

THE DOMINANCE OF PRACTICE IN CONSTRUCTIONARIUM: EXPLORING THE CHALLENGES OF LINKING THEORY AND PRACTICE

Paul W Chan¹

School of Mechanical, Aerospace and Civil Engineering, University of Manchester, PO Box 88, Manchester, UK, Postcode M60 1QD.

To address employer dissatisfaction with the quality of graduates, Constructionarium was developed in 2003 to develop practical skills for University students. This is a residential initiative where students are tasked to construct scaled-down structures of real buildings within a week. Drawing on the experience and lessons learnt from undertaking Constructionarium at a Northern University in the UK, data was collected over three years through student surveys and interviews with student, academic and practitioner participants. Observational data captured in the students' reflective essays after the events were also used in the analysis. The analysis reinforced the espoused benefits of exposing real-life situations to students, and revealed how quickly students 'conform' to poor practices that are well documented in the academic literature, including lapses in health and safety, inadequate industrial relations and poor time and cost management. These findings indicate the dominance of practice – at times worryingly ill practice – over academic theory. Consequently, there are implications on the extent in which educationalists can facilitate the development of next generation of practitioners who would adopt good practices. Furthermore, the experience challenges the mantra of organisational learning and poses the question as to whether habits of bad practice in industry can ever be unlearned.

Keywords: constructionarium, education, problem-based learning, role of objects.

INTRODUCTION

Over the years, skills development in business has seen a shift in emphasis away from formal training and education to more work-based, on-the-job provision. The growth in the rhetoric surrounding the importance of the knowledge economy, alongside interest in concepts such as organisational learning and continuous improvement has gained more prominence in the literature (see Chan *et al.*, 2005). On the one hand, there is admission that formal education and training cannot fully prepare for the skills necessary to perform a job in practice, particularly in vocational areas like construction (Boyd and Wild, 1993; Pitt, 1995; Bloom *et al.*, 2004). Numerous surveys have suggested that employers often bemoan the quality of graduates entering the workforce (see Learning and Skills Development Agency, 2003). Consequently, there is a focus on more demand-led approaches to skills development (Leitch, 2006). At the same time, skills development at the workplace is not straightforward. The qualification of skills deriving from work-based solutions, e.g. through the National Vocational Qualifications (NVQs) framework, is known to be fraught with problems

¹ paul.chan@manchester.ac.uk

(Grugulis, 2003). Furthermore, existing formal frameworks for assessing skills have largely failed to account for the skills that really matter in practice (Stasz, 2001).

The distinction between formal educational provision and work-based skills development is in itself not entirely helpful. What needs to be struck is a balance that can ensure that the acquisition of theoretical knowledge underpins the practical experience gained from the world of work (Clarke and Winch, 2004). However, in the age where employer investment in work placements and apprenticeships is known to decline (see Chan and Dainty, 2007), and especially in light of the current global economic recession, searching for effective ways to combine theory and practice can be somewhat challenging. A laudable example, nonetheless, can be found in the Constructionarium initiative (see <http://www.constructionarium.co.uk>), a residential initiative designed to get students to construct scaled down versions of real-life projects within a week. This was originally developed by Imperial College with the support of a medium sized contracting company (John Doyle PLC) and an engineering consultancy (Expedition Limited). Much professional publicity and academic literature on this have concentrated on promoting the benefits associated with putting theory into practice, with claims that this has made the educational curriculum more relevant, which in turn result in higher retention rates of students within the engineering and construction sectors (see Ahearn *et al.*, 2005).

Constructionarium has now garnered enormous interests among UK universities, with 15 institutions participating in the academic year 2008-2009. The experience of undertaking this at a Northern University in the UK is being considered for the purpose of this paper. This Northern University has integrated Constructionarium into the curriculum over the past three years (since academic year 2006-2007), and the post-hoc reflection presented here forms a critical, if longitudinal, review of the experience over the last three years. Notwithstanding the espoused benefits of connecting theory and practice, interesting observations were made that led to the conclusion that there are potential dangers in relation to the Constructionarium model. The findings pointed to the dominance of practice - at times ill-practice - over academic theory, thereby casting doubts on the extent in which educationalists can really challenge the mindsets of the next generation of practitioners that are being developed in the education system. The observations also provided practical insights as to why concepts such as organisational learning and continuous improvement remain a holy grail in reality. A brief explanation of the Constructionarium model will now be outlined. This is followed by a short note on methodology and the presentation and discussion of emergent findings.

THE CONSTRUCTIONARIUM MODEL

The idea of the Constructionarium was first conceived by Professor Chris Wise at Imperial College who noted that whereas students graduated from university were armed and adept with academic theory, they were not necessarily able to apply the theoretical knowledge in practical situations. Working closely with a design consultant, Imperial College sought to develop miniature projects based on real-life structures that their civil engineering students could construct in a week. Together with a contractor who provided the materials, plant and labour, Constructionarium was born in 2003. The Constructionarium process would require students to plan the programme and resource (i.e. financial, materials and people) requirements, and physically construct to completion within the week. Since its inception, a growing portfolio of scaled-down projects has been developed, including such iconic structures

as the Gherkin building in London (known also as the Swiss Re Building), Barcelona telecommunications tower, and the Millau Bridge in France. Teams of around 25 students are usually formed to tackle a single project. A decision was made by the construction department of a Northern University to participate in Constructionarium during the academic year 2006-2007. Constructionarium was initially designed for civil engineering students, so students mostly tackled infrastructure-type projects, e.g. bridges and oil rigs. However, because of the stronger focus on construction, this Northern University chose projects that involved constructing buildings, rather than infrastructure-type projects. This Northern University has now undertaken Constructionarium annually for the last three years, with up to 70 students working on three projects per year. The projects undertaken thus far included the Barcelona Tower, the Gherkin Building, Millennium Galleries shopping mall in Sheffield, and Naples Airport Underground Station (see also <http://www.constructionarium.co.uk> for graphical representation of these projects).

A NOTE ON METHODOLOGY

This reflection draws upon data gathered through multiple sources (see Figure 1 below), including a questionnaire survey administered to the students before and after each event, semi-structured interviews with student, academic and practitioner participants during each event and students' post-event reflective essays that were produced as part of their coursework. These sources were collected and analysed after the first two years of running Constructionarium at this Northern University (at the time of writing, this Northern University is still to run the Constructionarium week for academic year 2008-2009). The questionnaire survey was designed to determine whether the students had any prior experience of working at the coal-face of constructing building, and to elicit their perceptions of their professional role in the construction industry after graduation. The purpose of this was to ascertain whether Constructionarium help provided more clarity for the students in terms of what they were meant to do in practice after graduation and to establish whether Constructionarium was beneficial in helping students apply theoretical knowledge. The semi-structured interviews were designed to capture participants' perceptions of what they were learning as their projects progressed during the Constructionarium week, whilst the student reflective surveys presented the students' views of the successes and failures of their Constructionarium experience. The interviews were recorded and transcribed verbatim for analysis; the interviewees (n = 42 over two years) were randomly selected from student, academic and practitioner participants.

Concurrent to this, the researcher, who is also a teaching member of staff on the construction programme, is a participant observer of the entire process over the last three years. As an observer, the researcher actively recorded notes based on visual observations of how participants behaved, casual conversations and personal thoughts throughout the Constructionarium process. Because data was collected and analysed over the last three years, there is a longitudinal aspect that would contribute to the richness of the analysis and conclusions presented in this paper. It must also be added that the principal methodological approach is interpretive; that is, the focus here is on the qualitative nature of the experience that participants and the researcher have been through as opposed to the identification of objective, quantitative measures of the phenomenon. Furthermore, consent has been given by the participants to disseminate the findings from the feedback provided. An attempt has also been made to maintain the anonymity of those who provided feedback in this paper. The next section will outline some of the pertinent observations made within the confines of this paper.

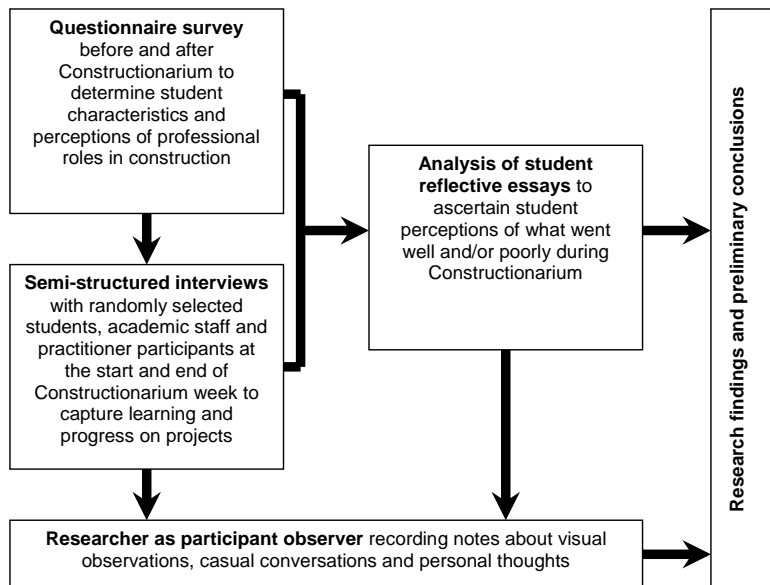


Figure 1: Flowchart representing methodological approach.

KEY OBSERVATIONS

Whilst the data collected provided rich and deep insights of the Constructionarium experience, the disparate nature of such data results in a somewhat unwieldy analysis. In order to make sense of the key observations, a number of critical events have been selected for re-presentation as vignettes in this section. It must be emphasised that these critical events also constituted the key action points for future improvements identified in the de-briefing sessions held with the industrial sponsors at the end of each Constructionarium week. This section summarises key observations in the following thematic vignettes: namely "Conforming to type and practice", and "The dilemma of planning".

Conforming to type and practice

As expected, students typically commented on how the Constructionarium experience has taught them what reality might look like when they graduate: "Just like how things go together and stuff and time management. Just seeing all the stuff that we've talked about in lectures [...] You hear about things and you see diagrams and stuff, but it's different actually doing and seeing how it's being done (male student, Naples Project, academic year 2006-2007)." A female student working on the same project went even further to remark, "I wouldn't do University work, but I would do this." For another, the Constructionarium experience has enabled him to clarify his role and validate his decision to study construction in the first place: "I still want to go into construction. I want to stick on my current course, it has validated my career choice. It has been really good fun, getting stuck into the project, and have the reward of seeing it all come together (male student, Millennium Project, academic year 2006-2007)." Thus, this echoes claims made by Ahearn *et al.* (2005) of how Constructionarium could encourage student retention on courses.

Indeed, students have suggested that Constructionarium has boosted their confidence in entering the world of construction work. A female student on the Millennium Galleries project during academic year 2006-2007 trained as a small tools operative for that week. She noted, "I've surprised myself because I came here thinking that I'm not going to just not do things, I knew I was going to get stuck in. But I've been surprised by my ability really, because when we were learning to use the small tools

on Monday, we had one go of everything and I remember thinking, gosh I shouldn't really have volunteered for this in the first place, and I was really very scared of the tools."

However, not all students seem to have put in the same amount of effort or reaped the full extent of the benefits on offer. As part of delivering the Constructionarium projects, students had to self-organise within their teams to identify who would undertake small tools training, who would be responsible for managerial activities and who would become the general labourers on the actual fabrication. A striking observation was made about how quickly students conformed to certain expectations of what the role meant. So, those students whose role was to be general labourers evidently abdicated responsibility from anything to do with management tasks (e.g. planning, cost management and decision-making), even though they were undertaking a degree course to ultimately become professional managers in construction! For example, the Naples Project was missing a detail on the staircase construction leading below-ground level (see Figure 2 below). Instead of proactively initiating a request for information, as was taught in their course on project planning, a male student working on the project just stood and waited for things to happen, as he remarked, "But we are just labourers on this site, so we just build what we've been told." Interestingly, the student 'managers' begrudged such behaviour and were quick to dismiss such response as "being typical of lazy workers." This tension appears to signal a breakdown of industrial relations between managers and workers, and it is interesting how rapidly students conform to type when put in such an intense situation. This reminds us of the psychological experiments surrounding simulated prison environments by Professor Philip Zimbardo at Stanford University in the 1970s, where students quickly conformed to their roles as guards or convicts (Zimbardo and White, 1972).

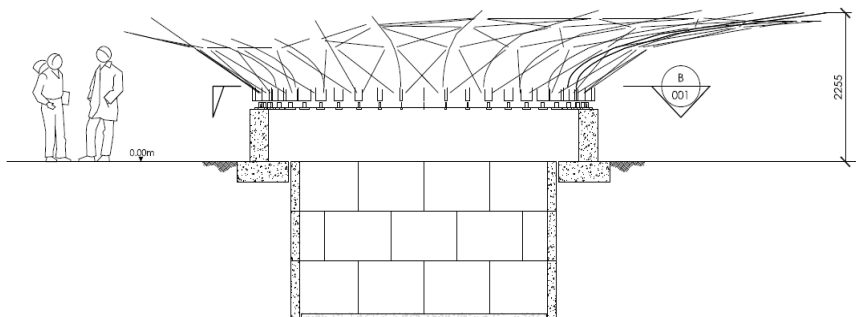


Figure 2: An elevation view of Naples Airport Underground Station project (Source: Constructionarium Limited, 2009).

Despite discussing the well-rehearsed problems of fragmentation and silo-mentality in the industry during lectures at the University, what was also startling was how novices were reinforcing the stereotypes that led to adversarial relationships on site. The comments of this male student, whose role was a labourer on the Gherkin project during academic year 2007-2008, is particularly noteworthy: "I was asked by the [student] project manager to work on compacting the ground, so I have to do this now. I cannot stop just because the [student] engineer has to check his levels." This is symptomatic of the problems that gave rise to such initiatives as 'Respect for people' in UK construction; alas, these lessons, whilst covered in the classroom, have fallen on deaf ears. It seems that the pressure of time to deliver quite challenging projects in a week has resulted in such behaviour. In fact, health and safety lapses were constantly recorded. For example, students typically remarked, "I haven't got time to put on my gloves because my team members need this piece of timber sawn now."

Another notable observation related to how certain roles were perceived to be more important than others. As part of the Constructionarium experience, students not only have to construct the structures, but also to manage both the costs and quality aspects of the construction process. However, it became clear very quickly that students became preoccupied in pushing for production delivery at the expense of maintaining up-to-date records of cost expenditure and quality control. During academic year 2006-2007, the contractor had assigned one of their trainee quantity surveyors to help police the work that students were doing for the Barcelona Tower Project. Although he was briefed to check on the cost management activities, it became obvious as with all the other teams that cost management played second fiddle to the need for completing the production of the building on time. Consequently, students consistently failed to account for the costs of their projects because they had concentrated their efforts on working hard on the manual aspects of the job. Still, the trainee quantity surveyor commented that he benefited from the experience by becoming more sympathetic towards the construction team in the future of his professional practice: "Whereas talking to subcontractors in the past, my whole conversation would be based around how much an issue is going to cost us. Now, I would be more sympathetic now, it would be what must we do to ensure that the project progresses."



Figure 3: A photograph of the Naples Airport Underground Station project in progress: April 2008 (Source: author's own).

Such pure focus on time progression, however, can be problematic. During academic year 2007-2008, the Naples Airport Underground Station project encountered a problem. According to the drawings, circular concrete columns had to be erected to support the timber canopy that featured in the design. However, because of the non-delivery of the circular formwork, the students had made a decision to erect square columns instead because of the relative simplicity of fabricating the shuttering formwork (see photograph in Figure 3 below). Yet, approvals were not sought for this and the changes to the design were not documented because the students were more concerned with finishing the building of something instead of ensuring that this was actually done correctly. Ironically, it is interesting to note how bad habits can form so quickly in an initiative that was designed to equip students with the right, practical skills.

The dilemma of planning

When Constructionarium was first developed, students were normally provided with the project information packs a week before commencement on site. When this

Northern University did this in academic year 2006-2007, it was unanimously agreed at the debriefing meeting after the event that students needed more time to plan the projects. At the same time, an 8-minute video of the activities that took place during Constructionarium was produced in that year. As such, during academic year 2007-2008, two additional briefing sessions were organised at the University a month prior to the event in April 2008, and students were shown the video then. They were also provided with the project information packs that included the drawings and suggested methods statement. Lengthy discussions were facilitated by academic staff and practitioner participants.

In spite of the amount of planning, a striking observation was made on the Naples Airport Underground Station project. This project was designed to simulate construction of an underground station 40 metres below ground level. The technology used was caisson construction. According to the methods statement, and as captured in the video from academic year 2006-2007, three levels of concrete rings (see Figure 2 above) were supposed to be constructed below ground level using the 'cut-and-sink' method. However, students could not visualise how this could be done in reality. The students did not believe the concrete rings, measuring 5m in diameter once assembled, could sink on its own weight - despite being shown the video of how students during academic year 2006-2007 had accomplished this. Instead, on seeing a large excavator on site, the students decided to excavate the soil out and build the rings from bottom-up. Consequently, this method led to a number of problems, which posed a threat in terms of health and safety.

First, excavating the ground to build the rings from bottom-up meant that there was an increased hazard of falling. Furthermore, this was exacerbated by the fact that the edges of the excavation were not supported due to time and resource constraints. Arguably, such an approach would be avoided for a real-life project involving 40 metres below ground level. Second, as the students built the rings from bottom-up, there was the problem of gaining accuracy in vertical alignment; this would not be the case had they followed the 'cut-and-sink' method of construction. To complicate matters, students had not properly compacted the ground when backfilling as they built the rings up to ground-level. As Constructionarium projects were designed to be 'recycled' every week, this created yet another hazard for the de-construction team that worked over the weekend. Many students who worked on this project in academic year 2007-2008, however, failed in their post-hoc reflective essays to learn this critical lesson, in part because they perceived that the project was successful as it was completed (see discussion on the primary focus on time progression above).

Interestingly, one of the students who worked on this project during academic year 2007-2008 is now working for the contractor as a placement student. As this Northern University is preparing for their third Constructionarium, this placement student has been assigned to help out as a practitioner participant policing the work of the students on the Naples Airport Underground Station project in academic year 2008-2009. Because the placement student had considered what his team had done in the previous year to be correct, he is now advising the current students to undertake construction using the wrong method described above. The intriguing point of this vignette is the fact that the extra time and space for students to plan for the projects, and the guidance provided in the video and methods statement, have not resulted in improvements. Instead, bad habits seem to dominate and the obsession with time progression prevails.

DISCUSSION

This section synthesises the key observations outlined above, and focuses the discussion on two main aspects, namely the problem with learning in practice and the importance of materiality in construction.

Problematizing learning in practice

Contemporary literature has advocated the need for organisational learning in construction, with scholars researching on how learning can be encouraged at the construction workplace (see Kululanga *et al.*, 2001; Cheng *et al.*, 2004). Others have promoted the need for sharing contextually-bound knowledge through such means as story-telling (Egbu, 2005). Cooper *et al.* (2005) also talked of the need for shared understanding of processes in construction. Yet, it is frustrating at times to note the perpetuation of the poor practices highlighted above. This is despite the additional resources made available to students in the planning phase. Critically, the observations suggest that bad habits can be learnt very quickly, though difficult to quell. It is probable that lessons learnt in the classroom, and exhortations of continuous improvement and professionalism by the research community, has a tendency to fall on deaf ears simply because organisational amnesia kicks in. It is notable that much of the bad practices originated from the students themselves, even though the academic and practitioner participants constantly emphasised the importance of producing high-quality work over the need to complete the projects on time. This is probably due to the fact that the students were novices and so led to a high propensity for them to adhere to an archetypal view of construction and commit to bad habits.

Nonetheless, this exposes the limitations inherent in prescriptive, planned processes and methodologies that educationalists constantly emphasise in the curriculum. Indeed, there is increasing recognition of the limitations of prescriptive, educator-led approaches. In turn, there is a gradual shift towards embracing more problem-based learning approaches, where the academic facilitates the learning process rather than act solely as purveyors of complete knowledge (see e.g. Savin-Baden, 2003; Douvrou, 2006). As demonstrated through the bad practices highlighted above, it is very difficult for academics in this context to exert control over the (learning) outcomes produced by the students. Perhaps emphasising the locally-embedded, practice-based emergent process and appreciating the ad-hoc, project-based nature of construction (see Bresnen *et al.*, 2005) represents all that can ever be achieved and so, it is important to concentrate on the informal and emergent as we have here! Still, the problem-based learning approach exemplified by Constructionarium signifies a useful, real-life opportunity for academics to take stock of how students are able to translate theory into practice.

The silent role of materiality of objects in practice

The Naples Airport Underground Station project vignette has also highlighted another critical issue; that is, what is the role of materiality of objects in the practice of construction management? Why is it that students were drawn by the presence of a large excavator, which in turn prompted a novice to abandon the suggested methods statement for constructing the concrete rings using a 'cut-and-sink' method? Why did the students not adhere to the lessons taught through the visual means of a video, which was thought to attract their attention? How did the advice provided by experienced practitioners and academics come to be ignored? Why is it more credence was paid to finishing the building on time, and not on undertaking the projects correctly? Indeed, these questions remain unresolved at this point. However, these

fundamentally raise interesting questions in the future regarding the role of objects in construction.

Bruno Latour (2007), when he introduced Actor-Network-Theory suggested that the social sciences need to start taking things as material objects seriously: "[...] no science of the social can even begin if the question of who and what participates in the action is not first of all thoroughly explored, even though it might mean letting elements in which, for lack of a better term, we would call non-humans (p. 72)." He added, "objects are nowhere to be said and everywhere to be felt (p. 73)." Arguably, there is now a strong recognition of the importance of social relationships in construction. However, just focusing on human relations is not entirely adequate; the role of these non-human objects, as the experience with Naples Airport Underground Station project illustrates, and how these influence human actions demands more attention in our research investigations.

CONCLUDING REMARKS

Without a doubt, Constructionarium has been a worthwhile endeavour for this Northern University. Notwithstanding the well-founded benefits of imparting practical skills and retaining interest among students, the experience detailed above has also provided invaluable insights into how dynamics of real-world construction projects might develop. Construction work is hard work! But the intensity of completing such challenging projects in a week has meant that relationship dynamics that would normally take a relatively longer time to mature is now forced to surface very rapidly. This was definitely demonstrated in the observations presented here. From a research perspective, nonetheless, such ethnographic richness and depth in such a short period of time is a rare opportunity. What is also peculiar here is that the reflection presented in this paper is drawn from a longitudinal analysis of experiencing Constructionarium over three consecutive years. Indeed, this combination yielded fruitful perspectives of how academic researchers problematise learning and the growing importance of materiality in practice. Doubts have been cast, however, on the extent in which educationalists can really challenge the mindsets of the next generation of practitioners that are being developed in the education system. Exhortations of good practice tend to be ignored as the novice practitioners succumb to the temptations of bad habits and the pitfalls of organisational amnesia. It would seem that documenting the informal and emergent dynamics is all we can ever achieve as academics.

REFERENCES

- Ahearn, A., Wise, C., McCann, E. and Goring, P. (2005) Constructionarium: building to learn. *CEBE transactions*, 2(1), 6-16.
- Bloom, N., Conway, N., Mole, K., Möslein, K., Neely, A. and Frost, C. (2004) *Solving the skills gap: summary report from a CIHE/AIM management research forum*.
- Boyd, D. and Wild, A. (1993) Educating and training for quality. In: *Conference proceedings of What is the future of construction?* University of Central England, Birmingham, UK.
- Bresnen, M., Goussevskaia, A. and Swan, J. (2005) Organisational routines, situated learning and processes of change in project-based organisations. *Project management journal*, 36(3), 27-41.
- Chan, P. W. and Dainty, A. R. J. (2007) Resolving the UK construction skills crisis: a critical perspective on the research and policy agenda. *Construction management and economics*, 25(4), 375-386.

- Chan, P., Cooper, R. and Tzortzopoulos, P. (2005) Organisational learning: conceptual challenges from a project perspective. *Construction management and economics*, **23**, 747-756.
- Cheng, E. W. L., Li, H., Love, P. and Irani, Z. (2004) A learning culture for strategic partnering in construction. *Construction innovation*, **4**, 53-65.
- Clarke, L. and Winch, C. (2004) Apprenticeship and applied theoretical knowledge. *Educational philosophy and theory*, **36**(5), 509-521.
- Constructionarium Limited (2009) *Project packs*. Accessed through <http://www.constructionarium.co.uk> on 26 April 2009.
- Cooper, R., Aouad, G., Lee, A., Wu, S., Fleming, A. and Kagioglou, M. (2004) *Process management in design and construction*, Oxford: Blackwell.
- Douvoulou, E. (2006) Effective teaching and learning: integrating problem based learning in the teaching of sustainable design, *CEBE Transactions*, **3**(2), 23-37.
- Egbu, C. O. (2005) Knowledge management as a driver for innovation. In: Anumba, C. J., Egbu, C. O. and Carrillo, P. M. (Eds.) *Knowledge management in construction*. Oxford: Blackwell.
- Grugulis, I. (2003) The contribution of National Vocational Qualifications to the growth of skills in the UK. *British journal of industrial relations*, **41**(3), 457-475.
- Kululanga, G. K., Edum-Fotwe, F. T. and McCaffer, R. (2001) Measuring construction contractors' organisational learning. *Building research and information*, **29**(1), 21-29.
- Latour, B. (2007) *Reassembling the social: an introduction to Actor-Network-Theory*. Oxford: Oxford University Press.
- Learning and Skills Development Agency (2003) *Vocational higher education: does it meet employers' needs?* London: LSDA.
- Leitch, A. (2006) *Prosperity for all in the global economy: work class skills*. Final report. December. Norwich: HMSO.
- Pitt, J. (1995) Integration of academic and vocational education. In: *Proceedings of CIB W89 Construction and building education and research beyond 2000*, 5-7 April, Florida, USA.
- Savin-Baden, M. (2003) *Facilitating problem-based learning: illuminating perspectives*. Buckingham: Open University Press and SRHE.
- Scarborough, H. (1998) Path(ological) dependency? Core competencies from an organisational perspective. *British journal of management*, **9**, 219-232.
- Zimbardo, P. G., and White, G. (1972) *The Stanford prison experiment slide-tape show*. Stanford: Stanford University.