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Learning structures in Architecture: a 'triple-lock' approach to pedagogy

George Fereday
London Metropolitan University

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Introduction

The mixed and multi-layered approach to teaching of Architecture structures syllabus, as discussed in this paper, was implemented in the Technology Modules taught to the Level 5 cohort of Architecture BA (Hons) at The CASS, London Metropolitan University in 2017/18.

This paper defines the three-tiered approach or 'triple-lock' method used and its benefits to broadened inclusivity and mixed modes of learning.

The implementation of practical making exercises, in particular, has helped to address some of the learning challenges associated with dyslexia whilst simultaneously promoting a sense of student community through collaborative, peer-to-peer learning. Emphasis has also been put on diversification of the curriculum delivery to align with a wide range of learning styles reflected in a diverse cohort at the undergraduate school. This 'triptych' teaching method is referred to here as a 'triple-lock' mechanism.

Context and rationale

The three-tiered teaching framework or was delivered as part of an Architectural Technology module integral to the BA (Hons) Architecture course; Level 5 cohort.

The pedagogical benefits of combining digital learning tools in Architectural education (Williams, 2014, Steinø et al, 2017) with physical making at the building scale, are well documented in the literature (Tang, 2013, Menges, 2017, Prizeman, 2005, Care et al, 2009, Erdman, et al 2002).

The CASS School of architecture has harnessed some of these well-established benefits through the module design of second year of undergraduate studies in Architectural Technology.

The second year of an architecture degree is traditionally seen as a pivotal period half-way through the course where students have established a good set of baseline skills and are free from the rigors of a third-year design thesis. In theory, second year students are in a prime position to experiment and freely explore their potential and we wanted to harness some of this energy through the structuring of the technology module. In response to this awareness, the first making workshop at the 1:1 scale took place in 2015/16 and has been iteratively refined on a rolling annual basis since.

The necessity to embrace a diversity of pedagogical experience is well established in schools of Architecture internationally. Verghaeghe writes that *"the term 'design' creates a distinction between the work of the architecture and its materiality, and the representation of its underlying concept*, posing instead that *"architecture can – rather than being taught – be learnt by experience through material-based pedagogies"* (Verghaeghe, 2017). Such pedagogical diversity not only challenges traditional concepts of Architecture, it also helps us reflect the diversity of our cohort – students of mixed ability, age, sex, race and practical experience. For many years, students of architectural disciplines have been shown to be disproportionately 'intuitive' as learners as compared to the general population. Brown et al found that such cohorts

> *"tend to learn best through problem-based learning, colloquia, and group work, and prefer workshops and seminars to lectures"* recommending that "*a wide range of teaching methods be employed in an attempt to communicate with all students"* (Brown et al, 1994).

Responding to the literature and student feedback, The Cass has developed a mixed-mode pedagogy including making workshops, peer-review and self-directed study, as a means of better suiting the broad spectrum of learning styles within each year group.

The net result of this is a distinctive, three-tiered approach to teaching involving live-drawing lectures, 1:1 scale 'making' workshops and model-making exercise:

- Live-drawing during structures lectures providing a more direct means for students to engage intuitively with structures theory without having to learn formal structural calculations. Over-laid drawing of structures also helped students hone their communication skills and complement structural concepts written up in their coursework submissions.

- Making at the 1:1 building scale providing insights for students into the buildability of architectural design as well as a greater appreciation for

the overlapping industries of Construction and Structural Engineering (Carpenter, 1997). Collaborative making also used as a social tool with which to build a strong sense of student community collaborative achievement, and responsibility towards the wider community (Jann, 2010).

- Individual small-scale modelling of larger built structures to encourage experimentation with structural arrangements not possible at the building scale (due to safety, weight and/or time constraints.)

The 'triple-lock' approach

A so-called 'triple-lock' approach has been developed to iteratively reinforce or seek to 'lock-in' structures learning. This was implemented through digital drawing, physical making experiences and self-reflective tasks. These tasks include model-making and critical self-evaluation through construction diaries as part of written module coursework. The teaching method established a philosophy of learning re-enforcement through carefully sequenced pedagogies delivered in three distinct stages (**fig.1**).

The first stage ('lock 1') is a dynamic approach to traditional lecture-based learning. Structures lectures were developed in collaboration with structural engineer Cíaran Malik of HRW Engineers with an emphasis on live digital sketching overlaid in real time on images of precedent building structures.

By reverse engineering these building structures through overlaid live drawing, students were better able to engage with and comprehend how forces were transferred through primary, secondary and tertiary structure and why the building structures had been designed to take a particular form. These lectures were digitally recorded and uploaded to a digital module interface (Weblearn) that allowed students to play-back the dynamic overlaid sketching as many times as required.

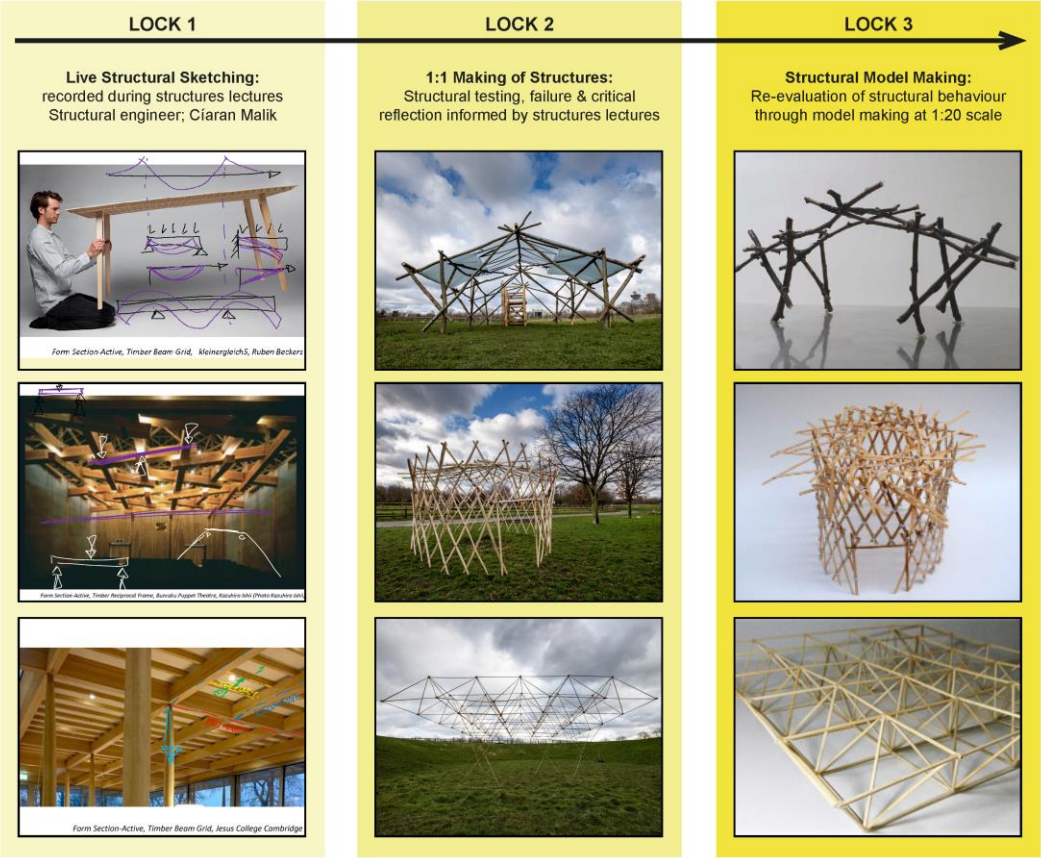

Figure 1: *The three stages of the 'triple-lock' approach to the reinforcement of learning outcomes*

The second stage ('lock 2') is a 1:1 scale structure making workshop. The cohort was divided into five workshop groups, each exploring a separate structural assemblage with their own set of materials and tools as limiting design constraints. Over a 4-day period each group applied learning from the structures lecture series directly preceding the making workshop by experimenting with real structures in the field. There is an emphasis put on free experimentation, collaboration and critical analysis of structural failure as methods of self-learning which is recorded by the students. Regular intervals of reflective evaluation are encouraged through sketching, photography and note making, the products of which form the content of a construction diary of the making event.

The third stage ('lock 3') involves two forms of structural modeling and self-directed study:

i. physical scale model of the 1:1 building structure ('lock2').
ii. digital modeling of a structural joint featured in the structures lectures through additional self-directed research from the literature.

Conclusions

Quantitative increases in student attainment showed that having experienced and documented structural failure at the 1:1 scale, the cohort felt better equipped to analyse the behaviour of other structures featured in the dynamic-sketch lecture series. Since the inception of the 1:1 scale making workshop and the 'triple lock' approach to teaching of structures, the spread of highest marks on the module has improved with a greater number of higher grades attained: 25% 'A-/A/A+' Grades in 2017/18 as compared to 14% in 2016/17 and 12% in 2015/16 respectively. This positive trend in higher marks has also been reflected in a reduction in low pass 'D' marks, down to 7% of cohort in 2017/18 from a 33% in 2016/17.

Small scale model making timetabled immediately after 1:1 construction initially seemed counter-intuitive but was found to benefit students for the following reasons:

- Re-modeling at 1:10 or 1:20 scale provided an opportunity to re-trace and re-evaluate structural behaviours, reinforcing experiences in the field and acting as a mechanism for synthesis and critical reflection.

- Some students also used the model as an opportunity to experiment with re-configurations of their structures that were not possible at the 1:1 scale due to size, weight or time constraints, enhancing explorative self-learning.

The 'triple-lock' approach outlined here has also anecdotally improved student confidence in design stage conceptualization of structures which suggests consecutive time-tabling of, dynamic lectures, 1:1 making and reflective exercises of self-evaluation, has reinforced learning as well as helped to implement a more inclusive learning experience. Previous critical reflection from alumni have included:

- *"The Mudchute workshop was an extremely useful step in beginning to understand how materials, structures and construction techniques function at a 1:1 scale, often parts of the technology module can be quite abstract heavily based on research about how materials and structures perform without actually being able to test this knowledge. The experience of building the bamboo dome made it possible to test materials to their limits and to intuitively reflect on how and why they might have failed, for me this kind experience is invaluable. What is also important is that the observations I*

made here are not only applicable to this particular construction but also to other materials and structures, so the knowledge and experience I have gained can be applied to future projects." (AM, 2017 Alumnus)

- *"The Mudchute Workshop was the part of the module I enjoyed the most. I had never experienced building a structure of that scale. I thought it was extremely useful and of key importance that we had the opportunity to work with specialists on traditional - and less traditional - ways of building. 1:1 building also gave me the ability to learn more on how structural elements are put together which is something we, as students, don't immediately understand when working on small models."* (GA, 2017 Alumnus)

- *"Learning by doing, the hands-on workshop, enabled me to see that the structural side is not a separate element to be handled by engineers or the contractor, it can be a key piece of the design concept driving the entire project." (*MD, 2017 Alumnus).

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Biographical note

George Fereday is Senior Lecturer and Technology Coordinator at the Cass School of Architecture. George studied at the Royal College of Art, has conducted research at the University of Cambridge and worked in practice at Foster+Partners Architects. George's teaching interests included materials innovation for the built environment, use of natural materials in construction and learning through making.