 

# Critically Learning from Practice in Construction Education

**David Boyd BSc, MSc, PhD, CEng, MCIBSE, ACIOB**
Birmingham City University
Birmingham, B42 2SU, United Kingdom

Construction practice involves facing the complex physical, organisational and relational situations which create its unique set of problems. In construction education, there is a propensity to simplify these situations and to deal with them separately in different courses in order to allow students to gradually understand this world. This paper argues that this is problematic as the simplification does not give a cognitive facility to deal with the complexity nor the personal skills to deal with the problematic situations. In an attempt to give students an access to these realities, a PG course is described which explores the different perspectives of aspects of construction practice. This involves students selecting an elemental technical topic and determining the codified knowledge of this, then interviewing practitioners about their knowledge, their practice and the problems they perceive of the topic. The approach is supported by theories of 'personal constructs' and 'sensemaking' which provide an explanation of differences and the consequences of working with them. Examples of students work are presented which demonstrate the depth of appreciation of complex areas that can result which enable students to develop unique approaches to their work and to continue this development through their careers. Students gain an insight into the limits of technical knowledge, the way that this is required and used differently by different roles and the way that construction systems integrate these differences. Students learn about the complexities of practice which is essential for their developing skills but also how an academic research approach can help them in practice.

**Key Words**: different perspectives, accessing practice, industry operation

## Introduction

In the UK, construction is consistently reported to fail for not delivering what clients and people want (e.g. Cabinet Office 2011). There have been numerous solutions postulated over the last 50 years (Murray and Langford 2003) but none seems to have succeeded completely. Lack of success has been blamed on the industry which unlike other industries apparently does not seek to become 'modern' (Woudhuysen et al , 2004). Thus, as educators we are left having to present students for an industry which is problematic. We have this belief that we want them to be able to do a better job but we continue to set the curriculum and teach using the same approach. Bernold (2005) called for a paradigm shift in construction education. This was a major critique mainly of the methods of teaching but also of the greater purpose of education. As educators, we are caught in a dilemma where we need to simplify content in order to communicate it to students yet this gives a false impression of what is in reality a complex and dynamic environment. These simplifications are presented in courses which focus on various disciplines thus fragmenting the way a project is seen and experienced.

The standard subjects are prescribed by professional institution such as the CIOB and RICS in the UK and by the ACCE in the US. Central to these frameworks is the science of building which dominates construction education (Boyd and Pierce, 2001). This is necessary to ensure accuracy and efficiency in technical construction. However, this science view is used beyond technology to building economics, project planning, law and even management where e.g. the parts of the subject are studied such as elemental costs, activity times, contract clauses and motivation. What this view contains is that there is a single correct view of the project and its construction. However, there is a move away from curriculum specificity to competency (CIOB ACCE) and this allows the challenge set by Bernold (2005) to be addressed.

There have been many studies and reports (e.g. Latham 1994) which identify the difficulties of communicating between the disparate actors as one of the key problems of construction. One aspect of communicating parties is that they seldom consider the other party in communications (Finnegan, 2002; Emmitt and Gorse, 2003). We know, but seldom account for the fact, that others do not perceive the world in the way that we do (Buchanan and Huczynski 2010). Even if we may look at the same thing, we see different aspects and these have different significances. Central to the approach described in this paper, is the belief that this is a key aspect of construction practice and one thing that prevents a better operation of the industry. Thus, it is a key realisation for those working in the industry that others see things differently from them and also as managers that the design and construction interactions need to overcome this aspect. There is one other dimension to this concept of different perspectives; that is the place of written knowledge. Written knowledge contains experiential description and reflection evident in practitioner literature, or theoretically derived knowledge evident in academic publications (Gummerson, 1991). This latter knowledge is central to construction education but is vicariously used in practice. Some of this knowledge comes from solidly scientifically derived studies but it is the assumption of its use which may make it context dependent. The use of written codified knowledge in practice is not well understood but it is certainly not as simple as is assumed which is as a direct transfer of fact to action.

We are left then to try to incorporate all these challenges into construction education and make it valid for practice and for academic credibility. This paper presents such an approach and some outputs from it demonstrating the depth of learning that can result. Students are required to access different perspectives from practitioners on a technological aspect of construction (e.g. lime mortar or raised floors) and compare this to theoretical knowledge; concluding with an assessment of how the different perspectives resolve their differences in practice. The educational approach involves presenting theories which places this appreciation into a model allowing students to explain their observations more clearly and develop this in their practice. These theories: 'Personal Construct Theory' (Kelly, 1955; Bannister and Fansella, 1971), and Sensemaking (Weick, 1995) are outlined here as they are central to the students development. They also provide an academic tool that the students can use in practice and in their assignments giving it academic credibility. The paper concludes with an evaluative discussion of the approach.

## Methodology

Such an educational approach that is described here is best seen as an action research project (Zuber-Skerritt 1992) as such it is critical that there is a also a large amount of feedback from students, and reflection by teachers, to drive the progression of the delivery. This paper is part of this reflective activity. In such education, the opportunity is there for the student to learn more than set out in the learning objectives as real learning is driven by their own engagement with the topic. This is essential for their development in that they are becoming self adapting. In undertaking such action research we are rejecting the positivist paradigm and adopting a naturalistic or phenomenological position (Easterby-Smith et al, 1991). We are variously engaged in ethnography, participant observation and cooperative inquiry in this research as faculty learn from the situation and students learn to learn from each other (Stuart 1989). The issue of assessment in these circumstances is complex as it can detract from learning, merely becoming a hurdle to overcome rather than an opportunity for self transformation. In this case the assessment involves an analytical reporting and reflection on the activity which in itself is a developmental task.

The choice to focus on technology is a challenge as this knowledge is normally regarded as fully codified and rationally operationalisable through standard processes. Herschbach (1995) argues that technological knowledge is a lot more complex as it is about application and does not yield to simple codification and the organisational aspects of its application are important for achievement. Herschbach (1995) presents technological knowledge in three dimension: descriptive, prescriptive and tacit. Descriptive involves a similar codified knowledge as science but in technology this is less completely developed theory. Prescriptive derives from experience whether observation or experimentation and is not complete but added to as the knowledge is used for application. Finally, tacit knowledge is held by individuals but recognised by groups and concerns judgement, skills and practice. Such a break down may not be rigorous but it is useful for starting the process of inquiry into what is known about a technology and how this knowledge operates in projects and between organisations.

## The Educational Process

The aim of this one semester course/module is to develop students into learning practitioners by them exploring the experience of practitioners in a critical manner. The objective is to look at the limits of codified and practice knowledge and how these are handled in practice and could be handled better. In particular, the way what different people know about an area affects practice. The assignment associated with this involves writing up the outputs from their inquiry and analysis plus presenting this to the class. Thus, this is a research based module rather than a subject testing module and so addresses the challenge of Bernold (2005) to facilitate student transformation.

The study involves each student:

1. Undertaking a study of factual knowledge in a technical area of construction
2. Determining what other people know about this area
3. Presenting 4 characteristic problems that occur in this area
4. Evaluating the operation of knowledge in this area
5. Presenting this information to the group

Students are asked to chose a technology into which they will research; examples are provided (cement, PV panels, BIM) but the more this choice is self directed either from curiosity because the student feels they should know more, or that they have some prior knowledge or they know people to ask; encourages more engagement from the student. Throughout the course students are given lectures which theorise about the issues during which they are encouraged to offer examples from their study and this enhances their appreciation of the example but also offers knowledge to other students.

The first task involves a literature study. Students are asked to be aware of the different value of sources; for example, manufacturers' literature may be promotional as well as informative; some text books may have out of date information or indeed have erroneous information in them, government reports have a political dimension and official standards may specify output aspirations but not methods. Students are also encouraged to inquire into the assumed context that the knowledge applies both the connecting technologies and the practice of application.

Having developed a detailed factual knowledge, students then need to approach 2 or 3 people from different backgrounds and different roles who might be involved with this area and determine their knowledge. The inquiry into this needs to be planned and a semi formal interview conducted. Early lectures assist student to undertake this and develop skills in purposeful inquiry and interviewing (Heron, 1990). In particular they are introduced to the idea of 'positioning' (Bandler and Grinder 1975) which allows them to see that their approach to their interviewee affects the situation and the results they get. We believe that this is a transferable skill which is useful not just in an academic assignment but also in how students work in practice. The ability to, not just work with people, but work with the way they think helps the immediate communications and also, once these students are at a managerial level, the design of integration of the parts of the construction system.

During these interviews the 3rd objective can also be undertaken; namely the problems that the interviewees have had in this area. All the problems do not need to be included in the assignment; and students are encouraged to prioritise these so that they present an awareness of the nature of the problems for this role. Indeed, the ability to do this is what would achieve higher grades. The students need to ask how the problems were resolved. Problems are key aspects of peoples' lives in construction; what these are and the way that they are conceptualised in the sense of the explanation of their occurrence is all part of understanding the world from the interviewee's perspective. It indicates what is important to the interviewees and what might enable them to do a better job.

Finally, students need to assimilate this rich information (that is often unstructured and heavily narrative based) and analyse the nature of the knowledge in the areas, presenting how outcomes are affected by the differences in thinking, responsibility and intent and making suggestions about how this could be managed better. Students are required to present this developing perspective to their group and this is assessed as part of the assignment. This aspect reinforces the idea of learning with others which is a critical skill required in the industry. It also allows feedback from other students and Faculty which are useful for improving the analysis in the final written assessment by the sharing of their insights from practice.

The final assessment involves a written submission of the inquiry and the analysis. Students are asked to present succinct details of this. Rather than just present standard textual knowledge, it requires them to identify what the key issues are. This requires a much more in depth awareness and appreciation of the values (what is good and bad) in the use of the technological artefact. The skill in doing this differentiates good students. Students then have to present their interview results. This is not a trivial transcription but an attempt at trying to present interviewee's understanding and perspective on the technology. Again it involves identifying, during and after the interview, what is important to the interviewee. The presentation and analysis of the interviewees' problems should follow naturally from what is important to them. Again the ability to access this knowledge from the interviewee and analyse it successfully differentiates good students. Students then describe how they believe the industry operates to resolve these different perspectives and problems. This establishes what industry norms are and also reveals where potential improvements can be made. One additional criteria in the assessment is determined from the assignment as whole and that is a demonstration that the student has undergone learning and evidenced this.

## Theorising for the Course and Industry Problems

There are two problems that theory can help us with, that is student education and construction organisational behaviour. The problem of education in this module is that we are not just feeding information to students but helping them to learn from a problematic industry in a new way. Key to this is the idea of creating a process of inquiry into the real world to surface the critical physical and social aspects. The former is well presented in technical documents however the later is more complex and it includes the way the former is dealt with in a social situation. The two most important theries presented are 'personal construct theory' which explains differences in perception and the way we experience the world differently and 'sensemaking' which is how we act when we do not have an explanation that works.

### *Personal Construct Theory*

The nature of interaction between groups and individuals is well conceived by organisational behaviour (e.g. Buchanan and Huczynski 2010). This balances psychological and sociological insights to explain why organisations act and deliver in the way they do. One key to this is the way participants perceive what they are doing and the environment they are doing this. Our understanding of perception is explicitly psychological, namely cognitive, but this is informed by the physiological input from our senses. Theories of psychology are often criticised (Reiss 2008) for being more about deviance than normality thus do not help us much in education. What we need is a psychology of the normal. Personal construct theory was elaborated by Kelly (1955) as a psychology to explain the normal actions of individuals. It views people as inquirers and inventors of their worlds. Although it is comprehensive, it does not seek to completely define the psychological world but enables a discourse on the processes. It focuses on individuals continually trying to understand and predict outcomes of the world which they inhabit. To do this, people invent models and it is these models or mental maps which are personal constructs. The theory is reflexive that is it accounts for itself. It assumes that everyone is researching into his or her world whether as a specialist or not and the interpretations are valid for them if they assist them in handling the world. In Kelly's theory the external world is real but we experience it, appreciate it and pro-act on it, through constructs; that is not the stimulus of the world but the interpretation of the stimulus. Each individual develops an idiosyncratic model of the world leading to alternative constructions of reality to those held by others because of their different life experiences. We can invent different constructs to understand our situation and act on it in a new way. This development takes place in a process of 'elaboration' which involves either a 'revision by definition' or a 'revision by extension'. In the process of definition, situations are encountered which appear similar to previous situations and so there may be some minor changes in detail of the constructs, but essentially they are revalidated. In the process of extension, a situation is met for which a well defined construct does not exist. Part of surviving and performing in a new situation involves changing constructs or developing new ones.

Beyond the most simple aspects of reality, personal constructs can diverge widely between people (Bannister D. and Fransella F., 1971). Since the majority of construction projects exhibit a technical, organisational and social complexity, they are fertile grounds for the valid existence of both competing and complimentary constructs. As construction personnel move from project to project they elaborate their personal constructs to cope with the new reality that they confront. Within this elaboration by definition or extension, their tacit knowledge is developed.

Challenges to one's constructs produce a number of characteristic emotions: anxiety, guilt, threat, fear, hostility and aggressiveness. Anxiety is met when our constructs do not adequately represent a situation. Guilt occurs when we act in a way which does not fit within our construct of ourselves. Threat and fear relate to situations in which our constructs may be invalidated in a fundamental or peripheral way respectively. Hostility is the forced creation of a situation which allows us to reconfirm our constructs often as self preservation, and aggressiveness is the emotion we project as we actively test out and explore a situation. As people meet situations which are inconsistent with their construct system, then they may either constrict or dilate their appreciation of it. By constriction they concentrate on some aspects of the situation and ignore others in order to support their constructs. By dilation they seek to maximise information from the situation in order to extend their constructs in a comprehensive way.

Constructs may be loose or tight. A tight construct is one which produces unvarying predictions of events which enables us to make concrete predictions which can be tested out. A loose construct is a fuzzy representation of the world which leads to varying predictions, however, it is flexible in dealing with a variety of situations and allows the harvesting of information to gain a wider understanding of a situation. It is in the loosening and tightening of constructs which is part of the Creativity Cycle enabling the understanding and performing in new situations. The cycle involves circumspection, pre-emption and control. Circumspection is a phase of fantasy and divergent thinking in order to generate a cornucopia of ideas. Pre-emption is a phase of reduction of ideas to a set of issues. Finally, Control is the drawing together of these ideas with which it is possible to act. This is also part of learning which in personal construct theory simply involves the changing of constructs either through definition or elaboration. We are assisting the students to work with their elaboration of constructs in unfamiliar situations.

## *Making sense*

These ideas align with another theory of organisational behaviour that of sensemaking in organisations (Weick 1995). The way we react to a situation, particularly those that are unfamiliar or even problematic, involves giving them meaning which involves sensemaking. This takes place in an active interaction between a person and their social and physical environment where meaning is formed through expectation, action and reaction. The student use the ideas of sensemaking in two ways; firstly in understanding how the practitioners that they are interviewing have made sense of their work environments and the problematic situations, and secondly, how they themselves make sense of what they are finding from texts and from the interviews in particular the contradictory aspects of this. This responds to Bertolt (2005) radical educational model and to the ideal of transformational learning (Mathis, 2010).

Weick(1995) proposes seven aspects to sensemaking: identity, retrospection, enactment, social interaction, ongoing reactivity, cue searching and plausibility. These aspects are very active in the sense that sensemaking is a process not a single achievement; this emphasises the way that practitioners and students are active participants in their worlds which are socially framed. *Identity* deals with the fact that we act in a situation depending on how we identify ourself in it. *Retrospection* deals with how aspects are brought to our attention in time; this is dependent on our past so that knowledge of a practitioner past can help us interpret why they act in a particular way. *Enactment* involves the actual practice and the talking about practice that we undertake; thus it is connected to retrospection and identity but involves others as our action induces particular responses from them. *Social interaction* is key to all of this (both in understanding practice and for the student to learn). Construction situations are complex as they often involve temporary multi-organisations where the interactions are formalised at one level but very self defining, involving much individual discretion, at another. Thus, the importance of the *Ongoing Reactivity* where the immediate action and reaction activities from participants determine as prevailing climate of sensemaking in the social situation. Key to this are the way each participant looks for *Cues* that make a situation sensible to them; the construction world is full of conventional expectations which are interpreted in particular ways and this understanding is key to appreciating what is happening in practice. Practitioners are also simultaneously giving out cues to others. *Plausibility* is what we are searching for in our making sense; it is not a search for accuracy but the most suitable and immediately satisfying reading of the complex phenomenon that is accepted.

Thiry (1999) has used these ideas in project management when teams are undertaking value engineering. He demonstrates that times of uncertainty are characterised by giving Cartesian Anxiety as our logical plans are found not to be effective. The sensemaking that takes place in practice situations that are problematic then involves not a transfer of meaning but a negotiation of perspectives and desirable outcome. In the technological area that the students investigate, the codified and textual knowledge which might apparently have authority is often bound up with detailed conditions of application making its correct use uncertain. Students are asked to search out these conflicts between text and practice and determine how negotiations of views take place to resolve the issue.

## Educational Outcomes

We look at two examples of outputs from students whose technological aspects are: lime mortar, and raised floors. There is something of a progression of technological development here which shows that the approach is applicable to all technologies and also the way that knowledge operates differently.

### *Student 1: Lime Mortar*

The student really got to grips with this topic as her respondents had a passion for their work in repairing historic buildings. She interviewed a stone mason with 30 years experience and an estimator (quantity surveyor) with 35 years in the industry and 15 in historic repair. She initially researched the factual knowledge of the subject.

#### *Factual Knowledge*

Lime mortars are principally used for the maintenance of historic buildings. Although being well document about their production and use they do not have the same scientific foundations as Portland cement. This is both a social as well as a scientific issue as those involved in historic buildings have other values associated with authenticity and the past being good or even better. Thus their prescriptive knowledge exceeds their descriptive knowledge and much lies within a tacit category. Lime mortars have a long historic development of knowledge being first used (explicitly at least) in the Roman Empire. Their continuous use through history also relates to their production methods both in the sense of location for material availability and in the sense of skill and quality of production. Quality control was not expressed in these terms early on but there was a clear awareness of quality being a function of location and personality of production rather than tied to testing or codification as in later years. Currently as with all cementatious products there is much information about 'correct' mixes and correct handling (including for H&S). The notion of lime mortars being more forgiving, but not suitable for exacting structural situations, gives them a different character in this respect. Thus, even now the idea of 'correct' mix is tenuous very much dependent on circumstances and those that are using the product.

#### *Experiential Knowledge*

The mason believed in the value of lime in restoration with a value of 'replacing like for like' and this was something he shared with commissioning architects in their effort to 'do the best for the buildings'. This aspect of being part of a social enterprise extended to his desire to pass on his experiences to apprentices and less experienced members of the workforce. The mason's problems surrounding the use of lime started with a very practical awareness that lime caused irritation to his skin, eyes and lungs and in winter he often suffers from sore hands. The use of lime is more temperature sensitive needing to avoid cold but also direct sunlight which 'dries it out too quickly'; in both cases time needs to be spent protecting the work to ensure proper application. Practically lime can stain the face of stone/brick work so must be used carefully with a ready supply of fresh water for 'sponging off'. He felt that every building was different and so required different preparation and tending which takes time and he likes to 'get to know a building' and how best to work with it. Considering other's knowledge, he was under pressure to work quickly by management but he felt that lime 'can't be rushed' and that sometimes 'management don't understand this'.

The estimator by his role and experience has a different perspective but shared in the special social enterprise of restoration. Although never having worked with lime, he had an appreciation of the skill required to properly use this material. He clearly sees it not just as an abstract element but one that has iconic status in use. However, he does experience problems from its use principally around the variability of its use. Every job he prices has a different mix which means he has to check and price each one individually. Stonework varies widely in size and type, joint sizes also vary widely. Each type and size will require a different quantity of mix to point them. This is very hard to cost accurately. Lime is an expensive material almost four times the price of cement and requires special aggregates in mixes. There appears to be an alarming rate of failure of lime pointing requiring rework and increased cost. He uses a lump sum method to price the material cost of lime mortar. He does not like doing this as there is quite an element of risk in this approach.
The tight knit community surrounding historic restoration allows for very fluid communications which resolves most problems. The conflict between cost management versus the skilful application is actually a healthy disagreement which is dealt with in the shared belief of doing the best for old buildings.

## *Student 2: Raised Access Floors*

Raised Access Floors are an elevated, load bearing floor which creates a void to allow the distribution of mechanical and electrical services. This flooring system is used in many modern buildings which contain heavily serviced rooms as it allows for future flexibility. The student interviewed an architect and a facilities manager about their knowledge of these.

### *Factual Knowledge*

These are modern modular products and so are surrounded by manufacturers' literature on dimensions, load bearing properties and installation procedures. There are particular requirements for fire proofing as they provide a route for smoke and fire spread but this has to work with the distribution of services and the layout on the floor. Similarly there are requirements to reduce impact noise and noise transfer through the void that is formed. They have been designed to be installed into a well dimensioned and constructed area by specialist subcontractors.

### *Experiential Knowledge*

The architect was aware that the size of ventilation duct is limited by the module width which is normally 600mm. In some areas, particularly at corridor entrances, a bridging system is required where services come together for entry into a vertical core. He indicated that most people believed that the whole floor is raised; however, there are some areas such as wet areas or acoustically sensitive areas which are difficult to service this way and other solutions are required. This means that there are different levels required to be produced during the construction. The architect relied on the manufacturers' literature but required specialist advice from an acoustician for sound transfer. He seemed unaware of occupancy problems with raised floors.

The facilities manager only understood raised floors because of his experience of managing them. He related problems that they did not deliver the flexibility assumed and that cost of changes was high. For example, constructed walls often go over a floor panel which means they cannot be lifted to maintain or change the services. This might mean that technicians had to crawl into areas to facilitate changes. Changes were more expensive than thought as carpet tiles had to be renewed and outlet boxes were difficult to move. There were also problems at edges, around heating trenches and around columns, where good finishes were difficult to undertaken such that these places were where finishes became broken easily. He expressed some frustration that designers did not understand that raised floors had problems and did not provide the advantages that were marketed.

The two perspectives were not brought together unless by an enlightened client. They both made comments about the specialist contractors who overcame design problems or made solutions fit. This product to some extent requires an engineered situation to work best.

## Discussion and Reflection

The examples show an extremely deep level of understanding of these technologies and their application. Students also realise what they and others do NOT know. There is always information available and people could keep accessing more but, in the practicality of construction, there is a limit to what anyone can know. Such terms as bounded rationality (March 1978) and satisficing (Green 1994) explain some of these problems. In construction, this induces a conflict of power over meaning where the winner's view is the one adopted; however, others do not really see the world in the winners way and this may cause errors or even intentional contrary actions; thus, explaining some of the problems endemic in construction.

Clearly a technological view would suggest that complete knowledge was available but using Herschbach's (1995) breakdown of technical knowledge, we see that completeness is only available in the descriptive domain. The prescriptive domain is very dependent on how the technology has been used in the past. In the examples above, lime mortar has an extensive prescriptive knowledge but this is held and passed on orally between practitioners. It thus has a large component in the tacit domain making it inaccessible to even adjacent roles, although they may at least have awareness of this knowledge. In the raised floor case, this operates completely differently. Raised floors are a pre-conceived engineering component and this is well presented in descriptive documents. The prescriptive knowledge of application is held by specialist sub-contractors which includes finishing-off at difficult junctions but they have no awareness of the operational functionality of the floor. This lack of knowledge of usability may also be present in the architect who merely specifies a raised floor as a component rather than an active feature of the operating building. Much tacit knowledge then is held by the facilities manager who is required to fix and creatively work with what has been given to them.

Such knowledge about the complexity of practice is immensely important to the learning of students. The presentation of this to the class extends the learning to some extent to more students. In feedback, students often also express how important to them is their new skill for acquiring critical technical knowledge, particularly as regards application which is the most difficult to access. However, this feedback from students often comes after an initial rejection and dissent as their other courses/modules appear to offer certain knowledge. We believe that this is a demonstration of learning which, as personal construct theory and sense making suggests, involves an emotional reaction to the unknown. When student's constructs are challenged they suffer anger and anxiety. Learning to deal with this unknown in a positive and integrative way using the different perspectives of others is a tremendous skill. Indeed this is what actually happens when students get into practice and so when they have overcome the initial anxiety they see that they are learning how to work with the complexities and problematic nature of practice.

Poor students merely reproduce technical knowledge as if it were fact and cannot see how different perspectives contribute to constructions problems. They believe that it is possible to tell people everything and so resolve all problems. The better students realise the significance of this in that they appreciate that no one can know everything about all products in construction. Therefore, there is a requirement for interaction and communications between roles to resolve the different perspectives which is explored in the inquiry

## Conclusion

The education described here, demonstrates that a critical perspective on practice is possible and can provide both practically useful knowledge and also academically credible learning. Indeed, the action research approach allows the usefulness of theory to work with practice which is a developmental need of academia. This addresses many of Bernold's (2005) points and creates a transformative education (Mathis 2010) even if students' feel insecure with this initially. There is potential for using this approach to help students' access the learning they require for a changing industry around developments in Integrate Project Delivery and Building Information Modelling where there are large uncertainties and variability's of practice. It is critical that faculty are determined to see these approaches through as students revert to functional styles and this requires a very reflective educational practice .

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