft Surface Pro devices (with type cover and mouse) were used in some of the sessions to evaluate their ability to aid active

learning techniques. These devices were selected due to their high quality stylus pen for sketching purposes, operating system compatibility, and all round usefulness for Architectural Technology students to allow for use and analysis within the space. The devices were remotely connected to a 50-inch TV monitor (fixed to a moveable display stand) for display purposes via a wireless display adapter connected using the Miracast feature. Other technologies and software used included Autodesk Sketchbook, Trimble SketchUp and Onuma platforms to design learning space layouts, the use of an online cloud based system (OneDrive) for group collaboration and for integrating a pre-recorded lecture, and the use of GoToMeeting videoconferencing technology to deliver a live lecture from a leading academic located in Copenhagen, Denmark. The full lecture schedule and content for each of the twelve sessions can be seen in Table 1.

TABLE 1. Year 4 Lecture Schedule

Week No. & Room	**Content**	**Technology Used**
1 Block 2	BIM Overview & Lean. *Delivered as a traditional lecture with questions for student engagement.*	PowerPoint projected onto fixed Whiteboard
2 ALS	BIM implementation in the UK and NI. *Presentation in professional space followed by activity and discussion in collaboration zone with final analysis in professional space.*	PowerPoint projected onto fixed TV Monitor
3 Block 2	BIM Protocol. *Traditional lecture followed by group activity aimed at evaluating the Protocol document.*	PowerPoint projected onto fixed Whiteboard. IPad to mark up document, which was then shared with the group.
4 Block 2	PAS1192-2 & BS 1192-2007. *Traditional lecture with video clips for demonstration/generate discussion.*	PowerPoint projected onto fixed Whiteboard. Laptop with Wi-Fi connection to play web based video clips.
5 Block 2	PAS1192-3 & BS 1192-4. *Traditional lecture with video clips for demonstration/generate discussion.*	PowerPoint projected onto fixed Whiteboard. Laptop with Wi-Fi connection to play web based video clips.

6 Block 2	BIM Internationally. *Traditional lecture with video clips for demonstration and to generate discussion.*	PowerPoint projected onto fixed Whiteboard. Laptop with Wi-Fi connection to play web based video clips.
7 ALS	BIM for Sustainable Design. *Traditional lecture with video clips for demonstration/generate discussion.*	PowerPoint projected onto fixed TV Monitor. Laptop with Wi-Fi connection to play web based video clips.
8 ALS	Software Demo and Use. *Interactive session with active learning activity. Class split into two groups for weeks 8 & 9 and weeks 10 & 11*	Surface Pro/s remotely connected to TV on moveable display stand using Miracast to display student designs created on Autodesk Sketchbook.
9 ALS	Software Demo and Use. *Interactive session with active learning activity*	Surface Pro/s remotely connected to TV on moveable display stand using Miracast
10 ALS	Repeat of week 8	
11 ALS	Repeat of week 9	
12 ALS	Live Lecture & BIM & Design. *Interactive session with live lecture and active learning group activity. Outcomes to be uploaded to Onedrive*	Laptop connected to TV on moveable display stand to display live lecture via GoToMeeting. OneDrive for group collaboration. Pre recorded lecture shared via OneDrive

5. Analysis and Discussion

The first research objective was to increase understanding of learning space layout. From the academics perspective it was clear that the ALS facilitated a more active and collaborative approach to educational delivery. Feedback from Part A of the questionnaire (Table 2) suggests that the cohort favoured this active learning approach. Note that the questionnaire feedback was solely based on the experiences within the module identified. 25 out of 29 students responded, giving an 86% response rate.

TABLE 2. Year 4 Feedback (Part A)

Question	SA	A	N	D	SD
I prefer teaching approaches which focus on lectures and note-taking, with minimal interaction between the tutor and the student	4%	12%	32%	40%	12%
I prefer teaching approaches which focus on discussion between the tutor and the class	0%	72%	20%	8%	0%
I prefer teaching approaches which are interactive, with active learning activities incorporated and feedback provided to the group	8%	72%	16%	4%	0%
I prefer teaching approaches where I can work on my own and am set tasks to work on individually	12%	24%	44%	20%	0%
I prefer teaching approaches where I can work in collaboration with others	4%	48%	40%	8%	0%

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree
All questions taken from or influenced by Wood et al (2010)

Focusing on space layout in the traditional teaching space, it was noticeable that students immediately moved towards the back of the room upon entry, and appeared to subconsciously use the empty seats towards the front of the room as a kind of barrier to engagement. The small space available coupled with heavy furniture meant that the space could not be easily rearranged and thus the traditional layout with students sitting in rows was employed. In Part B of the questionnaire it was interesting to note a majority (48%) were unsure when asked about their preference for traditional teaching layouts with desks in rows, facing the front of the room, yet a majority (64%) were in agreement that they preferred working in a room where furniture can be moved around to facilitate different activities, with only 8% disagreeing. The sessions in the ALS were much more interactive, with the larger space and easily moveable furniture meaning the space could be easily reconfigured for each class. As recorded in the reflective diary of the academic, "*it was as if the open layout meant that students felt they were expected to engage with activities/discussions*

during the session". There was a different atmosphere within the group and better all round engagement.

TABLE 3. Year 4 Feedback (Part B)

Question	**SA**	**A**	**N**	**D**	**SD**
I prefer working in a room with desks in rows, facing the front of the room	4%	16%	48%	32%	0%
I prefer working in a room where the desks are in groups of 4-6 seats	0%	48%	36%	12%	4%
I prefer working in a room with no tables, only chairs	0%	0%	16%	48%	36%
I prefer working in a room where furniture can be moved around to facilitate different activities	16%	48%	28%	8%	0%
I like working in a room with a good level of natural light (i.e. Student Hub) as opposed to other teaching spaces (06C39)	4%	52%	40%	4%	0%

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree
All questions taken from or influenced by Wood et al (2010)

Although the professional learning zone in the ALS was highly beneficial, in reality it was too small for the entire cohort to fit into. This is one reason why the class was split up for some of the sessions. The zone mirrored professional practice in terms of its layout, but ideally the partition wall should have been moveable to ensure the space was suitable for the cohort size. The windows (with obscure glass) facing onto the corridor outside allowed additional light into the space, but the feedback from the focus group discussion was that these windows were distracting due to people outside the space looking in. In terms of other layout considerations, the whiteboard walls, although not overly used, were seen as a good idea in principle.

The second research objective sought to gain an appreciation of how technology could impact on the learning space. In the traditional learning space it was noted that the room layout was unhelpful in terms of promoting interaction as the lecturer had to constantly move to the front of the class to play and pause videos that were part of the presentation. The

use of the tablet devices in the ALS were better in this regard as they could be controlled remotely and therefore be less disruptive to the flow of the class. The tablet devices worked particularly well with the moveable TV monitor, which could be repositioned within the class as needed, allowing for a flexible use of space for specific tasks. Whilst this was preferred to the fixed TV monitor, there is awareness that this presents security concerns.

It became apparent that having a detailed knowledge of the workings of the wireless display adapter and miracast facility is essential. For instance, for one task the students were divided in groups and requested to redesign the ALS to create their ideal learning area. This was done on the tablet devices using specialist software. The idea was that each group could remotely share their tablet screen using the wireless display adapter, mirroring it to display on the TV monitor, and present their ideas to the rest of the cohort. This did not work as expected, as there appeared to be interference between the devices. Upon reflection, the reason for this interference was most likely due to certain groups not disconnecting their devices after they had finished their presentation, and thus impacting on the ability of the other groups to connect to the Miracast wireless display. This highlights the importance of those using the technology, both students and academics, fully understanding how it operates.

Interestingly, most of the design layouts produced by the students seemed to favour a collaborative approach to learning. Wi-Fi connectivity was also an issue on occasions and a fixed connection port would have been useful, although again doing away with the wireless model sought. These are important considerations and highlight that the information technology infrastructure must be in place to support the technology used. Although there were some issues, the majority of students stated that the use of the tablet devices enhanced the lessons. In the final week a live lecture was scheduled to demonstrate that technology can allow industry experts, regardless of location, to interact and engage with students. A laptop was connected to the TV monitor for display purposes and GoToMeeting video conferencing software was used for the presentation. This worked extremely well with only minor technical issues and was well

received by the students; with 88% (Table 4) stating that they thought it enhanced the lesson.

TABLE 4. Year 4 Feedback (Part C)

Question	SA	A	N	D	SD
The use of the tablet devices enhanced the lessons	16%	48%	32%	4%	0%
The live interactive lecture enhanced the lesson	36%	52%	8%	4%	0%

SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, SD = Strongly Disagree

The Cloud based resource utilised also has a lot of potential. The cohort were split into groups and asked to evaluate and provide feedback on research articles using OneDrive. A shared folder structure was created to encourage each group to upload their evaluation, which could in turn be viewed by the rest of the cohort. Although in reality it was solely used to view content rather than provide evaluations, it has a lot of potential to be used as a collaborative platform for sharing information and generating discussions and debate outside the classroom.

6. Conclusion

Although a small-scale scoping study, the findings resonate with the research outlined at the beginning of the paper, with the feedback suggesting that the layout of the active learning space was favoured over the more traditional teaching space. The layout of the ALS also better facilitated the use of technology, which was generally well received and enhanced the lessons. The use of this technology also assisted in providing the students with experience of using the software and the collaborative working methods they will experience in professional practice. Another noteworthy point was the success of the live lecture. Although it is acknowledged that the use of video conferencing technology is nothing new, it provoked a positive response from the cohort and brought a new level of engagement into the group. Whilst the use of the various

technologies were beneficial in this study, it must be highlighted that technology should only be used where there will be a genuine benefit to learning and where it will enhance the lesson. Finally, the project also highlighted the importance of ensuring the technical infrastructure is in place to support such technology if it is used. Although the outcomes from this study are interesting and add to the existing research data in this area, it should be remembered that this has been a small-scale project, undertaken in a short time frame and with a relatively small group of students. Rather than draw conclusions from it directly, it will feed into a larger study at Ulster University, the results of which will provide a more comprehensive analysis and understanding of preferred learning approaches and the impact these will have on teaching styles both now and in future.

Acknowledgements

Thanks are expressed to the Centre for Higher Education Research and Practice (CHERP) at Ulster University for providing funding to support this research project and to Onuma and Trimble/Elmtec for granting a student license for the use of software. Thanks are also expressed to Dr. P Wood for granting permission for the use of questionnaire questions, previously used in a report by the University of Leicester. A verbal presentation of this work has been disseminated internally at Ulster University via the Centre for Higher Education Research and Practice (CHERP) Conference.

References

BEICHNER, R. J. SAUL, J. M. ABBOTT, D. S. MORSE, J. J. DEARDORFF, D. L. ALLAIN R. J. BONHAM S. W. DANCY M. H. and RISLEY J. S., 2007. The Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) Project. In Redish E. F. and Cooney P. J. (Eds.) Research-based Reform of University Physics. Available at http://www.compadre.org/PER/per_reviews/volume1.cfm Accessed December 2015

BOYS, J., 2010. Towards Creative Spaces: Rethinking the Architecture of Post-compulsory Education. Oxford: Routledge.

COMISKEY, D., 2011. Construct Online: Using Video and Screencasting to bring the Construction Site into the Classroom. In World Conference on Educational Multimedia, Hypermedia and Telecommunications (EDMEDIA) 2011, Lisbon, Portugal. Association for the Advancement of Computing in Education (AACE).

COMISKEY, D., MCCARTAN, K., and NICHOLL, P., 2013. From eLearning to iLearning. In: International Conference on Architectural Technology 2013, Sheffield Hallam University. The International Congress of Architectural Technology (ICAT).

COMISKEY, D., MCKANE, M., EADIE, R., and GOLDBERG, D., 2015. Providing Collaborative Education with an International Dimension. An Ulster University and Pennsylvania State University Case Study. In: A.V. Hore, B. McAuley and R. West, ed. Proceedings of the CITA BIM Gathering, 12-13 November 2015. The Construction IT Alliance, 249-256.

CORCORRAN, S., 2014. Foreword. In: Scott-Webber, L., Branch, J., Bartholomew, P., and Nygaard, C., (Eds) Learning Space Design in Higher Education, Libri Publishing.

DREW, S., and KLOPPER, C., 2014, Perceptions and Conceptions of Learning Spaces in Higher Education. In: Scott-Webber, L., Branch, J., Bartholomew, P. and Nygaard, C., (Eds) Learning Space Design in Higher Education, Libri Publishing.

JISC., 2006. Designing Spaces for Effective Learning - A guide to 21st century learning space design. [Online] Available at: http://www.jiscinfonet.ac.uk/infokits/learning-space-design/design-high Accessed November 2015

NOTTINGHAM TRENT UNIVERSITY., 2015. SCALE-UP: Student-Centred Active Learning Environment with Upside-down Pedagogies. Available at: http://www.ntu.ac.uk/adq/teaching/scale_up/ Accessed December 2015

OBLINGER, D.G., 2005. "Leading the Transition from Classroom to Learning Spaces: the Convergence of Technology, Pedagogy, and Space can lead to Exciting New Models of Campus Interaction." Educause Quarterly, 1: 14-18.

ROWLEY, J., 2014, Enhancing Student Learning through the Management of Technology-rich Physical Learning Spaces for Flexible Teaching. In: Scott-Webber, L., Branch, J., Bartholomew, P., and Nygaard, C., (Eds) Learning Space Design in Higher Education, Libri Publishing.

SCHADL S.M., NELSON M. and VALENCIA K.S., 2015. Uncommons: Transforming Dusty Reading Rooms into Artefactual "Third Space" Library Learning Labs. Journal of Learning Spaces, Volume 4, Number 1. Available at: http://libjournal.uncg.edu/jls/article/download/575/822 Accessed November 2015.

WOOD, P., WARWICK, P., and COX, D., 2010. Evaluation of Experimental Learning Spaces. University of Leicester.