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Education, Design and Practice

Understanding skills in a Complex World

AMPS CONFERENCE 17.1

Education, Design and Practice – Understanding skills in a Complex World.

Stevens Institute of Technology, AMPS, PARADE, Architecture_MPS.
17—19 June, 2019

Education, Design and Practice – Understanding skills in a Complex World.

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INTRODUCTION

This publication is the product of the conference *Education, Design and Practice – Understanding skills in a Complex World* held at Stevens Institute of Technology in 2019. The keynote speaker was Peggy Deamer, Yale University. The call upon which the conference and this publication are based argues that:

The relationship between education and practice in any discipline is complex. In an ever changing world, it is also in flux. In a context such as the built environment, it is also interdisciplinary. Today, educators in the liberal arts still identify learning as an end unto itself, and designers still draw on ideas about intuitive knowledge. By contrast, the businesses behind urban development or city and regional growth call for graduates armed with the skills required in practice from day one. At the same time local government and cultural or city management firms need creative thinkers capable of continual adaptation. In the industries and sectors such as construction, transport and engineering, managers focus on a foundational baseline and value engineers and designers as both pragmatic problem solvers and visionaries.

These alternative perspectives have been reflected in multiple changes to the practice and structure of the education sector. One such example was the Boyer-Mitgang report which restructured architectural education in the US to reflect other professions. As in other areas, it resulted in a 'degree arms race', with MAs and doctoral programs multiplying more rapidly than the research and teaching methods they required. At the same time, the 'widening participation' agenda produced an explosion of research and funding for new pedagogical approaches and initiatives. Attempts to fuse education with the creative arts, industry and business through university led partnership schemes also proliferated. More recently, changes in the financing of the HE sector in places like the UK, mean universities now stress educational efficiency and guarantees of graduate jobs.

Working within this context, educators in sectors connected with the design, management and construction of the built environment have developed new and innovative ways to teach, they have embedded collaborative practices into their pedagogy, have forged unique partnerships across disciplines and outside the academy, and much more. However, research into best practice learning and teaching in the classroom is still evolving and educational initiatives can sometimes be seen as contradicting on-the-job realities in practice. The *Education, Design and Practice* conference publication explores this complex and contradictory scenario from multiple perspectives.

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INTEGRATING SUSTAINABILITY IN DESIGN STUDIO THROUGH BLENDED LEARNING

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INTRODUCTION

The complexity of sustainability often makes its integration into architectural education a difficult challenge. Consequently, sustainability is often not taught holistically or critically, leaving students confused as to what sustainable architecture is and how they might approach this themselves. At the same time, sustainable design must not be at the expense of our architectural imagination, yet within education and practice this is also often the case

This paper investigates how to bring sustainability knowledge into the studio instead of bringing the architecture studio to sustainability knowledge. In doing so, through two case studies undertaken at Aarhus School of Architecture, Denmark, the authors illustrate the integration of sustainable design in architecture studio using blended learning, such as making use of pre-recorded video lectures; group seminars, discussions and presentations; workshops and peer-peer learning as well as traditional studio drawing activities.

Changes within pedagogies need to occur to ensure that sustainability is embedded within the design education, acknowledging the dichotomy between the technical requirements and creative expression which are crucial for well-integrated holistic, sustainable architecture [1]. To embed sustainability in the architectural studio, both poetics and sustainability need to be taught together, focusing especially on the aesthetic and spatial implications of sustainability. The key to integrating sustainability in the architectural studio is not only to give knowledge but to ensure that specific learning activities allow for the application of this knowledge into students' design process as well as to discuss the implications of this knowledge for the students' own design project and the subsequent architectural language. This supports deep learning, critical thinking, and reflection skills. In the two cases outlined in this paper, this incorporation was embedded through developing studio-specific learning activities that cover both architecture and sustainability aspects, with students completing in-depth investigations and mappings of exemplary sustainable architecture case studies.

BACKGROUND
Sustainability in the design studio

Sustainability has been taught within the architecture curriculum for many years, however often parallel to 'traditional' design studio and in some cases in conflict as a technical or engineering specialization – often taught as lecture-based elective classes [2]. Sustainable architecture has only recently shifted from this specialist position to a central concern of architectural education. However, there is still work to be done to ensure pedagogies fully embed sustainable architecture into the architecture curriculum, especially within studio environments [3].

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Architecture studio is based on 'making'[4] and problem-based learning, i.e. experiential learning through learning by doing [5], through reflective practice: students are "*thinking what they are doing, while they are doing it*" [6] However, as Schön posited, there is a design education paradox: initially students cannot understand what designing means as they can only learn this through the actual experience of designing: only by doing does a student learn it, and only then do they require the capacity to design [7]. Furthermore, Altomonte elaborates that design studio serves as an environment for synthesizing bodies of knowledge which are often delivered within parallel didactic areas [8]. While it is assumed that these fundamental principles and theoretical knowledge will be used to guide and inform students' projects, often this information is completely isolated from its design context [9]. Resulting in students rarely engaging creatively with this knowledge and integrating, in this case, sustainability in their design process.[10]

Integrating sustainability

To support students learning of sustainable architecture, new pedagogical methods need to be implemented within the architecture curriculum [11]. It is recognized that sustainability issues need to be incorporated early on in the design, yet sustainability is often excluded in architectural design studio due to lack of knowledge by design tutors.[12] Design tutors are usually trained architects with some architectural practice experience. They typically teach through individual tutorials to guide, question, discuss and demonstrate [13], often supplemented by lectures, or seminars, typically held in more formal settings outside the studio space. Improvisationally, the tutor demonstrates designing and design processes, by drawing different possible ways of designing, articulating the moves being made and why. As the focus is on teaching students how to design through reflection in action, some fear that by adding sustainability to an already broad architectural curriculum will distract from design skills, and might lead to superficial knowledge only.[14] As such, there is a lack of sustainability issues being considered in students' projects, and, by extension, in the real world.

Where sustainability aspects are considered, they are often 'bolted' on at late stages, preventing the integration of sustainability in design [15]. Yet sustainable design not only contributes to a better built environment, but can also enhance instead of inhibit creative solutions in design projects [16]. Moreover, given the climate emergency, integrating sustainability has become an extremely crucial part of the design process [17]. Hence both Hagan[18] and Donovan [19]argue that sustainability needs to be brought into the design studio. This opportunity arose at the Aarhus School of Architecture, where a new 'Emerging Sustainable Architecture' teaching and research programme was developed, encompassing around 120 undergraduate and graduate architecture students and a team of 10 design tutors with different areas of expertise within the field of sustainable architecture. Through discussion, the curriculum was revised to embed sustainable thinking from the early stages of students' education and design projects.

Blended learning: a solution to integrating sustainability in the design studio?

Blended learning is a hybrid teaching method using different ways of teaching and learning. Typically, it is considered to include a combination of e-learning with conventional face-face classroom methods (e.g., where direct interaction is of most benefit), and independent study of the material provided by e-learning (e.g., pre-recorded lectures that the student can watch in their own time) [20].

The blending of our teaching and learning activities was motivated to allow more technical knowledge to be delivered outside face-face time for deeper reflection and (peer-peer) guidance in between classes, while using the classroom time for testing, reflecting, discussion and the application and integration of sustainability knowledge into the creation of new ideas, guided by tutors. There might

also be other benefits to blended learning, such as increased student engagement and satisfaction, and deeper learning might support better average class grades [21]. Other learning outcomes might also be supported; for example, in one study, students felt it helped them improve presentation and discussion skills, and was especially helpful in the early and final stages of the design process [22]. However, another study indicated that satisfaction was higher for face-face learning, compared to blended learning (that included face-face and online modules) [23]. Other studies have also highlighted that students dislike technology-heavy courses, or when there is a lack of face-face contact, even if their overall grades improve [24]. These studies suggest that blended learning needs to be implemented critically and with careful consideration of the desired learning outcomes and student expectations.

METHODS

A hybrid of teaching methods (i.e., blended learning) were used to encourage active student engagement with their learning; to support using the best method for different learning outcomes; and to recognize that using different methods not only reflects the diversity of how students learn [25] but also the types of sustainable architecture they produce. Learning by doing workshops, which utilised blended learning, were the main pedagogical methods used with the aim to integrate sustainability in design studio, according to the following Bloom's revised taxonomy of learning objectives [26] (illustrated in Figure 1):

1. Providing general background sustainability knowledge, through students listening to lectures (including pre-recorded videos), reading, discussion (Bloom: remembering, understanding, analysing)
2. By 'thinking like an architect'[27], i.e., to make connections between sustainability knowledge and problem-based scenarios through applying the knowledge, analysing, and evaluating case studies (Bloom: applying, analysing, evaluation)
3. By 'reflection-in-action'[28], i.e., not every problem has a right answer or is solved by simply following 'rules.' Students construct and test new understanding, strategies, and framing of problems by generating new ideas (through text, and drawing). (Bloom: creating and through reflection also analysis and evaluation of own ideas)

The above is in support of bringing sustainability knowledge from the lower levels of learning to the higher levels of learning [29] i.e., in the creation of design projects. Specific pedagogical methods are discussed in each case study; however, peer-learning was also fundamental in the case studies, as described elsewhere.[30]

BLOOMS TAXONOMY

Produce new or original work
Design, assemble, construct, conjecture, develop, formulate, author, investigate

Justify a stand or decision
Appraise, arguye, defend, judge, select, support, value, critique, weigh

Draw connections amoung ideas
Differentiate, organise, relate, compare, contrast, distinguish, examine, experiment, question, test

Use information in new situations
Execute, implement, solve, use, demonstrate, interpret, examine, experiment, question, test

Explain ideas or concepts
Classify, describe, discuss, explain, identify, locate, recognise, report, select, translate

Recall facts and basic concepts
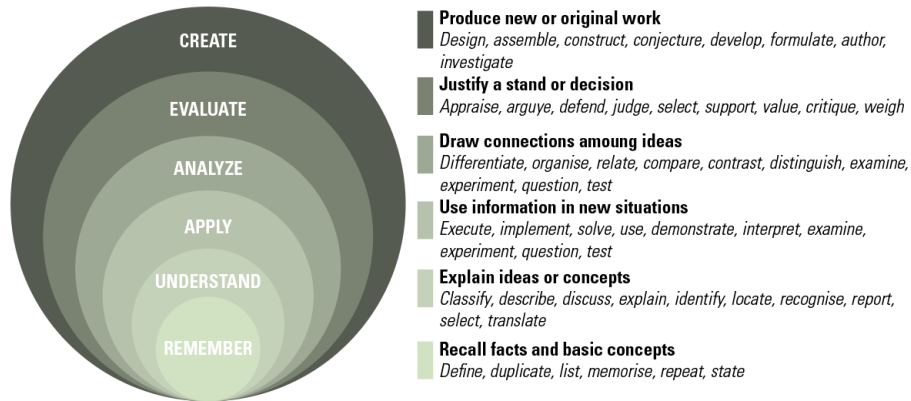*Define, duplicate, list, memorise, repeat, state*

Figure 1. Summary of Bloom's Taxonomy, adapted from Armstrong [31].

CASE STUDIES

Two case studies were conducted in 2018 at Aarhus School of Architecture to investigate how to embed isolated theoretical information of sustainable architecture within the studio environment. This was done through the development of creative studio-specific learning activities that covered general architecture and sustainability aspects. In the following section, the specificities of each workshop are described; however, typically, learning was blended by making use of:

- pre-recorded video lectures,
- group seminars and discussions, with peer-peer learning and feedback throughout (as described elsewhere 32)
- workshops (with 'roaming' tutors on hand to discuss, explain, and guide)
- in-depth investigating and mapping of exemplary sustainable architecture case studies
- traditional studio drawing activities
- Classroom Assessment Techniques were used for students to reflect on their own learning (and to help guide tutors on any issues arising). This was in addition to the collection of student feedback.

CASE STUDY 1: COMMON SUSTAINABILITY WORKSHOP

An introductory workshop was developed to upskill around 95 students – both graduate and undergraduate – on the topic of sustainable architecture. In addition to increasing awareness and knowledge, we strived for all information and principles to be explored within the context of design, thus integrating and embedding sustainability within the studio environment.
Specific content related to three different themes:

- What sustainability means
- Approaches to sustainable architecture
- Drawing sustainable architecture

Each of the three phases were designed with different levels of blended learning, depending on the content and level of student engagement needed. The first exercise aimed to help students form common, broad-spectrum understandings of what aspects may be addressed within sustainability; establishing a common language and definition of what sustainability may mean within the teaching

programme. Students were given short lectures but primarily utilized the ARUP 'Drivers of Change' cards [33] and their e-resources to facilitate discussions in small groups and presentations to the larger group, thus, situating and applying concerns to their regional context, creating a deeper awareness of the topic.

The second exercise aimed to introduce different approaches (theoretical knowledge) to sustainable architecture, to help students become familiar with the key concerns, concepts, and principles for a specific approach, increasing awareness of the many different ways in which sustainable architecture can be practiced. Students utilised lectures (from staff), pre-recorded lectures (online), group discussions, physical mapping in groups, peer presentations, and physical mapping in teams to reflect and translate theoretical knowledge into physical principles critically.

The third task was divided into two parts, the first, aiming to give insight into how a building uses design solutions to address concerns of sustainability. Students worked both in groups and individually to produce two drawings. The first hand-drawing was a collection of documentation and analytical drawings of a different assigned building accompanied by a short critical written reflection considering the sustainability success and failures of the given built example. Lastly, each student produced a creative drawing which visually represented their personal critical written reflection or position, synthesizing the information from the first tasks into critical self-evaluation and design forms. Throughout, blended learning was utilised to support learning by doing through the use of online resources and lectures, group discussions, peer learning, drawing, normal studio-based- and peer-peer learning.

CASE STUDY 2: MASTERS SUSTAINABILITY WORKSHOP

In the Masters sustainable architecture studio, 12 master's students from 4th and 5th year took part in blended learning activities with the aim to improve sustainability knowledge, and to integrate this knowledge in students' own design projects, which were at conceptual stage (i.e., apply, analyse, evaluate, create; higher learning in Bloom's taxonomy, see Figure 1).

The specific focus related to building-scale solar energy: its energy and CO_2 reduction potentials and its aesthetics. Delivery of content was blended and consisted of 15 to 30 minutes pre-recorded video lectures by the tutor (see Figure 2.); flipped learning (i.e., seminar after watching video lecture); group work and presentations; workshops with peer-feedback/discussion; and individual tutorials to support individual design work.
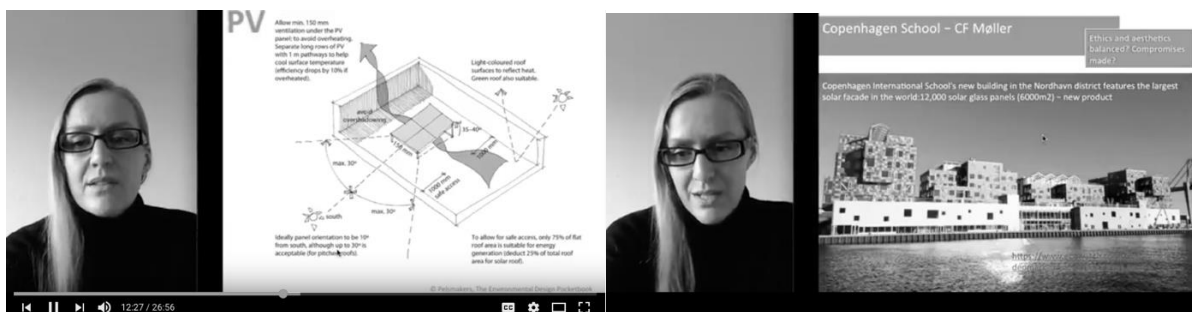

Figure 2. Screengrab of pre-recorded background lectures, focusing on both quantitative, technical knowledge, and its application and evaluation in built cases.

In the pre-recorded content, the design tutor practiced and demonstrated 'reflection in action' by analysing and evaluating the use of solar technology, and potential technical and aesthetic implications

through different case studies (see Figure 2). In self-selected pairs, students practiced the same for other built cases, and communicated their analysis and evaluation to the rest of the group. Peer-peer learning created a safe environment for discussion, reflection and sharing (as described elsewhere [34]), including students positioning themselves about the aesthetic implications of solar technology in different case studies. Peer-learning also supported in-class workshops, where students learned to select the most appropriate solar technology for a given case study, and to calculate the energy and carbon footprint of the case, before and after solar technology application. The tutor 'roamed' the classroom to guide, demonstrate, check, and question each student's (and group's) understanding and progress. The final evaluation of the case study and its results were communicated to the group as a workshop summary by the tutor, followed by a discussion of the case, and reflection on the learning process; this content was screencast recorded, for students to refer to if needed.

Finally, students – who already had an individual design concept and functional programme – started to apply their new knowledge to create new ideas in their design projects, and how this influenced their design (aesthetically and conceptually). Traditional desk tutorials supported this, and students included this in their project's design realisation report. Anonymous Classroom Assessment Techniques (CATs) were used at different stages for students' reflections on their own learning; this also supported teacher reflection.

Reflections of both cases

The use of blended-learning, learning by doing, and peer-peer learning successfully helped students to understand the complexity of sustainable architecture, integrating theoretical and empirical information within the studio environment. Blended learning allowed the design tutors to focus on the higher learning outcomes in face-face interactions, through a mix of workshops, peer-learning, and feedback, as well as traditional tutorials. It required the tutor to reflect in action to allow for 'live' adjustments to the teaching plan were needed to reflect the dynamic nature of interactive workshops. Aside from some practical issues (such as the online learning platform requiring significant compression of videos), the interactive, blended learning activities supported student engagement with the content and its application in their design. However, given the departure from traditional face-face tutorials, better clarification of expectations and reasons for the blending of learning would have been useful to reduce initial confusion among students about this way of learning. Moreover, blended learning successfully supported the 'learning by doing' sustainability workshops with active student participation, but it is unclear if blended learning would be similarly satisfactory without workshop activities.

CONCLUDING REMARKS

Architectural education still uses the design studio as its main tradition [35], and for decades design studios have remained very much the same, where the master-tutor model of individual tutorials and design reviews are the main teaching methods. However, decreased teaching resources, combined with growing knowledge demands and increased complexity of building design, traditional studio teaching is becoming more difficult, and blended learning may be a solution to support these pedagogical struggles. We used blended learning to integrate sustainability in the design studio, at three levels of learning: background sustainability knowledge, "thinking like an architect," and reflective practice for the creation of new ideas. This was done through pre-recorded lectures, group work, peer feedback and discussion and practical, interactive workshops where students learn by doing, through interactions with tutors and

peers. This engaged students with sustainable design through different, collaborative activities that supported reflective practice and more in-depth learning, embedding sustainability in design-thinking. Our role as teachers was to get students to accept and use the technicality of sustainable design as part of their creative reality, and to demonstrate that sustainability is not only desirable but essential for creative design approaches. This is necessary because sustainable design is no longer optional and is part of the architect's new required professionalism.[36]

On a practical level, by introducing blended learning activities, it is essential to:

- **clarify** the role of tutors to both colleagues and students; i.e., that of facilitator or initiator of activities at these moments, not as design tutor. This is important, especially when the blending of learning is a new method, and both students and teachers are not familiar with it.

- **build cultural change**: there is a move from the traditional methods to combing with the blending of methods; tutors need to be more explicit about this to manage expectations and to establish a broader learning community and culture built on open sharing and a collective spirit.

- **review and reflect**: i.e., plan ahead, but tutors to allow space for adjustments to encourage opportunities for collective reflection and exploration, which develops organically and is hard to plan for.

The blending of learning encouraged the application of sustainability knowledge into the creation of new ideas, but it also supported other skills that are not usually a primary focus in the design studio, e.g., project and learning management skills, group communication and collaboration, reflecting the reality and needs of architecture practice. Moreover, students were exposed to other students' thinking, learning, and design processes, and learned that there are different approaches to integrating sustainability in design, based on different priorities and interpretations; this was also notable in the studying of actual exemplary built projects and different architect's approaches. **Finally, by placing sustainability content in the studio, it elevated sustainable design issues, usually considered secondary.**

REFERENCES

[1] Sergio Altomonte, et al. Mapping the Way Forward: Education for Sustainability in Architecture and Urban Design. (Corporate Social Responsibility and Environmental Management. 21. 10.1002/csr.1311, 2014)
[2] Sergio Altomonte, et al. (2012). EDUCATION FOR SUSTAINABLE ENVIRONMENTAL DESIGN. THE EDUCATE PROJECT (2012)
[3] Sergio Altomonte, Environmental Education for Sustainable Architecture (Review of European Studies · December 2009)
[4] Donald Schön, Educating the reflective Practitioner, Toward a new design for teaching and learning in the professions (Jossey-Bass Publishers, USA, 1987)
[5] Donald Schön, Educating the reflective Practitioner, Toward a new design for teaching and learning in the professions (Jossey-Bass Publishers, USA, 1987), and David Nicol, et al Changing architectural Education, towards a new professionalism, Spon Press, London & NY (2000)
[6] Donald Schön, Educating the reflective Practitioner, Toward a new design for teaching and learning in the professions (Jossey-Bass Publishers, USA, 1987), p xi
[7] Donald Schön, Educating the reflective Practitioner, Toward a new design for teaching and learning in the professions (Jossey-Bass Publishers, USA, 1987),p 80-93
[8] Sergio Altomonte, et al. Mapping the Way Forward: Education for Sustainability in Architecture and Urban Design. (Corporate Social Responsibility and Environmental Management. 21. 10.1002/csr.1311, 2014)
[9] Sergio Altomonte, et al. Mapping the Way Forward: Education for Sustainability in Architecture and Urban Design. (Corporate Social Responsibility and Environmental Management. 21. 10.1002/csr.1311, 2014)
[10] Sergio Altomonte, Environmental Education for Sustainable Architecture (Review of European Studies · December 2009)

[11] Altomonte, Sergio. (2010). Enhancing Teaching and Learning of Sustainable Design through ICTs. 10.1109/ICETC.2010.5529441.

[12] Susannah Hagan, Environment and the studio: integrating the quantitative and the qualitative, Chapter in Roaf, S., Bairstow, A. (The Oxford Conference - A re-evaluation of education in architecture, Wiley, 2008) and Sergio Altomonte, Environmental Education for Sustainable Architecture (Review of European Studies · December 2009)

[13] Donald Schön, Educating the reflective Practitioner, Toward a new design for teaching and learning in the professions (Jossey-Bass Publishers, USA, 1987)

[14] Annemie Wyckmans, Environmental Learning in Architecture From Individual Choice to Collective Responsibility Nordic Journal of Architectural Research Volume 20, No 3, 2008

[15] Donovan, E., 2017. An Evolution of Sustainable Aesthetics., in: Design to Thrive. Presented at the PLEA: Passive Low Energy Architecture, Network for Comfort and Energy Use in Buildings, Edinburgh, Scotland.

[16] Sofie Pelsmakers, et al, The value of sustainable design to the profession, Design validation and collaboration to create relevant architecture, in Alan Jones et al, Defining Contemporary Professionalism: For Architects in Practice and Education (Riba Publishing, 2019)

[17] Sergio Altomonte, et al. Mapping the Way Forward: Education for Sustainability in Architecture and Urban Design. (Corporate Social Responsibility and Environmental Management. 21. 10.1002/csr.1311, 2014)

[18] Susannah Hagan, Environment and the studio: integrating the quantitative and the qualitative, Chapter in Roaf, S., Bairstow, A. (The Oxford Conference - A re-evaluation of education in architecture, Wiley, 2008)

[19] Elizabeth Donovan, *Sustainable Architecture Theory in Education: How architecture students engage and process knowledge of sustainable architecture,* Implementing Sustainability in the Curriculum of Universities (World Sustainability Series, Springer, 2017)

[20] Bayram Güzer, Hamit Caner. 2014. The Past, Present and Future of Blended Learning: An in Depth Analysis of Literature. Procedia - Social and Behavioral Sciences 116:4596-4603

[21] Yasemin Afacan. 2014. Blended Learning for Non-studio Courses: Interior Architecture Student Experiences. Procedia - Social and Behavioral Sciences 116:1599-1603, and Bayram Güzer, Hamit Caner. 2014. The Past, Present and Future of Blended Learning: An in Depth Analysis of Literature. Procedia - Social and Behavioral Sciences 116:4596-4603.

[22] Mohammed F. M. Mohammed. 2017. Blended E-learning in the architectural design studio: an experimental model, International Journal of Parallel, Emergent and Distributed Systems, 32:sup1, S73-S81

[23] Hill, Glen Andrew. 2017. The "Tutorless" Design Studio: A Radical Experiment in Blended Learning. Journal of Problem Based Learning in Higher Education 5(1):111-125 and Ingrid A.E. Spanjers, Karen D. Könings, Jimmie Leppink, Daniëlle M.L. Verstegen, Nynke de Jong, Katarzyna Czabanowska, Jeroen J.G. van Merriënboer. 2015. The promised land of blended learning: Quizzes as a moderator. Educational Research Review 15:59-74.

[24] Lane, M.C., Osborne, L., & Crowther, P. 2015. A Blended Learning Approach to the Teaching of Professional Practice in Architecture. Educ. Sci. 5:166–178 and Alla L. Nazarenko. 2015. Blended Learning vs. Traditional Learning: What Works? (A Case Study Research). Procedia - Social and Behavioral Sciences 200:77-82.

[25] Abeer Ali Okaz, Integrating Blended Learning in Higher Education, 5th World Conference on Learning, Teaching and Educational Leadership, WCLTA 2014, Pharos University

[26] David R. Krathwohl, A Revision of Bloom's Taxonomy: An Overview, THEORY INTO PRACTICE, (Ohio State University Volume 41, Number 4, Autumn 2002)

[27] Donald Schön, Educating the reflective Practitioner, Toward a new design for teaching and learning in the professions (Jossey-Bass Publishers, USA, 1987)

[28] Donald Schön, Educating the reflective Practitioner, Toward a new design for teaching and learning in the professions (Jossey-Bass Publishers, USA, 1987)

[29] Annemie Wyckmans, Environmental Learning in Architecture From Individual Choice to Collective Responsibility Nordic Journal of Architectural Research Volume 20, No 3, 2008,

[30] Sofie Pelsmakers, et al., Developing architecture studio culture: peer-peer learning, Education, Design and Practice – Understanding skills in a Complex World, AMPS, Architecture_MPS; Stevens Institute of Technology, New Jersey / New York (17-19 June, 2019), in publication.

[31] Patricia Armstrong, Bloom's Taxonomy, https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/ (accessed 25.08.2019)

[32] Sofie Pelsmakers, et al, Developing architecture studio culture: peer-peer learning, Education, Design and Practice – Understanding skills in a Complex World, AMPS, Architecture_MPS; Stevens Institute of Technology, New Jersey / New York (17-19 June, 2019), in publication.

[33] ARUP, Drivers of Change, https://www.arup.com/perspectives/publications/research/section/drivers-of-change (accessed 29,08.2019)

[34] Sofie Pelsmakers, et al, Developing architecture studio culture: peer-peer learning, Education, Design and Practice – Understanding skills in a Complex World, AMPS, Architecture_MPS; Stevens Institute of Technology, New Jersey / New York (17-19 June, 2019), in publication.

[35] Donald Schön, Educating the reflective Practitioner, Toward a new design for teaching and learning in the professions (Jossey-Bass Publishers, USA, 1987), p 43

---

[36] Annemie Wyckmans, Environmental Learning in Architecture From Individual Choice to Collective Responsibility Nordic Journal of Architectural Research Volume 20, No 3, 2008 and David Nicol, et al. Changing architectural Education, towards a new professionalism, Spon Press, London & NY (2000)

BIBLIOGRAPHY

Alla L. Nazarenko. 2015. Blended Learning vs. Traditional Learning: What Works? (A Case Study Research). Procedia - Social and Behavioral Sciences 200:77-82.

Altomonte, Sergio & Rutherford, Peter & Wilson, Robin. (2014). Mapping the Way Forward: Education for Sustainability in Architecture and Urban Design. Corporate Social Responsibility and Environmental Management. 21. 10.1002/csr.1311.

Altomonte, Sergio & Yannas, Simos & Herde, André & Riemer, Anna & Canguelli, Eliana & Horvath, Sara & LopezDeAsiain, Maria. (2012). EDUCATION FOR SUSTAINABLE ENVIRONMENTAL DESIGN. THE EDUCATE PROJECT.

Altomonte, S., Environmental Education for Sustainable Architecture, Review of European Studies · December 2009

Armstrong, P., Bloom's Taxonomy, https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/ (accessed 25.08.2019)

ARUP, Drivers of Change, https://www.arup.com/perspectives/publications/research/section/drivers-of-change (accessed 29,08.2019)

Bates, D., Mitsogianni, V., Ramirez-Lovering, D. Studio Futures, Changing Trajectories in Architectural Education Melbourne, 2015, URO

Bayram Güzer, Hamit Caner. 2014. The Past, Present and Future of Blended Learning: An in Depth Analysis of Literature. Procedia - Social and Behavioral Sciences 116:4596-4603.

Donovan, E. (2017), Sustainable Architecture Theory in Education: How architecture students engage and process knowledge of sustainable architecture, Implementing Sustainability in the Curriculum of Universities, World Sustainability Series, Springer

Donovan, E., 2017. An Evolution of Sustainable Aesthetics., in: Design to Thrive. Presented at the PLEA: Passive Low Energy Architecture, Network for Comfort and Energy Use in Buildings, Edinburgh, Scotland.

Donovan, E., Holder, A., 2016. How architecture students gain and apply knowledge of sustainable architecture, in: Innovation for Sustainable Future. Presented at the Central Europe Towards Sustainable Building (CESB16), Grada Publishing, Prague.

Hagan, S., Environment and the studio: integrating the quantitative and the qualitative, Chapter in Roaf, S., Bairstow, A., The Oxford Conference - A re-evaluation of education in architecture, Wiley, 2008

Hien M. Vo, Chang Zhu, Nguyet A. Diep. 2017. The effect of blended learning on student performance at course-level in higher education: A meta-analysis. Studies in Educational Evaluation 53: 17-28.

Hill, Glen Andrew. 2017. The "Tutorless" Design Studio: A Radical Experiment in Blended Learning. Journal of Problem Based Learning in Higher Education 5(1):111-125.

Krathwohl, D.R., A Revision of Bloom's Taxonomy: An Overview, THEORY INTO PRACTICE, (Ohio State University Volume 41, Number 4, Autumn 2002)

Lane, M.C., Osborne, L., & Crowther, P. 2015. A Blended Learning Approach to the Teaching of Professional Practice in Architecture. Educ. Sci. 5:166–178

Mohammed F. M. Mohammed. 2017. Blended E-learning in the architectural design studio: an experimental model, International Journal of Parallel, Emergent and Distributed Systems, 32:sup1, S73-S81

Nicol, D., Pilling, S., Changing architectural Education, towards a new professionalism, Spon Press, London & NY (2000)

Pelsmakers, S., Moseng, K. Eyebye, B., Donovan, E., et al, Developing architecture studio culture: peer-peer learning, education, design and practice – understanding skills in a complex World, AMPS, Architecture_MPS; Stevens Institute of Technology, New Jersey / New York (17-19 June, 2019), in publication.

Pelsmakers, S., Hoggard, A., The value of sustainable design to the profession, Design validation and collaboration to create relevant architecture, in Alan Jones & Rob Hyde, Defining Contemporary Professionalism: For Architects in Practice and Education (Riba Publishing, 2019)

Schön, Educating the Reflective Practitioner – Toward a new design for teaching and learning in the professions, Josey Bass Inc, USA, 1987

Spanjers, I., Könings, K., Leppink, J., Verstegen, D., de Jong, N., Czabanowska, K., van Merriënboer, J., 2015.
The promised land of blended learning: Quizzes as a moderator. Educational Research Review 15:59-74.
Yasemin Afacan. 2014. Blended Learning for Non-studio Courses: Interior Architecture Student Experiences.
Procedia - Social and Behavioral Sciences 116:1599-1603
Wyckmans, A., Environmental Learning in Architecture From Individual Choice to Collective Responsibility Nordic
Journal of Architectural Research Volume 20, No 3, 2008