Journal of Problem Based Learning in Higher Education

VOL. 5, No. 1, 2017 – Page I-V

Blended Learning in Architecture and Design Education

Nicolai Steinø, Jacob Davidsen *

INTRODUCTION

The aim of this special issue is to elucidate current practices and experiences of mixing traditional, physical, location-specific and face-to-face modes of learning with online learning formats – altogether known as blended learning. In the design disciplines, this poses particular challenges, as design learning has traditionally been deeply rooted in practices which involve interaction with both people – peers and instructors – and physical matter.

The focus in architecture and design education on solving design problems through project-oriented learning processes makes the field a perfect probe for investigating problem-based learning. As opposed to traditional learning formats in higher education such as lectures, seminars and colloquia which are still widely used in most higher education programs, architecture and design education, as a form of problem-based learning, has always been focused on the studio.

In creative and arts-related educational programs, the studio is a space for experimentation and creative development. The studio is a physical space, and rather than reading and writing, students perform design enquiries through drawing and modeling. And learning is haptic–kinesthetic and visual–spatial, rather than verbal–linguistic or logical–mathematical (Gardner, 1984). As such, architecture and design education is particularly interesting in the context of blended learning, compared to other fields of study in higher education.

Slightly caricatured, new online learning formats attempt to transport traditional learning formats into the digital media. Lectures become videos, seminars become chat rooms, and colloquia become online forums for the exchange and commenting of work in progress. Even if the quality and effectiveness of online learning may be debated, it therefore somehow seems to address the teaching needs and traditions of mainstream higher education, rather than those of the problem-based learning formats of architecture and design education.

* Nicolai Steinø, Aalborg University, Department of Architecture, Design and Media Technology, Aalborg, Denmark, Email: steino@create.aau.dk
Jacob Davidsen, Aalborg University, Department of Communication and Psychology, Aalborg, Denmark, Email: jdavidsen@hum.aau.dk

But even if online technologies to emulate drawing and modeling do exist, they do not seem to have found their way into online teaching by any substantial measure. Therefore, it is tempting to believe, that introducing blended learning into architecture and design education may cause rupture to well-established ways of teaching in this field. So where does it leave – or take – studio-based architecture and design education? Does it subtract from the long-standing qualities of the studio and it's important physical presence of both people and matter? Or does it add new and enriching qualities to the well-established learning formats of architecture and design education?

These are the questions which the papers in this special issue seek to address.

At this point, the observant reader may ask how blended learning in architecture and design education relates to the aim and scope of a journal on problem based learning in higher education. What, in other words, is the PBL component in this context? The answer is simple. In its deep foundation on the concept of the design studio – the idea that learning emerges from doing design projects (which, in turn, is based on the beaux-arts concept of the ateliér, where arts students would learn through creating artwork) – architecture and design learning was problem-based long before the theoretical formulation of the concept.

Therefore, it is probably fair to say that most architecture and design educators are implicitly PBL-oriented in their work, even if they are not explicitly aware of it. As Kocaturk contends in her contribution to this issue, "[d]esign-studio lies at the heart of Architectural Design education which aims to simulate aspects of professional practice in a studio-based learning environment. Students are given a complex design problem (project) and are assisted by their studio tutors in developing solutions."

In the call for this issue, we suggested a number of different themes. First, we thought someone had probably developed a new course format as a result of new online technologies. We also imagined that distance learning would trigger new balances of on-/off-campus learning activities, and that new forms of international collaboration would be enabled through online technologies. It seemed obvious that new technologies would facilitate new methodologies for analysis and/or design. And finally, we encouraged contributions on pilot learning design projects – successes, failures and lessons learned.

While some of these themes are covered in this issue, others are not. Among the seven contributions to the issue, a notable five take their point of departure in the architectural design studio. A recurring topic among this group of papers is blended learning in various forms. One contribution interestingly addresses architectural history teaching in an outdoor setting using mobile technology. While not addressing studio teaching, this paper is still situated in the context of architecture studies. Finally, one paper addresses collaborative and interdisciplinary learning in virtual space through gamification. While not specifically addressing architectural design education *per se*, it addresses issues which are highly relevant to it.

This distribution reflects the editors' impression that the classical studio teaching format in architectural design education is still very much alive, even if under pressure. Introducing elements of blended learning into studio teaching therefore has two aims. On the one hand, blended learning is explored as a means to enhance the quality of studio teaching through the application of ICT. And on the other, blended learning is explored as a means to compensate for the negative effects of cutbacks on resources for studio teaching.

Apart from the students' reflection through design, the reflective discussion between instructor and student during studio supervision, which has been seminally described by Schön (1983,1987) is central to the studio teaching model. Yet, in its traditional form where students and instructors engage one-on-one, it is also a very costly teaching format. Therefore, in most current-day settings, instruction therefore takes place among groups of students. Nonetheless, the model is under constant pressure, and new ways of compensating for the lack of former-day resources are in high demand.

Despite its many merits, the traditional studio format has its limitations. As MacKenzie et al. contend in their contribution, "[d]esign and architecture education traditionally relies on personal interactions between tutor and student in a physical space called the studio". But as instruction takes place between instructors and (groups of) students, learning is only shared among a limited number of students. Therefore, the format produces redundancy, as the instructor often has similar conversations with different groups of students. Using online teaching techniques can be a way to compensate for this, as the instructor can address larger numbers of students on issues of general concern.

The traditional studio – as the name implies – is a physical spaces as much as a learning space. Yet many programs do no longer have the resources to offer permanent work desks to all students. Therefore, informal learning – students learning from each other – has become more difficult, as students will not spontaneously meet to discuss ideas and see each others' work in progress to the same degree. The same is true for large studios with up to 50-100 students, even if they do have permanent work desks. Again, online fora can be a way of sharing ideas and work in progress among students.

It is important to note in this context, that sharing ideas and work in progress in architecture and design studies is a predominantly visual activity. In the physical studio, students will mount paper sketches on pin boards and have scale models sitting on tables. This visually rich environment is very important in order to get inspired and to learn. In this regard, the visual arts, architecture and design differ tremendously from most other teaching programs in their requirements for a visually stimulating study environment.

Taking her point of departure in a master's level design studio, Kocaturk investigates how both the mediational and instrumental use of digital media and face-to-face interaction can support collective knowledge construction and skill building, as well as how blended learning can support individual, collaborative and guided learning respectively. She does so by asking her students to use wikis for

developing, sharing, and documenting their design work in an array of representational modes, ranging from texts and sketches to animations and videos.

Kocaturk's research interest is similar to that of Steinø & Khalid, in that she focuses on the online platform's capacity to foster instructor to/from student and student to student communication, sharing of work and ideas, and peer learning. The two studies also adopt similar methodological approaches. While the former is an ethnographic study and the latter is a phenomenographic study, they both use qualitative student responses in the form of interviews and workshops respectively, as a way to document their findings.

While both Kocaturk's and Steinø & Khalid's primary interest is the potential of blended learning for improving the didactical and pedagogical quality of learning, both MacKenzie et al. and Hill are more focused on how online tools can substitute traditional face-to-face teaching modes. MacKenzie et al. investigate how an LMS (Moodle) can be put to use for giving course information and student feedback in a number of media formats in order to support the convergent-divergent dynamic of the learning process.

Hill takes the efficiency aspect to the extreme in his account of the "tutorless studio" in his examination of whether it is possible to reduce or even eliminate the role of tutors through blended learning. The challenge of substituting blended learning for tutors while still being able to provide students with high quality feedback, was tackled in part by training students to give peer feedback and in part by summarizing general feedback through live lectures. While the experiment was not entirely conclusive, the students interestingly performed better than in previous comparable traditional studio courses.

Reporting from a global multidisciplinary network on housing research and learning, Bregger gives an account of a course on housing in which extensive use was made of a host of ICT tools, including an online workspace, facilitating international collaborative learning including both students and instructors from different programs. While a special online platform was developed for this international collaboration, student feedback indicated that the online platform which was used could be improved with regard to live features, upload system and interface design.

As mentioned above, two contributions, while not addressing studio teaching, demonstrate innovative use of ICT technology in architecture and design related learning. Smith et al., on the one hand, give an account of a new approach to teaching architectural history, landscape and urban design, using mobile technology in combination with site visits, video and audio recordings, and various creative notation formats.

Finally, Jensen investigates virtual reality (VR) as an environment for collaborative and problem-based learning in architecture and building construction education, with a special focus on gamification. Although not entirely successful in this early adoption, gamified learning in VR suggests

enticing new ways of learning in architecture and design, as technology matures and pedagogical models ripen.

All in all, the papers presented here offer a glimpse of a world of blended learning in architecture and design education, in which new technologies challenge old paradigms, where educators struggle to make the best of two worlds, and where the last word is far from having been said. Hopefully, this issue will be as informative as inspiring, when it comes to the ways in which the traditional studio format can be developed and transformed through blended learning, and how entirely new teaching formats may be enabled through ICT.

Happy reading!

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Journal of Problem Based Learning in Higher Education

VOL. 5, NO. 1, 2017 – Page 1-21
http://dx.doi.org/10.5278/ojs.jpblhe.v5i1.1544

A Socio-Cognitive approach to Knowledge construction in Design Studio through Blended Learning

Tuba Kocaturk *

ABSTRACT

This paper results from an educational research project that was undertaken by the School of Architecture, at the University of Liverpool funded by the Higher Education Academy in UK. The research explored technology driven shifts in architectural design studio education, identified their cognitive effects on design learning and developed an innovative blended learning approach that was implemented at a master's level digital design studio. The contribution of the research and the proposed approach to the existing knowledge and practice are twofold. Firstly, it offers a new pedagogical framework which integrates social, technical and cognitive dimensions of knowledge construction. And secondly, it offers a unique operational model through the integration of both mediational and instrumental use of digital media. The proposed model provides a useful basis for the effective mobilization of next generation learning technologies which can effectively respond to the learning challenges specific to architectural design knowledge and its means of creation.

INTRODUCTION

The potentials to advance design education through the use of online digital media, Web 2.0 and computer-mediated collaborations have been extensively covered in literature (Bendar & Vredevoogd, 2006; Chen & You, 2010) with references to their diverse implementations in specific contexts such as in virtual and augmented design studios (Kvan, 2001; Laiserin, 2002; Reffat, 2007) and with implications on the design studio pedagogy (Osborne et al., 2011). The literature identifies several factors that contribute to the added value and efficacy of technology integration into design studio education especially when implemented within a blended learning context (Ham & Schnabel, 2011; Saghafi et al., 2012). The potentials of blended learning to enhance student learning experience and aiding the development of

* Dr. Tuba Kocaturk, University of Liverpool. Email: kocaturk@liverpool.ac.uk

critical thinking and communication skills have commonly been acknowledged and widely published (Behling & Klingner, 2010; Garrison & Vaughan, 2008). However, the potentials of blended learning on collective knowledge construction have not yet been explored in a design studio context.

Design-studio lies at the heart of Architectural Design education which aims to simulate aspects of professional practice in a studio-based learning environment. Students are given a complex design problem (project) and are assisted by their studio tutors in developing solutions. The underlying pedagogical approach is very similar to problem-based learning but combined with "design-thinking" as its core methodology for creative problem solving. In a design studio, students learn through learning-by-doing, in a continuous dialogue with their tutors and peers and through continuous reflection on their action (Schön, 1983).

The integration of information technology into the specific context of architectural design-studio has two distinct dimensions and subsequent repercussions on design learning. First is the *mediational* dimension where digital media is used as a mediating platform within which formal or informal learning take place. Various social media and engagement tools, such as blogs, social-networking sites, open source platforms and wikis facilitate informal modes of interactions across a community of learners, providing various opportunities including skill building and access to various resources (Lane et al., 2015). A more formal use of mediational platforms are through the 'Virtual Learning Environments (VLEs) (e.g. Blackboard, WebCT), currently used across most higher education institutions, providing structured and administrative support for module delivery, student tracking, assessment and access to resources (Mizban & Roberts, 2008). However, a common observation is that a majority of the existing VLEs are based on top-down, instructionist principles (Cannings & Stager, 2003). This does not fit with the reflective, dynamic and situated knowledge building necessary for design learning inspired by the principles of constructivist and experiential learning (Kipcak, 2007).

The second is the *instrumental* dimension where various digital design media and software serve as a means or agency for generating disciplinary knowledge content, as well as aiding the conceptualization and actual production of designs and new design methods. Various digital and computational design and analysis software (Rhinoceros, Grasshopper, Revit, Sketch-up, AutoCAD, etc.) offer designers and learners the means to explore vastly complex building forms, and make possible to model complex behaviour, including environmental and structural performance, pedestrian flow, code compliance, and other systems which open up unprecedented possibilities in embedding intelligence into the conception and realization of designs.

This paper argues that an effective utilization of blended learning in architectural education requires careful consideration and effective integration of *mediational* and *instrumental*

dimensions of information technologies specific to the discipline and practice of Architecture, and as such, presents findings obtained through the development and implementation of a new pedagogical approach in the context of a master's level design studio. The paper will demonstrate:

- A new pedagogical framework which integrates *social, technical* and *cognitive* dimensions of *knowledge construction* in the development of an effective blended learning environment.
- A new approach to blended learning through the integration of both *mediational* and *instrumental* use of digital media under the same operational model.

The practical development of the proposed blended learning approach have been (i) founded on the theoretical principles of social (Spady, 2001) and cognitive construction of knowledge (Forman & Cazden, 1985); and (ii) formulated to aid the development of both *autonomous* and *distributed* cognitions in learners (Kocaturk et al., 2012). One of the motivations and rationale behind the formulation of this research is closely related to the recent changes and emerging themes in the professional and educational context of Architecture discipline which calls for a re-orientation of the design curriculum, new methods of delivery and pedagogical agendas (Allen, 2012) as described in the following section. The paper will then present the theoretical grounding of the proposed approach, formulation of the main research questions, followed by a detailed report on the development, implementation and analysis of the proposed blended learning environment.

EMERGING PEDAGOGICAL AND COGNITIVE CHALLENGES IN ARCHITECTURAL EDUCATION

When we look back over the past two decades of architectural education, we distinguish three distinct, yet interconnected, tendencies that have emerged and currently challenging the conventional norms and practices of architectural education. The first is a newly formed link between education and profession through social, technological and intellectual networks among (design) tool builders, practices and academy. Through various workshops, real design scenarios are collectively developed, modelled, computed, simulated and fabricated, opening paths to new agendas as well as experimenting with new ideas, theories, methods and techniques of educating the new digital designer. The second is the emerging modes of informal learning through online social media which is already becoming an integral part of student experience in higher education. Many online platforms and blogs provide online training and open-source design scripts, 3D models and other forms of information accessible by a global network of designers. These highly fragmented modes of informal web-based knowledge acquisition and sharing provide powerful inputs to knowledge/skill building, but the process is highly learner centric and driven by the needs and aspirations of the individual

learner(s). This contradicts with the existing top-down and controlled course structures of the formal architectural education with pre-defined learning outcomes. One of the main challenges today is, for students, to make sense of the highly complex, contradictory and very contextual knowledge they encounter without relevant frames of reference, and for the educator, to balance the freedom/ autonomy of individual learner with the critical interpretation of the captured information (Siemens, 2004). The third is the expansion of the profession's knowledge-base. An increasing emphasis is placed on architecture's instrumentality and ability to confront actual problems and integration of digital design media and multi-disciplinary values into the design education (Kocaturk et al., 2012). This has led to a diversity of skill sets and pluralist tendencies. Today, there is not a single dominating design direction or agenda, but a series of diverse intellectual agendas and points of views. This pluralism is contributed by the intrinsic methodologies implicitly embedded in the commercially available "digital design tools". A student working with various design media, such as Rhinoceros, Grasshopper, Generative Components, Autodesk Revit or Digital Project develop both complimentary and at times contradictory approaches to design tasks and become exposed to highly contextual, technology-bound and situated perceptions of the problems. The influence of tools on the way we think and design has never been of this magnitude and variety.

Both *instrumental* and *mediational* use of information technology in design education have led to the emergence of a highly 'tool-aided', 'socially shared' and 'situated' form of cognition commonly referred to in literature by developmental psychologists and learning theorists as "distributed cognition" (Hutchins et al., 1986) or "distributed intelligence" (Pea, 1993). The central idea in both theories is that the resources that shape and enable activity are distributed in configuration across people, environments, situations and artefacts (tools). In pointing out the mind-environment interface (Simon, 1996) in his seminal work: The Sciences of the Artificial, Simon questions whether what we often consider the complexity of some act of thought may have more to do with the complexity of the environment in which action takes place than the intrinsic mental complexity of the activity. He then suggests looking at problem solving as distributed between mind and the mediational structures that the world offers. This is a very distinct departure from earlier models and approaches to "design cognition" which has traditionally been perceived as residing in the head of the designers and traditional architectural education has commonly geared towards the development of individual (or autonomous) cognition. One of the main pedagogical dilemmas today can be grounded on the gap between *distributed* and *autonomous* dimensions of cognition that students are building, simultaneously, through various modes of knowledge acquisition without any explicit recipes of how to build the link between the two. This observation resonates with Salomon's description of the 2 distinct impact of technologies on individual cognition (Salomon, 1993):

- *Effects with* - intellectual partnership with technology through direct contact with digital media (Distributed Cognition)

- *Effects of* - transferrable cognitive impact that the aforementioned partnership leaves behind in the form of better mastery of skills and strategies; also referred as "meta-cognition" (Perkins, 1993) which not only informs the construction of an understanding of content-level knowledge (of the discipline), but also provides conscious use and development of skills.

An effective blended learning approach in architectural studio education should take into consideration both of the aforementioned impacts of technology on learning. This would imply that the added value of a blended learning approach in the design studio would not only be the development of essential skills to work with diverse design and communication technologies but also equipping the learner with an awareness and understanding of his/her own thought processes.

RESEARCH QUESTIONS AND CONTEXT

The aforementioned discussions provided the main theoretical and methodological grounding for the formulation of the following research questions with the aim of drawing conclusions that are of generic relevance to architecture educators.

- How can *mediational/instrumental* use of digital media and face-to-face interaction effectively be integrated in a studio context in support of collective "*knowledge construction*" and "*skill building*" that would not have been possible in a traditional studio approach?
- How to utilize this blended learning approach with the necessary social, technical and cognitive scaffolding to support the three crucial and highly complementary dimensions of learning (and cognition), *individual, collaborative and guided,* under the same pedagogical framework?

Implementations of blended learning in traditional design studios, through the integration of various *mediational* media are already common practice. In order to explore the integration of *meditational* and *instrumental* use of digital media under the same pedagogical framework, the research has been specifically set up in the context of a *digital design studio* where students were expected to embed various digital design and simulation media into the actual design process from conception through to physical production of their solutions/creations. The digital design studio was a semester long, campus based masters level design studio module with the following learning outcomes:

- Demonstrate a novel understanding of parametric and computational design thinking in an architectural design project.

- Demonstrate a critical understanding of how to select and apply appropriate design strategies and techniques to generate, represent and communicate innovative architectural design solutions.
- Critically appraise the limitations and opportunities in embedding generative design thinking in response to spatial, social, environmental and material investigations in Architecture.

The studio comprised of 30 students coming from diverse educational backgrounds relevant to the AEC (Architecture, Engineering and Construction) sector, primarily from Architecture, Building Surveying, Architectural Technology, Product Design and Civil Engineering backgrounds. One of the challenges we faced throughout the studio was to embed a complex computational design challenge in a design studio module with very specific learning outcomes, with students who have very little or no prior knowledge or skills of computational and parametric design, with only 2 hours contact time per week.

The design brief comprised of the design and development of a temporary pavilion through an "informed" and "collaborative" design process, in response to a range of design criteria such as day-lighting, energy use, structural stability, and local climate conditions. Parametric design process had been introduced as a means (instead of an end) in identifying, selecting, optimizing, controlling and linking parameters in the design and development of a pavilion design. Students had been given the freedom to work with any design, modelling and analysis software of their own choice. The brief required students to design in teams where each team member was assigned both individual and group tasks. Each team was composed of 3 members, composed of; a Design Architect, a Manufacturing and Sustainability Consultant, and a Knowledge and Communication Manager. Each team was expected to identify and collectively formulate cross-disciplinary challenges and problems, first, and then develop creative design solutions.

In addition to the design task, the second part of the design brief focused on the task of *knowledge construction*. Knowledge construction is one of the key activities of a design-based learning environment where students build and integrate different types of design knowledge (e.g. procedural, conceptual, factual) - individually and collectively. However, students are not always conscious about their knowledge building process as it occurs naturally during the design process. By embedding "knowledge construction" as an additional task into the brief, we aimed to make students consciously aware of the knowledge they use, generate, and exchange and, thereby, we placed knowledge construction (and its representation) at the heart of our blended learning framework. This approach required a thorough exploration of not only technological but also social configurations needed to achieve the "aid" a design studio could realistically benefit from a blended learning approach. In this regard, how digital technology could aid the mediation of collaborative and individual knowledge construction (and cognition) has been central to our enquiry.

The context surrounding the process of knowledge construction aimed to interlink both autonomous (individual) and distributed (collaborative) actions spanning across technological, social and cognitive scaffolding of the studio, including both on-line and off-line learning modes. For this purpose, each group has been assigned a blank Wiki group page, hosted under the relevant module of the University's official VLE – Blackboard - platform to manage, coordinate and document their knowledge construction and communication during the entire design process. This idea largely resonates with Gerry Stahl's work (Stahl, 2006) where computers and software technology had been explored according to the extent to which they support collaborative knowledge building for the development of shared understandings and new meanings. New knowledge and strategies gained through peer collaboration and by interpersonal discourse could then be documented through these Wiki sites, composed of both individual and team input, and shared by peers and tutors. Students have been required to "exploit" a wide range of and the most suitable representational modalities to assemble their Wiki sites. Team members were not only required to collaborate for the design of the pavilion, but also for the production, selection, preparation and curation of the relevant knowledge content they generated for their Wikis.

The teams had also embedded a "conversation page" into their Wiki sites where online communication of team members with tutors and each other could be recorded in support of the knowledge construction task (in addition to face-to-face interaction). At key times during the semester, teams were asked to share their Wikis across all teams where the entire studio could communicate online, share design ideas and provide peer feedback.

It is important to note that setting the research within the context of an existing studio module had posed a number of constraints in data collection and analysis. Firstly, the module had pre-defined learning outcomes which could not be altered. This meant that the research objectives had to be carefully aligned with the objectives of the brief. In order to do that we introduced two separate – yet interlinked – tasks into the design brief (one linked to the learning outcomes and the other linked to the research objectives). However, the additional task (knowledge construction) brought forth an additional workload for the students and therefore could not be introduced as an assessable component of the module. Although all teams were involved in the knowledge construction task, only half of the students volunteered for the interviews. The second constraint was with regards to the choice of the Wiki platform for knowledge construction which had to be the official VLE (virtual learning environment) of the University (Blackboard). Therefore the research set-up and the findings were somewhat influenced by the capabilities and shortcomings of this platform. Although we allowed students to use external web environments as and when needed; the links to these environments had to be created within the official University-based Wiki platforms.

METHODOLOGY

The study adopted an ethnographic approach which focused on gathering data on student and staff perceptions. Ethnographic based research encompasses participant observation, interviews, literature analysis and information gathering. It can be summarized as "the study of people in naturally occurring settings", and "involving the researcher participating directly in the setting", "in order to collect data", without meaning being imposed externally (Brewer, 2000). An ethnographic approach is most relevant when the study is carried out in situ and where the researcher takes a first hand view of phenomenon under investigation. It differs from similar types of qualitative study by its purpose to study people in their natural environments (Joel et al., 2005). Although data collection and analysis were predominantly qualitative in nature, we also referred to quantitative data analysis methods. This mixed approach has proved to be rather useful in our attempt to draw meaningful results from a large body of qualitative data with complex nature of inter-relationships between different factors. For example, the correlation between the frequency of cross-team interactions and the quality of the (design) content could have been effectively revealed through collection and cross-analysis of both quantitative (e.g. frequency of interaction captured by the Wiki platform) and qualitative data (e.g. student interviews and tutor perceptions). As a result of the different methods of data collection, data had been visualized and categorized in different ways which helped to identify the numerous factors that might have had a bearing on those components of the qualitative information that could not be easily interpreted.

Main data collection comprised of two sets of individual and group interviews and personal observations to gather different kinds of data. Data sources included field notes, audio recordings (of interviews) and Wikis (and the constituent sites) developed by students and data records obtained through the Blackboard system. A total of 5 hours of recordings were produced with 40 sheets of notes and 10 wiki sites. The interviews were transcribed verbatim, data-coded and analysed using comparative procedures where every response in the field notes and transcripts were labelled with terms that best captured what the main idea and concept was about. The wiki sites which were built by the students had also been comparatively analysed with respect to the utilization of various representational modalities in knowledge construction.

Two sets of semi-structured interviews were conducted at two separate times (mid-semester, and end-semester) with a random selection of 15 students for each interview. Students took part in the interviews on a voluntary basis. All signed ethical consent forms before each interview in compliance with the guidelines of the University of Liverpool and the British Educational Researchers Association (BERA, 2011) with respect to anonymity. Students had been interviewed both individually and with their team members (in groups of 3) to identify

patterns in data whilst enabling the collation of material on different views, motives, reasons and explanations. Semi-structured interviews were preferred over questionnaires with pre-defined questions for the following reasons, specific to the context of the study.

1) since this was an exploratory research, novel and unexpected emergent issues could also contribute to the data analysis and interpretation,
2) the students were from different nationalities (e.g. British, Indian, Ethiopian and Chinese) which required frequent clarifications of terms and rephrasing the questions - in some occasions several times - in order to convey the intended meanings correctly,
3) students' different understanding and interpretations of terms, such as "design process", "tools" or "models", due to their varying educational/disciplinary backgrounds and levels of experience, required additional clarifications of terms and concepts.

Every interview comprised of 3 stages: the explanation of the research project (aim and objectives), the signature of the ethical consent form and the interview which was digitally recorded using a laptop and a voice recording application. Interviews were conducted by one of the research assistants of the project who was not part of the tutoring team in the studio, to ensure student anonymity. The interviews focused on collating information on (i) students' background and motivations, (ii) their previous knowledge and skills in use of digital design and social media, and (iii) their reflection on own learning specifically focusing on individual, collaborative and guided learning experience – in line with the project objectives. Students were asked about their perceptions of the opportunity afforded by the on-line components of the blended learning, and also for their perceived level of engagement.

DISCUSSION OF FINDINGS

The primary modes of use of the Wikis sites were twofold: (i) creating content, and (ii) communication; which had been regarded as the main activities leading to knowledge construction. We monitored both modes of use on a regular basis to have an overview of the frequency of use, quality of the content uploaded, as well as team and cross-team interactions. Additionally, we captured the day and time of every comment made in the Wiki sites for the duration of Semester 1 (Figure 1).

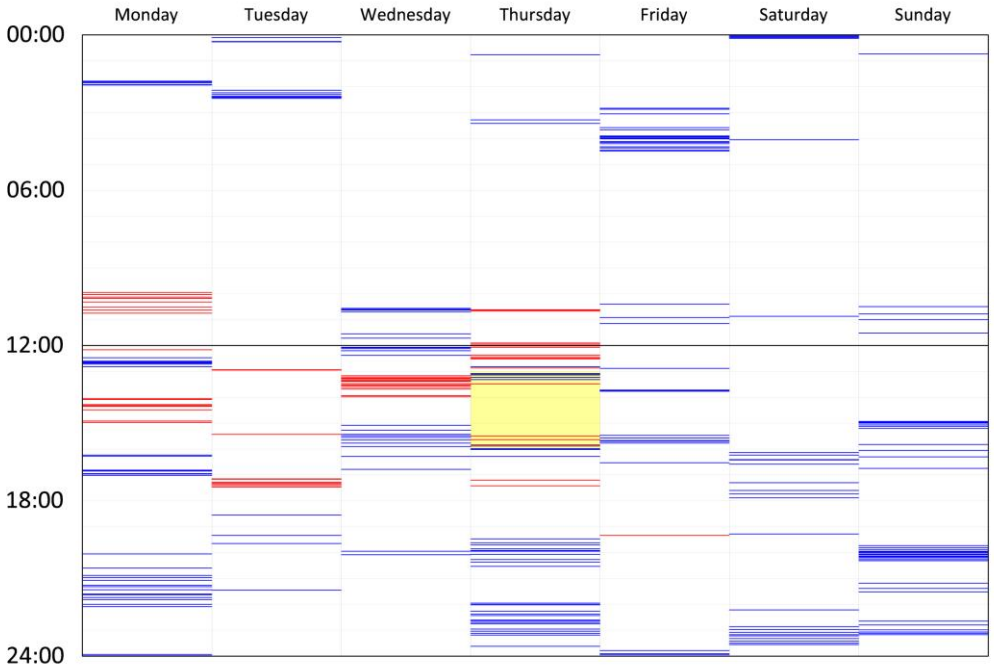

Figure 1 Distribution of comments made throughout the semester over a weekly calendar. Blue lines indicate student comments, red lines indicate tutor comments, and yellow highlight indicates the formal teaching hours

Figure 1 provides evidence of almost constant use of Wikis outside formal teaching hours throughout the semester. Clusters of comments can be identified as evidence of students' visits to various Wiki sites during a single visit. There is also clear evidence that tutors' comments are predominantly kept within working hours, although spread across different days of the week (outside teaching hours). According to the interviews, students outlined the main benefits of the Wikis as (i) communication with tutors outside working hours; (ii) organizing and recording their own work; (iii) reflecting back on their design process (iv) having access to other students' work and thinking; (v) communicating with peers and learning from them.

Cognitive Aid to Learning Through Multi-Modal Representations

Due to the richness of representations used, the Wikis in this particular project, can be regarded as a "learning portfolio" rather than a "reflective journal" (Roberts, 2013). While students made use of a very rich variety of representational modes, techniques and assemblies, different media were carefully chosen to convey the intended messages through the right content; including texts, 3D visualisations, sketches, diagrams, mind maps, animations among others. Additionally, some groups were able to embed videos using

external sites such as YouTube and provide hyperlinks to external presentations (e.g. Prezi). Texts and images were mainly used as descriptive and reflective resources or to transcribe group communications and meetings. However, Wiki sites also entailed prescriptive information, such as the use of a design software for modelling purposes. The below figure is a compilation of snapshots from different Wiki sites illustrating the richness of representational modalities used by different teams (Figure 2). Additional media resources (presentations and videos) were hosted outside the wikis but were embedded into the wikis through hyperlinks.

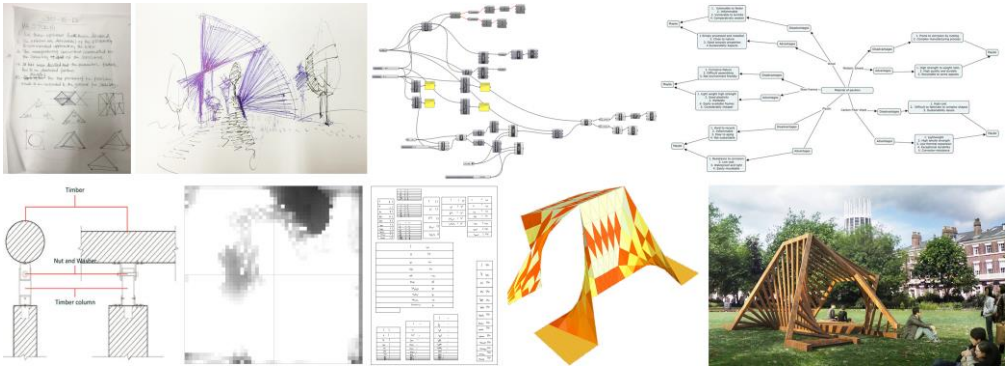

Figure 2: Different representations uploaded to the Wiki sites by students. From left to right and top to bottom: Notes from a group meeting (Group 10), handmade sketches (Group 10), Grasshopper modelling sequence (Group 10), mind-map (Group 5), building detail (Group 9), radiation map (Group 2), laser cutting patterns (Group 7), solar lighting analysis (Group 10) and realistic render (Group 10).

It is important to note that Wikis did not comprise of single or standalone representations of design ideas, but instead, they were intended to act as intelligently structured interactive platforms. Therefore, students were specifically instructed about the rationale behind constructing their Wikis where information/knowledge they gathered during the semester could be clearly linked to the evolution of their design ideas and solutions, with an easy-to-follow navigational path. And to this end, a rich variety of representational tools and media have been explored and utilized to assemble the sites.

Wikis acted as the primary *mediational platform* wherein students compiled and recorded various design ideas, information, insights and solutions that have been created either individually or as a team. In this process, students used a variety of digital media for generating and modelling the knowledge content. An analysis of the interview records indicates that there were clear differences in the way digital tools had been utilized, and which had been highly influenced by the students' personal experiences and backgrounds. For example, one mature student, with no formal training on digital design tools, was used to working with intranets to share files across different people in his practice. This past

experience helped him use and organize the Wiki pages much more effectively for recording and sharing design information. On the other hand, students with no collaborative working experience focused more on exchanging files through social media (such as QQ - a chinese social networking site similar to Skype) without much consideration to the semantics embedded in the files. In support of group interaction, social media was mostly used to chat (in real time) and to exchange files (both features not provided by Wikis). One group attempted to use Wikis as a real-time and synchronous communication platform however the lack of instant notifications makes Wikis unsuitable for this purpose. Other shortages of the Wikis were reported as lack of (i) real-time chat and (ii) instant file sharing functions. Therefore, Wikis could only aid the asynchronous modes of design communication, yet synchronous communication was sustained through social and other online media. The following diagram summarises the use of the following modelling/representational and communication tools by the students (Figure 3).

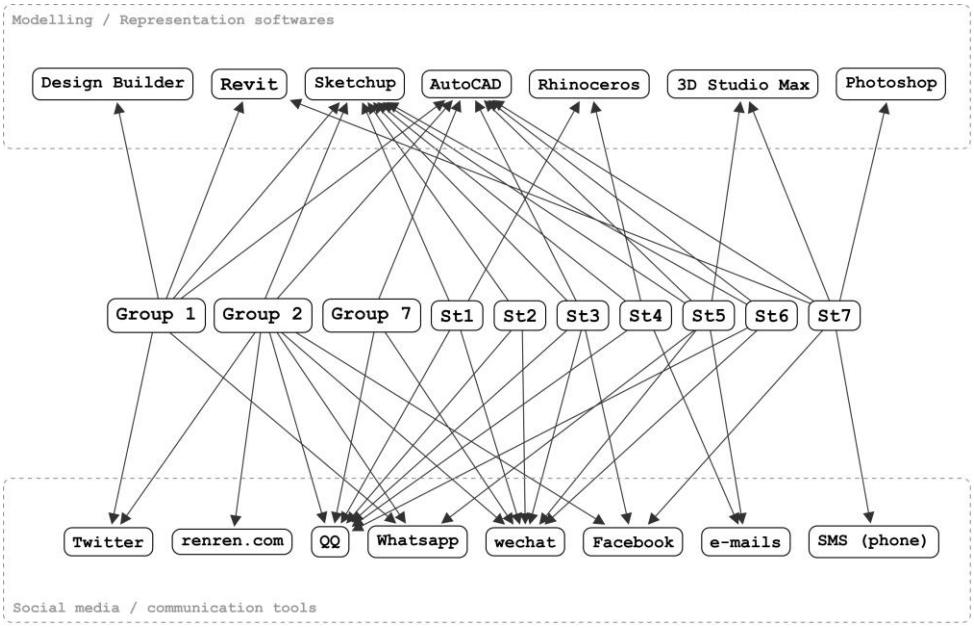

Figure 3 Use of different meditational and instrumental media during the semester

The versatility with which students made use of available media was aligned with the well-established studio tradition where different modes of representations are produced and presented (Iordanova & Tidafi, 2007). However the main added value obtained through the construction of Wiki sites was exposing students to a rich repertoire of representational modalities as a vehicle to convey the intended meaning to the intended audience (e.g. peers, instructor, team members) for a specific purpose.

In digital design studios, students spend considerable time in developing software skills in parallel to the design task. In order to remedy this, the tutors have created a dedicated space within the Blackboard environment where students could access to a selection of highly relevant video tutorials of the most preferred design/modelling software. Students were

expected to follow these tutorials in their own learning time but were given guidance in terms of the order with which they should follow these tutorials in line with the progression of their parametric design process. An anonymously shared view among students was that the most effective way to build their software skills was to share experiences with their peers through the Wiki sites. Indeed, Wiki pages with the highest number of comments and replies were those dedicated to strategic and operational use of the design and modelling software (e.g. Rhino/Grasshopper) in converting specific design ideas into 3D parametric models.

Collaborative Learning Versus Individual Learning

While collaborative work is considered a fundamental skill in contemporary higher education and particularly in architectural design, its use blurs the boundaries between individual and collaborative work, making individual contributions difficult to identify and assess (Trentin, 2009). Web-based tools can support this issue by facilitating the monitoring work, and sets of variables have been developed for monitoring collaborative and individual work such as "levels of learning" (Trentin, 2009) or quantitative estimations of both individual and group activities (Simoff & Maher, 2000). In our research, interview questions related to the estimation of individual and group work were mapped to students' roles in the team and the team dynamics. These questions were repeated both in group and individual interviews to identify potential discrepancies in student perceptions. Students perceived that their work for studio purposes entailed, on average, 16.7 hrs per week ranging from 5 up to 50 hrs across the interviewees. An interesting variable was, however, how much of this work was dedicated to collaborative work versus individual work. Students reported that a majority of the time dedicated to the studio work was spent on collaborative work, whereas an average of only 6.8 hrs a week was reported to be spent on individual work (which also includes software training time). The individual work in the design studio focused on the delivery of the tasks defined by the roles each student played in their teams. However, each role required different tasks which varied in terms of the time they consumed. Team work focused more on collective decision making on various matters. A more detailed, case-by-case analysis is required to set relationships across variables, however some initial observations suggests that there were obvious correlations between how the different roles in teams were adhered to and managed, as well as individual and team performances. Teams that did not clearly distinguish tasks associated with each role and tended to mix tasks on a "everybody-does-everything" basis had difficulty in progressing their projects and the designs. Conversely, groups with clearly defined roles – e.g. the knowledge manager responsible for updating the Wiki sites, or Design Architect spends more time on parametric modelling - seemed to work more efficiently. Although students themselves volunteered to take on their preferred role, in most cases their learning motivation went beyond their role description and led to conflicting perceptions of the time allocated for their team responsibilities and personal (individual) development.

The integration of formal and informal learning modes in a blended learning environment contributes significantly to the "self-directed" hours of design learning. However, the

perception of this additional workload varies significantly across students, especially in terms of the distribution of workload between individual and collaborative work, as indicated in Figure 4 below.

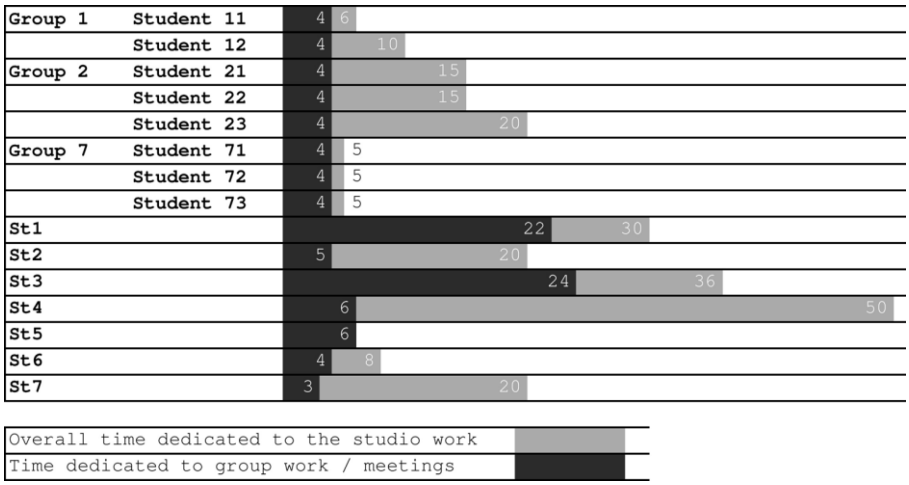

Figure 4 Variances in student's perceptions of their studio related workload

The graph is built upon students' perceptions of studio-related workload, expressed as hours per week. An interesting observation is the changing perceptions of individual and collaborative workload of the students within the same group. For instance, St1 and St2 worked in the same group, yet their workload perceptions vary more than 10 hrs per week and moreover, the collaborative work indicated by St1 is greater than the overall studio workload indicated by student St2. The most anomalous case is that of St4 and St5 who also worked within the same group. A possible explanation for this might be that St4 had the role of the "Design Architect" and spent a substantial amount of time, since the beginning of the semester, on software training which he also counts towards group work. However, St5 worked as the "engineering and manufacturing consultant" and did not prefer to spend any additional time on software training nor did he perceive his individual work differently than the collaborative work of his team. This is a typical example of a commonly observed phenomenon about blended learning, due to embedding new media environments into learning experience, which require students to apply higher levels of personal motivation and autonomy through high levels of student-led activity and as such are not suited to all students (Lane et al., 2015).

Tutors As Curators of The Individual And Collaborative Learning

The role of studio tutors focused predominantly on providing guidance on the conceptual organization of students' learning experience (Glaserfeld, 1983) through both face-to-face and online modes of blended learning. The first two weeks were front-loaded with face-to-face

seminars where all students were engaged in highly interactive discussions on the subject matter to form the foundational intellectual basis that was deemed minimum to build before they got engaged in any tool-driven design activity. Students were also encouraged to follow the online video tutorials for the essential modelling software at the pace and order suggested by the tutors. Wiki sites have been introduced and knowledge construction model was explained together with the design brief. The central aspect of tutor guidance was to support students' design knowledge construction and, to that end, create the necessary physical and online spaces where students could build, explore, and connect different knowledge elements and skill sets. The guidance provided to individuals and different groups varied according to specific requirements.

Referring to the taxonomy of (Blignaut & Trollip, 2003), the online guidance provided by tutors consisted of the following modes as described and exemplified with actual comments left by tutors on Wikis, in Table 1.

CATEGORY	**Posts by Tutors on the Wiki Communication pages**
Affective	*"… I think your group communication through this Wiki site is one of the best in the class. And [Student] is doing a great job stimulating the group to be more active on the Wiki…."*
Corrective	*"… could be done as a lofted surface... you may use the script i gave you last week for grasshopper" (referred to the 3D modelling of a design alternative, suggesting to modify the modelling technique).*
Informative	*"… the Grasshopper model still seems to be trying to copy the Rhino model. The contribution of the "parametric design process" to the evolution of the design is not very clear. The parametric model does not seem to be driving the process. Have you already tried to update your parametric model in respond to the feedback you received at the interim?"*
Socratic	*"… there is still lack of clarity about how the structure is actually going to work. The issues about ergonomy, and health/safety regarding the walking path in the pavillion are not fully resolved. However, the unique process you've followed from the very beginning is really interesting - the formation of the space and then subtracting it from the overall form to achieve the final form."*

Table 1 Modes of online guidance provided by the tutors

As previously mentioned in Figure 1, tutors interacted with the students outside formal teaching hours through the Wiki sites, which mostly entailed:

- Technical comments related to the operational use of certain design tools,
- Feedback and comments on the design product, process and representations,
- Requests for new uploads and content updates.

The use of Wikis varied over the course of the semester. Teams were given the control to adjust privacy settings to control the accessibility to their Wikis at certain times of the

semester (by fellow students). Such temporal dynamics was also guided by tutors to follow the natural sequence of the design process.

CONCLUSIONS

This educational research project reinforces two fundamental points. The first is the view that design knowledge is both a social and a cognitive construct. The second is that information technologies and design tools act as *cognitive tools* and influence the way people learn, share information, and construct knowledge (Kolbitsch & Maurer, 2006).

Setting the research within the context of an existing studio module posed a number of constraints which affected the research design and findings to a certain degree. Firstly, the pre-defined learning outcomes of the studio module could not be altered. In order to align the research objectives with the objectives of the brief, two separate – yet interlinked – tasks had been introduced into the design brief. However, the additional task (knowledge construction) brought about an additional workload for the students and therefore could not be introduced as an assessable component of the module. Although all teams were involved in the knowledge construction process, only 15 students volunteered for the interviews. The second constraint was with regards to the choice of the Wiki platform for knowledge construction. For ease of monitoring of student activity, and in order to adhere to the University regulations, the Wiki component of the official VLE of the University (Blackboard) had been adopted. Therefore the research set-up and findings were influenced by the capabilities and shortcomings of Wikis although some students created links to external web-environments which proved to have more representational capabilities in knowledge construction. In order to improve the conditions imposed by these two constraints, in the future, it will be useful to allow students to choose their preferred web-platform for knowledge construction and implement this in a studio setting where this additional task is also introduced as an assessable component of the module. This would help increase the student response, and increase the number of data to be used for the analysis.

As our findings suggest, blended learning does not merely imply adding information technology into an existing design studio practice but it changes and challenges some of the fundamental assumptions and practices of the traditional design studio. For instance, the construction of Wiki sites facilitated a deeper understanding of the crucial link between "design representation" and "knowledge representation" which introduced a radical shift of emphasis from a *product oriented* to a *process oriented* approach in design learning. Our pedagogical framework in support of the proposed blended learning model placed "knowledge construction" at the centre of the design studio (Figure 5) which proved to deliver an effective social, technical and cognitive scaffolding in support of the highly complementary dimensions of *individual learning*, *skill building* and *collective knowledge*

construction of the students in the design studio. This aspect helped bring to the foreground other types of knowledge (other than product knowledge) that are usually disregarded or left unnoticed in design education, namely; *procedural, declarative, domain specific, conceptual, structural,* etc. Through knowledge construction and representations, students became much more aware of the different types and qualities of knowledge they produced in relation to the different tasks associated with different phases of the design process.

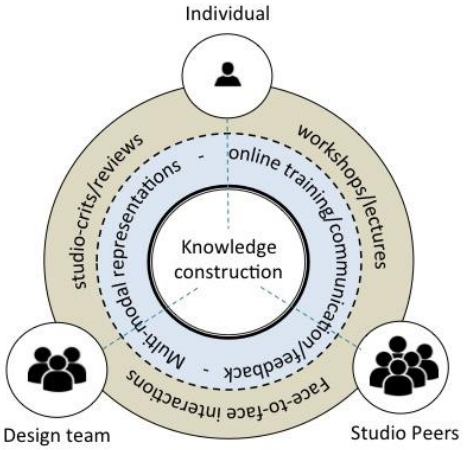

Figure 5 Pedagogical Framework which places individual and collective knowledge Construction at the centre of the learning process

One of the challenges tutors faced in the studio was to balance the reciprocal interplay between the development of both *autonomous* and *distributed* cognitions. This was closely related to the interplay of externalization and internalization processes associated with the process of knowledge construction and also raised a methodical question about how to distinguish variance that is due to individual learner and variance due to tutoring approach.

In summary, the main innovation introduced by the proposed pedagogical framework for blended learning in a design studio are three-fold:

- provides effective cognitive support to design learning through shared knowledge construction and representation among peers,
- integrates the different dimensions of collaborative and individual learning under the same pedagogical framework,
- provides effective support to design studio-tutors in curating students' learning experiences more effectively.

Evidently, what our study shows is that embedding new media and socio-technical environments into learning experience required students to apply higher levels of personal

motivation and autonomy through greater levels of student-led activity. An analysis of the interview records indicated that the way online media was utilized towards learning and skill building varied greatly among teams. Consequently, the benefits of the blended learning in the studio were experienced and exploited differently by each team. Various factors contributing to this variety had been identified, such as previous experience in teamwork, familiarity with digital media, personal motivation, and educational background. This variance had been observed to be strongly correlated to the discrepancies between students' perceptions of their workload even within the same team. This finding suggests that future work, in similar settings, should consist of variables that address both "expectations" and "perceptions" of students simultaneously.

In the short term, the research outputs are expected to accelerate the development of new online and blended learning strategies for the design studio teaching/learning. In the mid to long term, the proposed approach, especially with regards to the integration of *mediational* and *instrumental* dimensions of information technologies under the same operational model is anticipated to have a high impact potential. Currently, technologies that are used to "create content" in design disciplines are completely disconnected from the technologies which "mediate content". Although attempts have been made over the years by some of the CAD (computer aided design) software developers through the addition of communication features (e.g. file versioning, commenting function) into the software platform, for the most part, these attempts had minimal degrees of success, and certainly not in any substantial form which could be used as part of the pedagogical framework developed by this research.

The theoretical and practical model developed through this research was based on the integration of these 2 different groups of technologies under the same learning framework. A more impactful implementation of this model would be through the development of technologies that are intrinsically based on this integrative model. This would potentially lead to the design of mediational platforms with features aligned and interoperable with various design media which are used to create design content (3D models, 2D drawings, structural analysis, urban models, sketches, design scripts, etc.) This could, in turn, provide a basis for the next generation learning environments and next generation training technologies which can effectively respond to the learning challenges that are specific to the knowledge content and its means of creation.

Acknowledgements

The research outlined in this paper was financially supported by the UK Higher Education Academy. The author would like to thank the co-tutor of the studio module Asterios Agkathidis for the helpful discussions, and Mohammad Qabshoqa & Dr. Alejandro Veliz for their insightful support throughout this educational research.

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Journal of Problem Based Learning in Higher Education

VOL. 5, NO. 1, 2017 – Page 22-46
http://dx.doi.org/10.5278/ojs.jpblhe.v5i1.1562

The Hybrid Studio - Introducing Google+ as a Blended Learning Platform for Architectural Design Studio Teaching

*Nicolai Steinø and Md. Saufuddin Khalid **

ABSTRACT

Much architecture and design teaching is based on the studio format, where the co-presence in time and space of students, instructors and physical learning artefacts form a triangle from which the learning emerges. Yet with the advent of online communication platforms and learning management systems (LMS), there is reason to study how these technologies may enhance this well-established learning format and transform it into a blended learning format.

In this paper, the introduction of an online communication platform – Google+ – as a supplement to an administrative LMS – Moodle – in a four month BSc level urban design studio course is evaluated and discussed with regard to its capacity to facilitate blended learning as a transforming blend. The online platform was used for general instructor/student communication, for student/student communication, as well as for sharing of student work in progress. It also worked as a one-on-one supervision platform for whenever students were in need of supervision and advice outside class hours.

Methodologically, a phenomenographic approach was adopted in a single-case study in the form of a student workshop using an adapted problem-tree analysis method as a participatory learning and action method, in order to understand the students' experiences and evaluation of blended learning systems and contexts.

The paper gives an introduction to the traditional architecture and design studio teaching format, to blended learning, as well as to the preparation and setup of the studied blended learning course. The implementation of Google+ into the studio course was experimental and ran alongside the administrative Moodle platform which was used in parallel.

The positive and negative aspects of both platforms were evaluated by the students. While they were mostly critical of Moodle, they valued the functionality of Google+ from several

* Nicolai Steinø, Assoc. Professor, Department of Architecture, Design, and Media Technology, Aalborg University. Email: steino@create.aau.dk
Md. Saifuddin Khalid, Assoc. Professor, Department of Learning and Philosophy, Aalborg University. Email: khalid@learning.aau.dk

perspectives, although they also made critical remarks. While the experiment was not entirely successful, it seems to suggest that transforming blends, if well implemented, may offer a pedagogical enhancement to architecture and design studio teaching.

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INTRODUCTION

Studio teaching in architecture and design is traditionally based on the presence of both instructors and material learning artefacts. Instructors typically give supervision to students one-on-one at their drawing tables. Students, in turn, work with tangible material such as pens and tracing paper, and scale model material such as cardboard and styrofoam. From this triangle of students, instructors and learning artefacts, the learning emerges. As such, the physical presence of people and stuff is a fundamental premise of the traditional studio learning format.

As the object of study in architecture and design is physical – the designed artefacts in the form of objects and buildings – a certain hesitation seems to reside in architecture and design education towards new mediated forms of learning. But while completely mediated forms of learning such as MOOCs may not be a feasible replacement for the traditional architecture and design studio, forms of blended learning, combining physical and online learning has the potential to make the best of both worlds, enriching studio learning without losing its indisputable merits in architecture and design education.

Blended learning (BL) has become an essential pedagogical approach in higher education due to the adoption and integration of learning management systems (for example, Moodle, Blackboard, etc.) and other web 2.0 platforms (for example, Google+). "Blended learning systems combine face-to-face instruction with computer-mediated instruction." (Bonk, Graham 2012). Among many definitions of blended learning, Bonk and Graham (ibid.) reviewed and reported three most commonly mentioned definitions: (1) combining instructional modalities (or delivery media), (2) combining instructional methods, and (3) combining online and face-to-face instruction. In the online spaces, the communication and learning activities that occur among the teacher(s), students, and online learning objects are expected to contribute in achieving the teaching and learning goals.

Architectural design education emphasizes on gaining cultural, social, technical and technological aspects alongside studio teaching (Afacan 2015). "Since design pedagogy is project-oriented, studio assignments play a key role in architectural design education" (Chen, Heylighen 2012). Typically, studio projects include studying and working on "architectural space and form, using of appropriate materials and construction techniques and presenting of drawings and 3D models" (Afacan 2015, p. 2). The experiences of architectural design studio

students in the process of blending such online learning components has remained understudied.

Six reasons behind choosing a blended learning system are: (1) pedagogical richness, (2) access to knowledge, (3) social interaction, (4) personal agency, (5) cost-effectiveness, and (6) ease of revision (Osguthorpe and Graham cited in Bonk, Graham 2012). "Overwhelmingly, people chose BL for three reasons: (1) improved pedagogy, (2) increased access and flexibility, and (3) increased cost-effectiveness" (Bonk, Graham 2012, p. 5). In this study, the course instructor intended to improve the pedagogy, and increase access and flexibility of the studio course in a Danish context.

The case of this study is the Spring 2016 4th semester bachelor (BSc4) urban design studio course (15 ECTS) of the architecture and design programme at Aalborg University (AAU), Denmark. The study explores how the students of this architecture and design studio course perceived benefits and challenges in the process of adopting and integrating Google+, with the existing university-facilitated learning management system Moodle. Applying participatory and mixed research methods, this study addresses the following two research questions:

- What is the problem with the existing Moodle-supported studio at AAU? What are the causes and effects of the problem associated with Moodle-mediated studio courses?
- What are the students' perceived problems, benefits and expectations with regard to achieving a more interactive learning experience by blending Google+ in studio project courses?

THE TRADITIONAL STUDIO

Architecture and design are making disciplines and thus fundamentally based on creative processes. Architecture and design essentially deal with configurations of physical form and space for the purpose of fulfilling criteria for use, construction and aesthetics. Hence, architecture and design education is focused on the creative processes of form-making. Teaching programmes in architecture and design have traditionally been oriented towards studio teaching and project based learning. As it has been beautifully demonstrated in the documentary film Archiculture (Krantz, Harris 2013), teaching programmes in architecture and design are traditionally oriented towards studio teaching and project based learning (Parsons 2007, Yürekli 2007), in, as contended by Turkienicz & Westphal (2012), a problem-solving format:

"Hands-on learning is generally thought of as the default path to follow through design school. It is thought to be epitomized in the design studio where design is exercised through solving

design problems of varying complexity. Design is generally learnt through practice because it simultaneously involves making, seeing (often with the whole body), reflecting, and forming habits."
– (Steinø, Özkar 2012)

Originating in the beaux-arts tradition, there is a focus on learning by doing (Dewey 1966), and the predominant mode of instruction is one-on-one studio supervision, where supervisors discuss project ideas with students. As Schön explains (1983), learning in this process emerges as the result of reflection in action.

Figure 1: The traditional architecture and design studio. Middle East Technical University, Faculty of Architecture. Photo: Nicolai Steinø

In addition to this, the 'critique' – or crit – where professors and optionally invited guest critics (practitioners and/or academics) give their opinion and their comments on the students' work in progress, plays a major role in the traditional architecture and design studio learning format (Krantz, Harris 2013).

Therefore, architecture and design is created and communicated, not (primarily) through text and numbers, but through visual representations in the form of drawings, scale models and prototypes. These artifacts are traditionally physical – graphite and ink on paper, and objects made from wood, cardboard, plaster and other materials – and therefore tangible. With the advent of computer-aided design (CAD), immaterial artefacts in the form of digital images, movies and models have been added to this list.

In extension, peer learning through sharing of visual material and work in progress (sketches) is central to the studio learning format. Learning from precedents (Potamianos 2012) or past examples of "good architecture" (Chen, Heylighen 2012) plays an important role in building a design vocabulary. Traditionally, displaying sketches, physical working models and reference material has been an important part of studio culture.

Figure 2: The architecture and design crit. Aalborg University, Architecture and Design. Photo: Nicolai Steinø

BLENDED LEARNING

"The capacity of online learning makes it possible to interact with learning assets (texts, videos, etc.) without having to go to the physical location of the library at whatever opening hours it may have. Likewise, it also makes it possible to interact with peers and instructors without being physically present at the same location at the same time. In addition, online learning systems make it possible to share work in progress, thus enabling collaborative learning and evaluation across time and space. These three qualities of online learning seem to represent the most important advantages of blended learning to traditional learning."
– (Steinø 2014).

The pros and cons of traditional and online learning have been much debated. But as several studies seem to suggest, rather than contemplating the complete substitution of online courses for campus-based courses, what may drive learning to new levels, is the combination and integration of ICT with face-to-face learning in what is generally referred to as blended

learning (Rovai, Jordan 2004, Lim, Morris & Kupritz 2007, Aspden, Helm 2004, Garrison, Kanuka 2004).

The term blended learning is used in different ways by different researchers. This leaves uncertainty about its definition (Mortera-Gutierrez 2006, Osguthorpe, Graham 2003, Oliver, Trigwell 2005). In fact, Oliver & Trigwell (2005) even make the argument that the term blended learning is redundant and unnecessary by all its definitions.

Blended learning may take on more or less radical forms. Bonk and Graham (2012), in their quest to answer "How to blend?", divide blended learning systems into three categories (see table 1). They review and identify six major issues that are related to designing blended learning systems: "(1) the role of live interaction, (2) the role of learner choice and self-regulation, (2) models for support and training, (4) finding balance between innovation and production, (5) cultural adaptation, and (6) dealing with the digital divide."

Enabling blends	Primarily focus on addressing issues of access and convenience, for example, blends that are intended to provide additional flexibility to the learners or blends that attempt to provide the same opportunities or learning experience but through a different modality.
Enhancing blends	Allow incremental changes to the pedagogy but do not radically change the way teaching and learning occurs. This can occur at both ends of the spectrum. For example, in a traditional face-to-face learning environment, additional resources and perhaps some supplementary materials may be included online.
Transforming blends	Blends that allow a radical transformation of the pedagogy, for example, a change from a model where learners are just receivers of information to a model where learners actively construct knowledge through dynamic interactions. These types of blends enable intellectual activity that was not practically possible without the technology.

Table 1: Categories of Blended Learning Systems

Source: (Bonk, Graham 2012, p. 47-49)

Enabling blends do not vary much from traditional learning formats. In fact, interaction with different media and interfaces happens in practically all learning formats (essentially, books and blackboards are media with interfaces). Hence, "what makes online learning particular is not the media (online material) or the interface (the computer screen) per se, but the fact, that

online interaction with media offers the opportunity to learn independently of time and space" (Steinø 2014).

Any blended learning software must offer affordance (Gibson 1986), i.e. it must speak of how it should be used. Human-computer interaction (HCI) is of the essence in this regard, as the online learning system may otherwise hinder rather than foster interaction and thus cause frustration (So, Brush 2008). If not, the user may be alienated as a result of not being physically co-present with peers and instructors (Rovai, Jordan 2004).

In traditional as in blended learning formats, social presence, or the psychological distance which exists among students, and between students and instructors, is important for successful learning outcomes. And establishing a sense of connectedness is particularly important in collaborative online learning (So, Brush 2008). The emotional learning climate, the sense of intimacy and immediacy, as well as the feeling of being connected and to belong, is an important indicator of the effectiveness of the learning (Wu, Tennyson & Hsia 2010).

Independent blended-learning can occur only when the media and interface usability factors are of required quality, the contents and communication options are desirable by the students, and learning objectives and students' learning goals are integrated with the real-virtual-mixed activity spaces. From a learner's perspective, Ehlers (2004) has devised a model of user preferences in e-learning to investigate the quality dimensions of instructional and technological interface design, and empirically categorized 30 dimensions of subjective quality in 7 fields of quality.

Offering satisfactory blended learning in all these quality fields and dimension is a major challenge. Furthermore, due to dearth of literature on blended studio teaching, which includes multiple activity spaces in both physical and virtual learning environments, the learners' expectations have remained unknown and understudied. Moreover, the implementation of learning and communication platforms (for example, Moodle, Google+, Facebook and Skype) bring along the issues of functionalities, personalisable functions, and privacy policies.

GOOGLE+

There are some previous examples of Google+ being integrated as a blended learning platform for higher education. "Google Plus has the potential to improve students' collaboration through circles, conduct research for projects with sparks, improve the student-instructor relationship by using this kind of social media to get in touch with each other, and support blended learning with the hang out functionality" (Erkollar, Oberer 2011, p. 569). Erkollar and Oberer (2012a) have emphasized educators' preparedness and challenges to

integrate Google+ throughout a course in higher education, and demonstrated cross-course Google+ integration (Oberer, Erkollar 2012b).

Erkollar and Oberer (2013) also reported a research design, which will compare Google+ functionalities with Blackboard by devising and applying three hypotheses in relation to collaborative (student-student, student-group) communication functionalities available in Google+, core learning activities offered and implemented through a learning management system (LMS), and student-instructor interaction in LMS versus Google+. Kang et al. (2015 p. 1444) investigated and suggested in favour of "using Google Plus as a project-based learning platform for higher education context."

There is little existing knowledge, however, on whether the integration of Google+ with LMS is meaningful in order to circumvent or alleviate the limitations of LMS as faced by educators in higher education. The same is true for the perception by students towards Google+ as a complementary (to Moodle) or alternative blended-learning platforms.

The perceived advantages and disadvantages of blended learning using Google+ by architectural design studio students could not be extracted from existing literature. Furthermore, it is assumed that the interaction between students, instructor and learning resources in architecture and design studio courses raises sets of expectations among students and instructors, which are different from those of other courses. This study, therefore, contributes to the scope of research on architecture and design students' perception towards a blended learning environment using Google+ and Moodle.

SETUP OF THE BLENDED LEARNING STUDIO COURSE

The AAU architecture and design programme takes its point of departure in the traditional architecture and design studio format, although with some variation. The general pedagogical format at AAU is the project oriented problem based learning approach (PBL/POPBL). This format is akin to the studio approach in the shared focus on projects and reviews. However, while the studio approach focuses mainly on the work of individuals, the AAU version of PBL is based on group work.

A major difference exists in the attitude towards evaluation. The traditional studio crit, based on the (unquestionable) opinion of the critic (a professor) in a kind of master-apprentice hierarchy between professors and students, is subject to increasing criticism (Turkienicz, Westphal 2012, Oxman 2001), and in line with this, the PBL review format is based on a critical approach of questions and dialogue. Still, the PBL studio project modules of the AAU architecture and design programme take their point of departure in a design challenge which the students will try to respond to through repeated cycles of design.

AAU uses Moodle as its general e-learning platform across all programmes. As explained above, studio teaching depends heavily on peer learning and sharing of visual artefacts. In addition, while the AAU architecture and design programme does not involve individual one-on-one supervision, even group supervision is under pressure from receding resources. Therefore, making efficient use of instructor time and resources is of the essence.

In its AAU implementation however, Moodle does not offer the functionality one could desire in these regards for an architecture and design studio course. In addition, the information and training resources made available to instructors at AAU with regard to the use and functionality of Moodle, as well as general support for the system, are virtually non existent. As the built-in functionality of Moodle is deeply integrated into the administrative procedures of the programme, however, it could not be entirely replaced by another system.

Therefore, in order to introduce transformation blend qualities to the course, a supplementary platform had to be found. The platform would have to offer functionality not present or not well implemented in Moodle. This involves supporting chat for questions, answers and comments, and sharing of visual material for sketches, photos of physical working models and reference material in an easy-to-use and graphically acceptable format.

The initiative was not supported by funding and the platform of choice therefore had to be free of charge – and preferably add-free. No resources were made available for technical support and it therefore also had to be easy to set up, manage and use (which is a serious constraint of Moodle), and finally, it had to be restricted (not public). After some research, Google+ was chosen, as it fulfils all of these requirements.

Once set up and introduced, students were asked to sign up for the G+ community. The community was organised into categories for tasks, messages, documents and links, submissions, discussions, as well as for each of the twelve study groups into which the students were organised. In a blog-like structure, posts could be added into each category. While instructors would post assignments and general info into the tasks and messages categories, students would post working material into their respective group categories (see figure 3), questions and into the discussion category, and partial submissions into the submissions category. Everyone would post documents and links into the documents and links category.

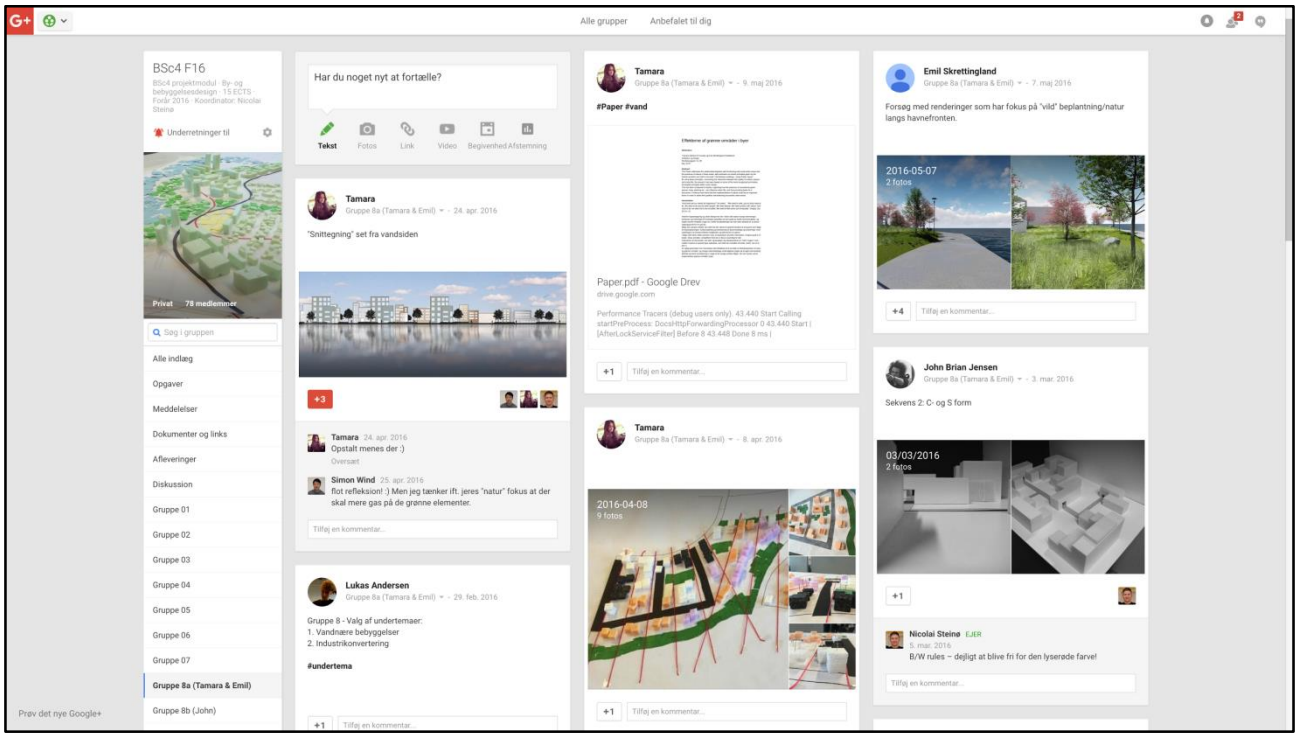

Figure 3: Screenshot of posts (section drawing (with comments), theory paper, renderings, message, and physical work model photos) in Google+ group category.

While most students seemed to quickly learn how to use the platform, there was much variation as to whether they would actually do so. During the early phases of the studio, there was some enthusiasm about sharing material, while this activity tended to level out towards the end of the studio when everyone was increasingly busy finalising their course projects. Throughout the course, asking questions to the supervisors between class hours was consistently popular. As a smartphone app for Google+ exists which makes this feature function much like sms texting, supervisors would respond quickly whenever possible.

The existing Moodle implementation may at best be characterised as an enabling blend (Bonk, Graham 2012), as it merely facilitates the access for students to learning materials, and facilitates the communication from programme administration and instructors to students. With the application of Google+ however, new forms of learning were enabled, turning the studio into a transformational blend (ibid.). Students could communicate graphically and in writing about their work in progress peer to peer. They could engage with the instructors across time and space, independently of class hours. And answers from instructors could be shared by all students, rather than just by the students asking the questions.

RESEARCH METHODOLOGY

Learners, as e-learning system users and blended-learning context participants, can be categorised into four target groups according to their quality preferences: (1) the individualist, who is content-oriented, (2) the result-oriented, who is independent and goal-oriented, (3) the pragmatic, who is need-oriented, and (4) the avant-gardist, who is interaction-oriented (Ehlers 2004). Due to these differences in expectations among students, their experiences and evaluation of blended learning systems and contexts might not be sufficiently understood through surveys and individual interviews.

In order to identify qualitative details of the complex inter-dependent satisfaction and dissatisfaction factors experienced by the students, and thus to give a qualitative answer to the research questions, this study applies methods that engage students in group discussions and does not categorize the students according to their quality preferences. Positioned within the transformative paradigm, this research therefore applies a phenomenographic approach.

The course instructor of the studio course, the first author, played an active role in integrating Google+. The transformative paradigm (TP) encourages the empowerment of the students in formulating the research problem (Akner-Koler s.d.). Inheriting the properties of the social constructivist paradigm, instead of beginning with a theory, this TP-based study "generate[s] or inductively develop[s] a theory or pattern of meanings" (Akner-Koler s.d., p. 39).

The research was designed as a single-case study (where the studio is considered as the case) with embedded units (i.e. students) (Steinø 2006). It was situated in the AAU architecture and design programme. 24 students of the Spring 2016 BSc4 architecture and urban design studio course (15 ECTS) were invited, and 14 participated, in an hour-long workshop (see table 2). An adapted problem-tree analysis (PTA) method was used as a participatory learning and action method (Khalid, Nyvang 2013).

Among the two problem-tree analyses, the first activity for the students was to establish a problem focusing on the use of Moodle in studio courses they had participated in, in order to identify the underlying causes and to identify both desirable and undesirable effects. The researchers' intention of the second PTA was to establish a problem focusing on Google+ and to identify the causes and effects, which would essentially function as an evaluation of blending Google+ in the studio course. The two PTAs deal with the two research questions of this study.

In the workshop, students were divided into three groups. The groups were provided with paper, pens and post-its, and discussions were video-recorded. Strict facilitation could not be

provided as video recording had to be monitored and one facilitator per group was not an option. So, for the first PTA, two of the groups didn't seem to understand the methodology and an agreed-upon problem statement was not established. As a result, the causes and effects in the PTAs overlapped the desired reflections in relation to the two research questions. So, the PTAs could not be reported as-is, and the analyses of students were reconstructed by the authors, based on the video, observed discussions, and meaning-condensation.

Units	Method(s)	Outcome	Participants
Commonly agreed problem selection and definition	Three focus group discussions (FGDs)	Problem statement	Group A: 5-member group Group B: 5-member group Group C: 4-member group
Cause-and-effect relationships with the problem	Two problem-tree analyses	What are the causes and effects?	
Context-dependent clarifications about cause and effects	FGDs and SSIs	Explicit examples to understand the terms causes and effects	
How are the causes inter-dependent? How are the effects inter-dependent?	Further refinement of the two problem-tree analyses	Unfolding of the "how" question(s) of the phenomenographic study.	

Table 2. Stage-Outcome-Method-Participants Sequence of Participatory Learning and Action for Problem Formulation (adapted from (Khalid, Nyvang 2013)*)*

The PTAs and discussions were conducted in Danish. The first author (as the course instructor and native Danish speaker) has translated and reconstructed the PTAs upon translating into English. The second author, to whom Danish is a second language, contributed in the subsequent analysis and discussion. Considering the strength of the PTA method, which covers participant-contributed compilation and analysis, the video recordings were not transcribed and only used for validation at the conceptions stage.

Considering the procedure for analysis reported above, this study falls into the category of *discursive phenomenography* for the following reasons: "firstly to the attributed status of conceptions by phenomenographers, secondly to their ideas concerning the genuine location or residence of conceptions and thirdly in terms of the notion that they can be voiced in a

general and context free discourse to be understood non-hermeneutically" (Akner-Koler 2007 , p. 197). The five steps of *discursive phenomenography* are: conversation, transcription, compilation, analysis and conceptions (ibid.). *Discursive phenomenographic* methodology does not build on existing frameworks or models for the investigation, but emphasizes the specific context and situation experienced by the participants

ANALYSIS AND FINDINGS

In order to understand how the students experienced the existing Moodle-supported studio at AAU and the possible causes and effects of the problems associated with Moodle-mediated studio courses, as well as the problems, benefits and expectations with regard to achieving a more interactive learning experience by blending Google+ in studio project courses, they were asked to perform two problem tree analyses.

The first problem-tree analysis which the students were asked to perform was this:

> Our purpose is to establish that there is a need for blending other online platforms, in addition to or excluding Moodle, to create better learning opportunities in a studio project course. In groups, please discuss and establish/agree on a problem statement that you consider as the main issue behind suggesting Google+ and/or other platforms. The underlying question is: What is the problem with the existing/traditional studio at AAU (supported by Moodle)?

The second problem-tree analysis which the students were asked to perform was this:

> Our purpose is to evaluate Google+ as a means to offer a more interactive learning experience in an architecture and design studio course. In groups, please discuss and establish/agree on a problem statement that will enable you to illustrate the causes and effects of the problem.

The workshop discussions and outcomes, in the form of video recordings and posters, were analysed and organised in four categories which resulted from the students' evaluation points on Moodle and Google+:

1. The structure and design of the platform
2. Implementation
3. Graphic communication aspects
4. Written communication aspects

Both positive and negative aspects of Moodle and Google+ respectively were evaluated. Evaluation points in category 3 and 4 have been sorted into two sub-categories:

1. Peer to peer communication
2. Student to/from instructor communication

In addition to organising the workshop results into categories, negative evaluation points were organised graphically into problem trees (figure 4 and 5) in order to establish causes and effects.

MOODLE

Students were strongly critical of Moodle, particularly with regard to its structure and design (as set up at Aalborg University). It is notable that some of their points of critique address the lack of aspects which they had come to appreciate from Google+. Hence, their contention that Moodle only offers one-way communication and that students have no editing rights may stem from this experience. In terms of its implementation, it is notable, that the students contend that both instructors and students may have little knowledge of how to use Moodle.
On the positive side, the students contend that Moodle provides composure and overview for the students. Again, this may stem from the observation that Google+ does not (see below). It should be noted that the fact that only one aspect of Moodle is evaluated positively does not necessarily mean that they are highly critical of Moodle. As the evaluation workshop was framed with regard to Google+ as the 'new' platform, they may as well have focused more on Moodle's deficiencies than its adequacies.

	Positive aspects	Negative aspects
Structure and design	○ Provides composure and overview for the students	○ Only one-way communication ○ Poor interface ○ Poor tool ○ Conceived as an administrative tool; does not offer freedom to the instructor ○ Guest instructors do not have access to Moodle and therefore cannot use it to communicate with the students ○ This leads to information scattering ○ Students do not have editing rights in Moodle
Implementation	(no evaluation points)	○ Instructors may have little knowledge of how to use Moodle ○ Students may have little knowledge of how to use Moodle

Table 3. Positive and negative aspects of the structure, design and implementation of Moodle

The students' criticism of Moodle with regard to its graphic and written communication functionality is even harsher than of its design and implementation. They list a range of deficiencies resulting from its lack of peer to peer graphic and written communication features. That Moodle offers no way to get mutual inspiration from peers through graphic communication and the effects of this on the quality of the design work is mentioned in several forms. That Moodle offers no way to communicate in writing between peers and the effects of this on lack of feedback is also mentioned. Notably, Moodle is criticised for what it does not, rather than for what it does poorly.

When it comes to communication between students and instructors, the students are critical of Moodle for its lack of features allowing immediacy and informality in communication, They also note that Moodle does not facilitate group learning and thinking. No positive aspects were mentioned of Moodle's graphic and written communication features, neither peer to peer, student to instructor (as none of those were available), nor instructor to student.

	Positive aspects	Negative aspects
Graphic communication peer to peer	(no evaluation points)	○ [As this is not a feature,] you can have no inspiration from peers ○ [As this is not a feature,] you only talk to peers whom you already know about design ○ Students in the outset do not want/dare/manage to share with their peers. Moodle does not help them to overcome these obstacles ○ [As this is not a feature,] views and ideas get lost ○ Lack of a graphic communication feature may lead to narrow projects with lack of variation ○ Without mutual inspiration, projects may become esoteric and uninspired ○ Without mutual inspiration, students may be going in circles
Written communication peer to peer	(no evaluation points)	○ [As this is not a feature,] there is no means of instant communication between all students ○ [As this is not a feature,] there is no means of getting feedback from other that the instructor ○ [As this is not a feature,] there is no way of knowing what peers are working on ○ Lack of communication options ○ Lack of feedback/views ○ It is important for students to have the

		feeling that they are going in the right direction
Written communication student to instructor	(no evaluation points)	○ [As this is not a feature,] questions are asked by email ○ When questions are asked by eMail, answers do not reach everyone ○ No scope for informal communication with instructor
Written communication instructor to student	(no evaluation points)	○ Only one-way communication ○ not good for instant messaging ○ Only used for distributing material ○ Students are themselves responsible for retrieving the teaching material ○ No possibility for group thinking; questions are asked several times ○ Not suitable for instant feedback

Table 4. Positive and negative aspects of the graphic and written communication in Moodle

When organised into a problem tree (see figure 4), it becomes clear how the students' feedback distributes across causes and effects in different categories. Among the causes, it is mentioned that not everything is communicated through Moodle, as, for different reasons other communication channels are used. It is mentioned that Moodle is used only for distributing information. It is mentioned that Moodle only facilitates one-way communication, and (as a consequence) no peer to peer communication is possible. Importantly, it is also mentioned that students as well as instructors have little knowledge of how to use Moodle.

Among the effects, it is mentioned that, as a consequence of the deficiencies of Moodle, students share less with their peers, they cannot have inspiration from all peers, and have no way of getting feedback from peers or knowing what peers are working on altogether. It is also mentioned that there is no means of instant communication, that questions from students are asked by email and (as a consequence of this) there is no way of getting feedback from the instructors from within Moodle.

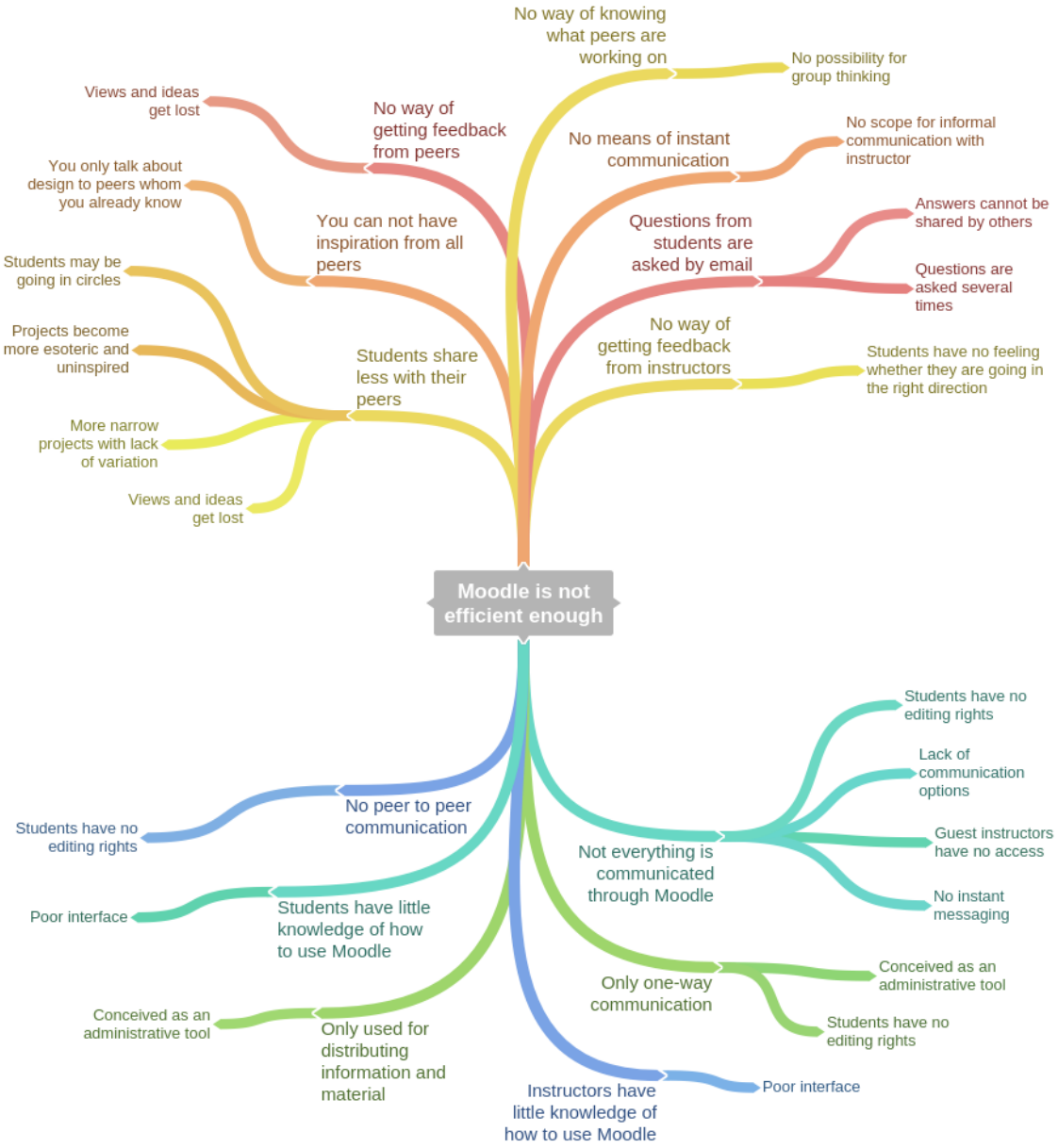

Figure 4. Moodle Problem Tree

GOOGLE+

The students perceive Google+ as a social networking platform which is more formal than Facebook, and experience more (creative) freedom with Google+ than with Moodle. While notification of new information is desirable, the lack of *categorization*, *priority level* and *searchability* appear to be the underlying causes of the perceived negative aspects. Moreover, the relevance or priority of a material or information is not the same for all the students.

During the discussion it also became clear that while some students expect all actions to be notified by email, some expect only priority information to be sent by email, and some prefer the notification through app only. So, a student-centred structure can be designed, and students might be provided guidelines for customizing notification preferences. It is unclear from the discussion how Google+ is expected to be integrated with Moodle and which functions or features of Pinterest is better than Google+.

	Positive aspects	Negative aspects
Structure and design	○ Appears more serious than Facebook ○ Is less private than Facebook ○ More free / creative than Moodle	○ Lack of structure/overview of the posted information ○ Not possible to find older material ○ Messy ○ Too much information ○ Irrelevant information ○ Not suitable for sharing materials and information ○ Not suitable for important information ○ Important information must be sent out by email ○ All types of communication melt together ○ G+ is not integrated with Moodle ○ Pinterest is better than G+
Implementation	(no evaluation points)	○ No information about how to use G+ ○ Poor knowledge of G+ ○ Lack of training about the file hierarchy ○ The status of G+ relative to Moodle is unclear ○ Are communications voluntary or mandatory ○ Problematic to use more concurrent platforms ○ Students are not inclined to check G+ very often ○ In times of high activity, it is difficult to find important communications

Table 5. Positive and negative aspects of the structure, design and implementation of Google+

Table 5 shows that both student-student and student-instructor graphic communication in Google+ are perceived as positive for sharing and receiving feedback on posted visual material. Both positive and negative aspects of written communication, whether peer to peer or student to/from instructor, are perceived. The phrase "poor feedback" refers to both irrelevant or not-so-interesting peer feedback, and very little or no peer feedback. Such

dilemmas will remain irrespective of the choice of platform. While some students value Google+ for instant feedback, other students contend that Google+ (or any online platform) is a replacement for face-to-face interaction.

	Positive aspects	Negative aspects
Graphic communication peer to peer	○ Has capacity to share visual material ○ A good way to get inspired ○ Good for sharing work in progress ○ Promotes peer learning ○ Promotes sharing ○ Promotes openness	(no evaluation points)
Graphic communication student to/from instructor	○ Get comments on work in progress	(no evaluation points)
Written communication peer to peer	○ Communicate with everyone (rather than only project group) ○ Promotes personal contact	○ Online communication often leads to misunderstandings ○ Lack of interest in what is being posted ○ Poor feedback from other students
Written communication student to/from instructor	○ Ask questions ○ Get feedback ○ Get feedback fast ○ Efficient way to get inputs from instructors ○ Feedback is shared (not individual)	○ Feedback can be shallow ○ Poor feedback from instructors ○ Sometimes feedback is not constructive ○ Online communication often leads to misunderstandings ○ Cannot replaces face-to-face meetings ○ Some see G+ as a replacement for face-to-face interaction and therefore as negative

Table 6. Positive and negative aspects of the graphic and written communication in Google+

It is agreed among the groups that Moodle should not be replaced with Google+. These offer two different types of advantages. While Moodle is good to get the course organised (education), Google+ is good to get the projects going (inspiration). The different platforms facilitate different activities and offer conveniences throughout the phases of the course. Google+ is good for inspiration during the start-up phase of the project. However, one group stresses that concurrent implementation of both Moodle and Google+ is undesirable (see figure 5).

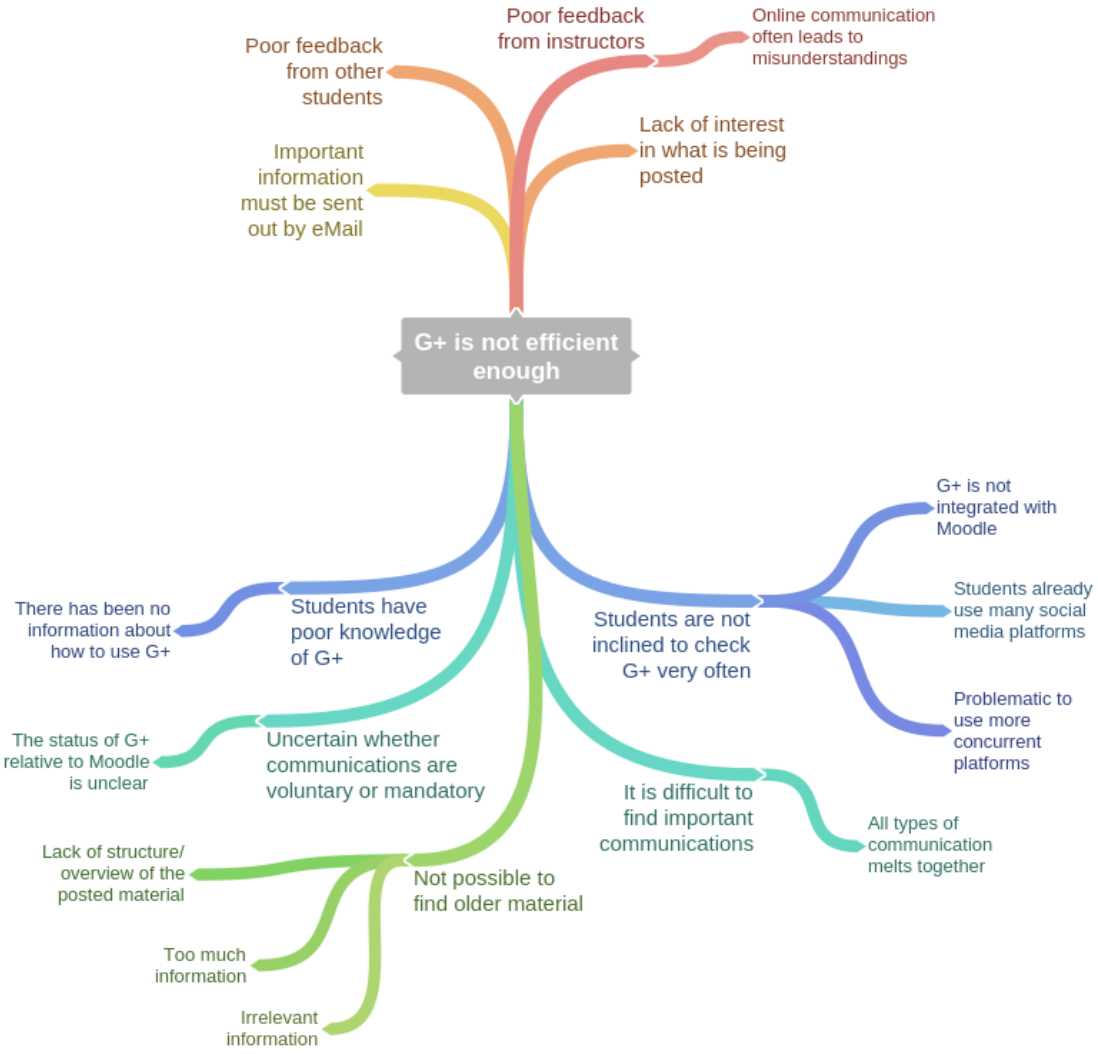

Figure 5. Google+ problem tree

DISCUSSION

The students' major concerns during their evaluation of Moodle and Google+ were inspiration, efficiency and the importance of using a single online learning platform. The word 'inspiration' in various forms occurs ten times in the workshop posters. For instance, "Moodle does not give the option to show illustrations, which can inspire one-another." (Group A, PTA 2). The word 'efficiency' in various forms occurs three times in the workshop posters. For instance, "supervisor's input/links as effective source of inspiration" mediated by Google+ post (Group B, PTA 2).

In the visually oriented culture of the architecture and design studio, 'inspiration' relates to the functionality of peer sharing of graphics. In this regard, Google+ was evaluated more positively than Moodle. Efficiency relates to how well the platforms perform the tasks which the students expect from them. Here, they generally evaluate Google+ positively with regard to feedback, and particularly instant feedback, while they are overwhelmingly critical of Google+' capacity to present, structure and retrieve information and prefer Moodle in this regard.

Interestingly, the AAU Moodle version 3.0 allows activities (chat, feedback, forum, wiki and workshop), and enables or provides environments for communication and collaboration (comments, messages, SMS sender, online users and participants) which might offer similar functions to the ones that were evaluated positively in Google+. Hence, the students' discussions suggest that the lack of knowledge of how to use Moodle among both instructors and students may be a central barrier towards blended learning using Moodle.

Conversely, Google+ was perceived as a poor performer in presenting, organising and retrieving information. In fact, when used properly, tags and categories facilitate these operations also in Google+. Thus, the students' discussions indicate also here, that the lack of knowledge of how to use Google+ is is a barrier towards blended learning using Google+.
While the students were critical of different aspects of the two platforms, they were also critical of using several platforms. While these two criticisms may appear irreconcilable, they might be mediated. Even if no one platform may be the best choice for all desired activities during a blended learning architecture and design studio course, much can be done in clarifying to the students, what the different platforms are good for and how they should be used.[1]

CONCLUSION

This discursive phenomenographic study identifies the perceived problems, causes and effects of integrating Google+ as a concurrent platform with the institution-provided Moodle for the Spring 2016 BSc4 architecture and urban design studio course. The six problem-tree analyses, created and discussed by 14 students in three groups, were re-constructed by the authors. The causes and effects are grouped into positive and negative factors and further divided into four categories: 1) structure and design, 2) implementation, 3) graphic communication and 4)

[1] In this regard, it noteworthy that the students ran an informal Facebook group for student-to-student communication in parallel to Moodle and Google+. This, however, did not raise any concerns among the students. While students categorised Moodle as formal and Google+ as less formal, the complete informality of Facebook (as it did not involve the university, nor the instructors) led the students to leave Facebook entirely out of the equation.

written communication. The latter two communication categories are sub-grouped into peer-to-peer communication and instructor-student communication.

It can be concluded that even if Moodle may possess the functionality which was sought compensated for through the introduction of Google+, this is not clear to instructors and students. Hence the university, in this case, may not get the full potential of its Moodle implementation without better support and training for both instructors and students (and possibly administrative staff). It can also be concluded that Google+ facilitates blended learning functionalities for architecture and design studio such as graphic, peer to peer and instant communication very well. When used as a supplement to Moodle however, students should be better informed about how to use the different platforms and for which activities.
The participant-contributed problem statements were: "Moodle is not efficient enough" and "Google+ is not efficient enough". It can be argued that the lack of knowledge about the functionalities of both Moodle and Google+ caused the perceived inefficiency of both. The lack of explicit information about the role of Google+, which was instructor-led and thereby imposed by the institution, turned it less efficient than desired.

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Journal of Problem Based Learning in Higher Education

VOL. 5, NO. 1, 2017 – Page 47-63
http://dx.doi.org/10.5278/ojs.jpblhe.v0i0.1558

The Intentional use of Learning Management Systems (LMS) to Improve Outcomes in Studio

*Andrew MacKenzie, Milica Muminovic, Karin Oerlemans**

ABSTRACT

At the University of Canberra, Australia, the design and architecture faculty are trialling a range of approaches to incorporating learning technologies in the first year foundation studio to improve student learning outcomes. For this study researchers collected information on students' access to their assignment information and feedback from the learning management system (LMS) to discover how the students engaged in the design process.

The studio curriculum was designed to encourage students to engage in a convergence, divergence dynamic (Brown 2009, Thomas, Billsberry et al. 2014) in developing their own understanding of the design process. The staff tailored around points of convergence, online instruction, assessment tools and feedback in studio. We argue that using learning technologies in this way can improve intentionality at the beginning of semester, enhance students understanding of feedback and facilitate a more iterative approach to problem based learning in studio practice.

INTRODUCTION

Design and architecture education traditionally relies on personal interactions between tutor and student in a physical space called the studio. Increasingly in Australian universities, studio tutors are expected to adopt LMS for delivery of information and provision of feedback (MacKenzie and Hocking 2014). This approach to blended learning in studio is therefore worthy of investigation. While there is no consensus on the use of the term, blended learning (Funda 2011, Pektaş and Gürel 2014), it is generally defined as the combination of traditional

* Dr. Andrew MacKenzie, University of Canberra. Email: andrew.mackenzie@canberra.edu.au
Milica Muminovic, Assist. Prof., University of Canberra. Email: milica.muminovic@canberra.edu.au
Karin Oerlemans. Email: oerlemans.karin@gmail.com

delivery methods (face to face) with online learning technologies to enhance teaching methods (Hyo-Jeong and Bonk 2010). This paper extends this definition to consciously incorporate a convergence, divergence dynamic (Brown 2009, Thomas, Billsberry et al. 2014) widely used in education, but also synonymous with design thinking to blend traditional ways of teaching design process into the curriculum. The blended learning component of the study is the incorporation of LMS and hand held devices to engage students is design thinking without explicitly teaching theories underpinning the design process they are undertaking.
Technology in design education can provide students with rich and meaningful multimedia content that is contextually relevant and can be accessed and enacted upon (Bower, Howe et al. 2014). Technology can provide cognitive support for difficult tasks with pre-packaged learning experiences, allowing the user to control the speed, frequency and iteration of their access to content to suit their learning abilities.

In this context, there is an ongoing need to investigate the pedagogical practices that are most suited to a design curriculum influenced by technologies. For example Van Haren (2010) argues technology should support the agency of students in enacting, developing and determining rather than passively accepting so that they can achieve a deeper understanding of subject matter. While this approach to learning is familiar in a studio environment, using technology for technologies sake should be critically evaluated in both learning and assessment.

This project examines the question; how do LMS support students engaging in the design process? The question can be further broken down to; how do they use feedback to improve and to what extent do these learning technologies support the student to develop a design process around the convergence/divergence dynamic. Understanding how students engage with and benefit from different forms of feedback forms a key part of this enquiry.

DESIGN THINKING AND FEEDBACK

Design thinking is increasingly integrated throughout the curriculum of higher education institutions, particularly at post graduate level. Yet while there is consensus about the value of teaching design thinking, there is little consensus on how it should be taught (Wrigley and Straker 2015). In particular the problems are centred around the generalised approach to design thinking as a universal cognitive practice, ignoring how design is shaped by the role of institutions and socio-cultural developments over time (Kimbell 2011). As a result the value of design thinking in furthering creative output and generating innovation is poorly grounded in evidence-based practices (Dong 2015). Although design thinking lacks a formal definition, this paper adopts of a design thinking approach to curriculum delivery in first year design studio. In this case studio is not the place for learning design studies, but rather opportunity to develop design practice (Tonkinwise 2014). Rather than teaching the theory of how designers

think, the studio tutors incorporate learning technologies in order to scaffold the students' projects and feedback in a way that encourages them to develop their comprehension and practice.

Learning design practice presents students with their own anxieties. Tonkenwise (2014) argues this is unsurprising as studio demands that students harness design thinking to creatively traverse the domains of specialised knowledge yet design education tends to reflect what is done in professional practice; something students cannot comprehend in their early years of training. Underlying this anxiety, in addressing social problems such as sustainability, practical education (learning by doing) is counter intuitive to the more abstract, risk taking approaches that tend to generate more creative ideas, generating a larger solution space for progressing a design problem within its socio-technical context (Bleuzé, Ciocci et al. 2014).

Evaluation of design in the form of criticism also tends to value the students' design work in terms of appearance or affect, privileging the high art content, history and theory courses in the curriculum of most schools and reflecting the research background of faculty staff. While some schools take a more sociological stance to design theory, engaging with the everyday cultural practices, such programs are in the minority (Tonkinwise 2014). In this way feedback in the form of criticism can reinforce the notions that students need to demonstrate adequate discipline knowledge more so than contextually relevant knowledge to the world we live in (Moore 2005).

Research suggests feedback is the most powerful method of engaging with students, and can be used to improve learning (Hattie and Timperley 2007, Hattie 2009). But other research focused on the use of written feedback, seemingly contradicts this finding and states that students actually seldom access their feedback and learn very little from it for a number of reasons. These included a lack of understanding, relying on their memory of what was said, and because they are more focussed on their grades then on the feedback (Higgins 2000, Carless 2006, Weaver 2006). Recent research by Blair et.al. (2013) suggests that immediacy of feedback in written form, timely and accessible, and using a wider range of feedback mechanisms would enhance the student learning experience.

There are a number of definitions of feedback, Hattie (2007) giving a very broad characterisation defined it as the "information provided by an agent about aspects of one's performance or understanding" (p. 187). In a meta-analysis of over 134 studies on the use of feedback in education, he found that it was essential to the learning process and was among the most powerful influence on achievement (Hattie 2009). In an earlier work, Winne and Butler (1994) defined feedback from the perspective of the learner, as the "information with which a learner can confirm, add to, overwrite, tune, or restructure information in memory, whether that information is domain knowledge, meta-cognitive knowledge, beliefs about self

and tasks, or cognitive tactics and strategies" (p. 5740). Carless (2006) limited his use of the term feedback to the responses made on student assignments. For him, "it encompasses written annotations and comments on drafts or on finalised assignments, in addition to verbal dialogues prior to or after submission" (Carless 2006), although he goes on to argue that this form of feedback can serve multiple functions, for improving future assessments (Carless 2007), to justify a grade, or even "the fulfilment of a ritual which is part of academic life" (p. 220). In this paper we limit the meaning to the feedback, verbal or written, given to students for their assessment tasks. But also explore Winne and Butler's understanding to see how much the learner in fact uses the feedback received to add to, fine tune, or change their responses.

Hattie found that the value of feedback could be described as a powerful motivator and improver of learning, but Carless (2006) found in his study that most students were primarily motivated by marks and did not engage much with the written feedback they received (see also Crips, 2007). Weaver (2006) concurs, arguing that the value of feedback depended on the student's individual notions and understanding of the written information, which may not be the same as their tutor or lecturer, in which case students would have a great deal of difficulty in using the feedback received to improve their learning. Higgins (2000) also found that many students were simply not able to understand written feedback or knew what to do with it, failing to understand the comments or alternatively misinterpreting them. This may particularly be true if the feedback comments are written as suggestions for improvement, which some students may take as literal, but others may take these as optional (Crisp 2007). In fact Crips argued that students seldom responded to feedback by making changes to their subsequent submissions, as suggested in the given feedback.

This was a problem identified in our research, so in this study we explored whether students used feedback, and what if any impact this had on their subsequent results. Some researchers have suggested that the difference is in the quality, accessibility, timeliness, legibility and relational aspects of the feedback given (Chang, Watson et al. 2013). Similarly, in their study of e-feedback, McCabe, Doerflinger, and Fox (2011) found that students and staff perceptions were that "e-feedback procedures increase clarity of feedback compared to handwriting, save paper and ink resources, and result in faster and also better, more detailed feedback" (p. 178). However, Blair et al (2013) found that although students wanted quality feedback, that directed them in their learning, and that was given in a timely manner, they also found that whilst some students preferred written feedback, others preferred verbal feedback. This was because students found the verbal feedback was easier to understand, they were able to request further clarification, and because written feedback was often poorly constructed or used overly academic language. An assumption could be made here that students view feedback for no other purpose than to see what they need to improve or at least meet the learning outcomes of the activity, depending on whether they were deep or surface learners (Calvo and Ellis 2010).

In this study we asked students what type of feedback they preferred and sought to understand what it was about that feedback that they found improved their learning. The following section describes the methodology followed by the findings of these questions.

METHODS

This research used both qualitative and quantitative data to evaluate the effectiveness of LMS for providing feedback in a first year design studio. Student patterns of access to Moodle, the University LMS, were collected. Data included students' frequency of access, timing of access compared to the release of project briefs, feedback (formative) and results (summative) for each project. Data was also collected data on student views of videos as recorded in EchoSystem, the lecture capture and video streaming system. Other data included student results collated from the rubric, and final grades following the final assessment of each project. Reflective summaries for each assessment were collected from the LMS following the final submission. Semi structured interviews were undertaken with studio tutors to evaluate their perception of the effectiveness and ease of use of the LMS for providing feedback.

CASE STUDY

The case study was an introductory design studio for students studying majors in architecture, landscape architecture, interior architecture and industrial design. The unit was delivered with a combination of online and face to face lectures. All studio work was undertaken in a conventional face to face format in a purpose built studio space. Students were delivered information and feedback via Moodle, the University LMS. Two tutors conducted the studios with approximately twenty students per class. Both tutors participated in the research and research ethics was granted for both surveying and interviewing students and staff.

The curriculum developed for this studio is based on the design thinking approach of divergence and convergence (Brown 2009). The studio had three assessment stages (A01, A02 and A03) based on three interrelated and interdependent assignments that were scaffolded to create a final design piece incorporating all the assessment into a single final presentation. The three assignment themes; idea, form and object guided the students through a design thinking process based on the convergence/divergence dynamic (Figure 1).

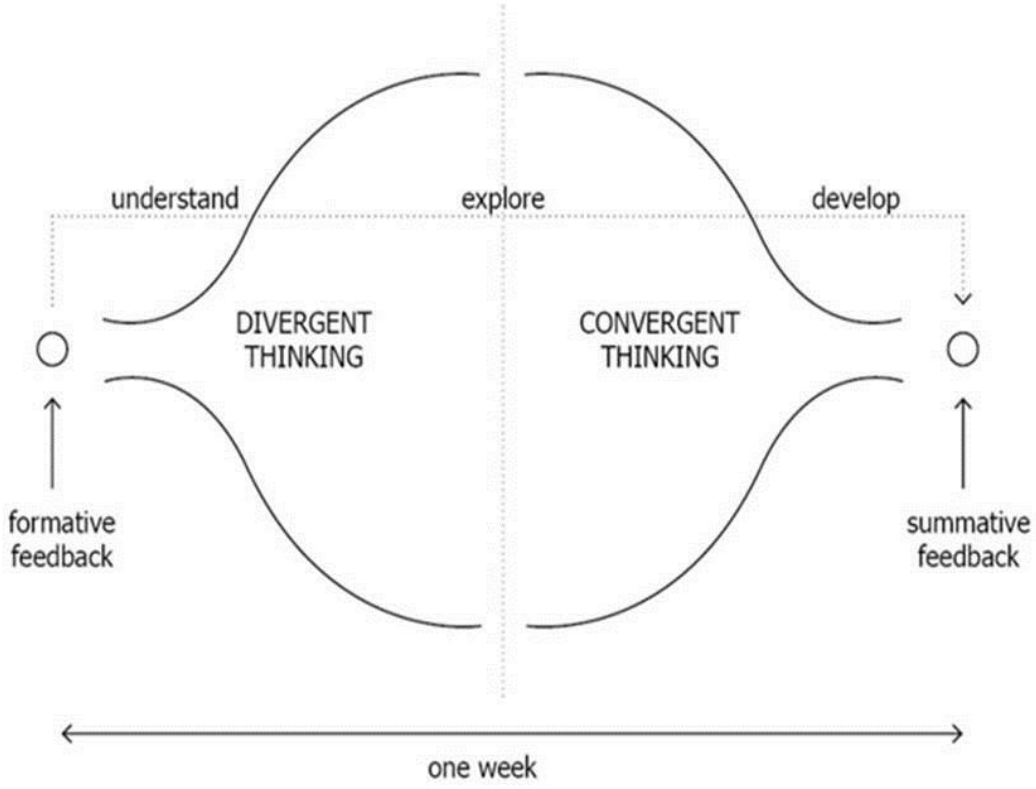

Figure 1 Design thinking process used in the research (adapted from Brown (2009)).

Furthermore, the information for each assignment (project brief, project value, submission requirements, and assessment criteria) reflected the phases of a design process. The delivery of that information along with the provision of online feedback was timed to coincide with points of convergence in the students design thinking process (Figure 2).

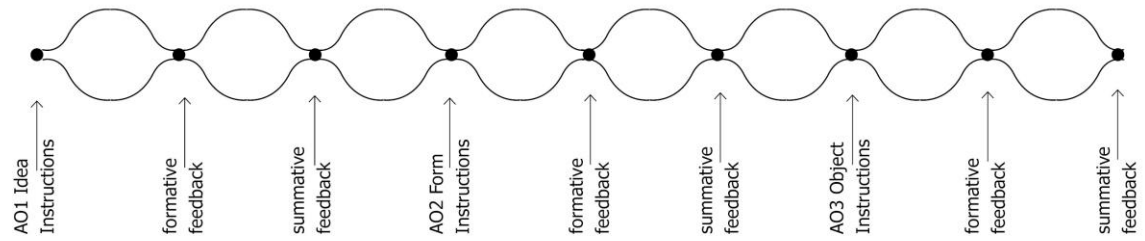

Figure 2 Design thinking process applied to the curriculum.

To set the expectations in the studio, the staff used videos to explain the nature of studio and ways of learning. The importance of feedback has been reinforced with the former students' experiences videos and the process was explained during lectures and studio classes. Students were informed of the nature of feedback and its importance before every formative feedback session at the beginning of the class. The design language was presented and explained in the

lectures and further enhanced during the verbal and written feedback. In this studio, tutors encouraged students to reflect on their feedback by extending the process using the formative and summative feedback and including various techniques of feedback, both face-to-face and online via the LMS.

PROVISION OF FEEDBACK

The feedback was provided in two stages: formative (feed forward) and summative (grade and short comment) (Table 1). During the studios where formative feedback was provided, students presented their work in front of their peers and received verbal feedback and a rubric with comments from their tutors using a touch screen on a hand held device (Figure 6). Students were explained their grade by the tutor using the rubric to help them understand discursively why they achieved the grade and how they can improve. The qualitative terms in the rubric text reflected the University assessment policy relating decryptions to grades. (E.g. satisfactory equates to a pass, excellent equates to a distinction) The verbal comments during the critique sessions were also recorded in form of the notes by a student peer. The students were provided an additional week to improve their assignment based on this feedback. The students were required to reflect on their formative feedback in 200 words and submit that in conjunction with their assignments. The refined work was then submitted using LMS, on which they would receive the summative feedback.

Video views

Video Title	Duration (Minutes)	% Students viewing	Average total time
Introduction to Design Studio	3	54%	2.50
Students on Design	5	35%	2.49
Light Tone and Colour	20	6%	17.17
Ordering Elements	21	21%	15.68
Point Line Plane	26	33%	18.60
Volume	12	27%	11.10

Table 1: Percentage of students viewing the videos and their average total time

The most complete feedback process was in the second assignment, and thus we have selected those results for the purpose of this paper. In order to evaluate how effective the rubric feedback was in the process, the tutors were asked to provide verbal and written feedback differently. Tutor 1 adopted a personally tailored and more precise approach to written and

verbal feedback. Tutor 2 used general formulation using generic terms to describe the students work.

DATA ANALYSIS

Use data was collated for each student, descriptive statistics derived, and plotted in excel. The time series data was based on the date and time stamp information for all accesses of information by the students.

The student reflections were collated, information de-identified, and a discourse analysis conducted looking at both the structure and practice of the language used by the students (Jorgensen and Phillips 2002). This enabled the research team to make observations about the language use in the context of the design discipline, and within the practice of the students. This allowed the researchers to tentatively make decisions about the students' change in learning of design literacy, and help contribute to a general understanding of the process.
The interview data from the tutors was analysed to identify how the students' experience of receiving the feedback correlated with the tutors' experience of providing the feedback. This triangulation helped us to understand the value of the immediacy of the feedback rather than focussing on the students' comprehension.

FINDINGS

The findings from the research interrogate the students' access to online information. The data is presented in two parts. The first part, resources, includes instructional videos and online lectures, and assessment instructions including assignment briefs and sample assessment rubrics. The second part, feedback, includes formative feedback in the form of written rubrics and comments, and summative, or grade only.

STUDENT INSTRUCTIONS

Throughout the course a number of resources were developed to support the students in their progress, these included short instructional videos, similar to the example videos described by Kay (2012), but with a focus on specific design elements and the use of these in the design process. Extensive documentation and instruction information was developed using the webpage tool in Moodle. Information included submission criteria, and how to submit the work electronically, as well as a sample of the assessment criteria.

VIDEOS

In addition to the online lectures, two additional videos were included. The introduction video established the expectations for the assignments. The students on design video includes past students talking about their experience of the unit. These two videos better meet the definition of extra materials (Kay, 2014), but proved the most popular with the students. Students accessed these items much as expected, as is common across other disciplines (Danielson, Preast et al. 2014). Table 1a shows the percentage of students viewing the videos. The data indicates the instructional videos (1 and 2) provided on Moodle in the first week were the most popular. The aim of these videos was to help student prepare for studio practice, with practical tips and advice from previous students about how to work successfully. Videos 5 and 6 included conceptual examples of successful project outcomes to help students understand what was expected.

The videos are listed in order that they appear on the LMS unit site. As always, not all students will watch all videos. There were 137 students enrolled in the unit who viewed none, one or some of the videos, but not one video was viewed by all students. What is surprising and perhaps contrary to previous findings (Wiese and Newton 2013, Danielson, Preast et al. 2014) is the length of views. Table 1b shows that students who viewed the videos watched approximately 50% of videos 1 and 2 and between 70%- 92% of the remaining instructional videos. This could be an indication of the type of video, which fit more into the category of worked examples (Kay 2012), rather than the more common lecture capture videos.

		AO1	AO2	AO3
Tutor 2	formative	86%	71%	79%
	summative	93%	90%	81%
Tutor 1	formative	100%	95%	75%
	summative	100%	95%	90%

Table 2: Submission of assessments Time 1 and Time 2 for each assessment task

ASSESSMENT INSTRUCTIONS

The team also examined the viewing patterns of the assignment instructions. Figure 4 shows the number of times the assignment instructions were viewed by students. Between 22 and 30 students viewed the assignment instructions once on Moodle for each project. The viewing patterns for each project were similar. As expected students viewed assignment 1 instructions the most, but as they moved through the tasks, they showed less dependency on the instructions.

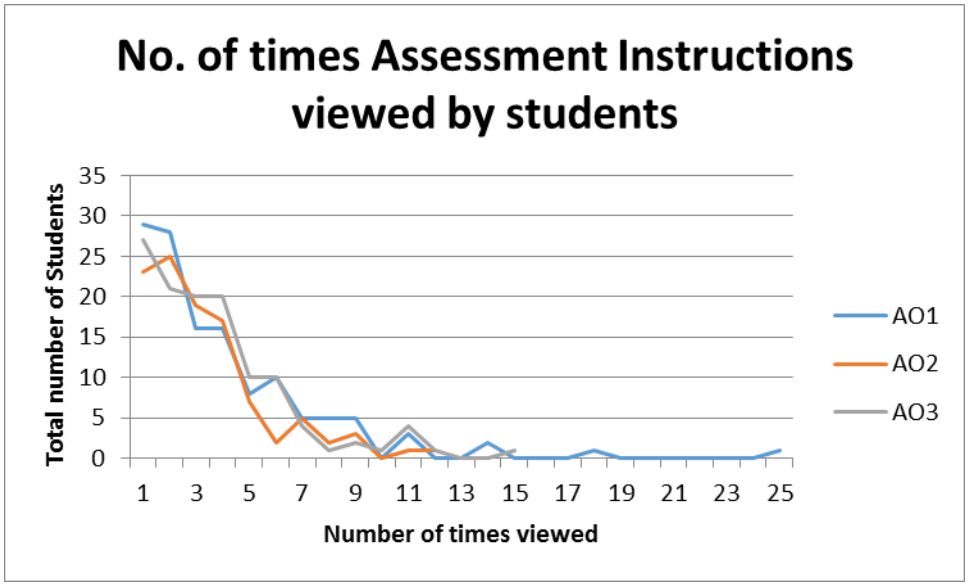

Figure 4 Number of times Assessment instructions viewed by students.

More interesting for our study, is the findings in Figure 5, which shows a timeline of access of the views of the assignment instructions. The x axis shows the weeks of studio, including the assessment window. For example AO1 formative feedback was given in the week starting 7/3/16 and summative assessment was provided the following week beginning 14/3/16. The Y axis shows the frequency of students' access to assessment instructions. For example A01 was viewed 56 times immediately after the first week of formative feedback. There is an ebb and flow showing how students access the assessment instructions in order to understand the project requirements. There are students who will view all the information, but there are also those students who only view what they need to as the tasks get closer to their due date. However, what the time series information shows us is that students engage in convergence moments prior to the submission of their assignments, in order to meet the requirements of the submission. We also see that students engage in convergence moments for subsequent submissions by viewing the instructions from the previous submission.

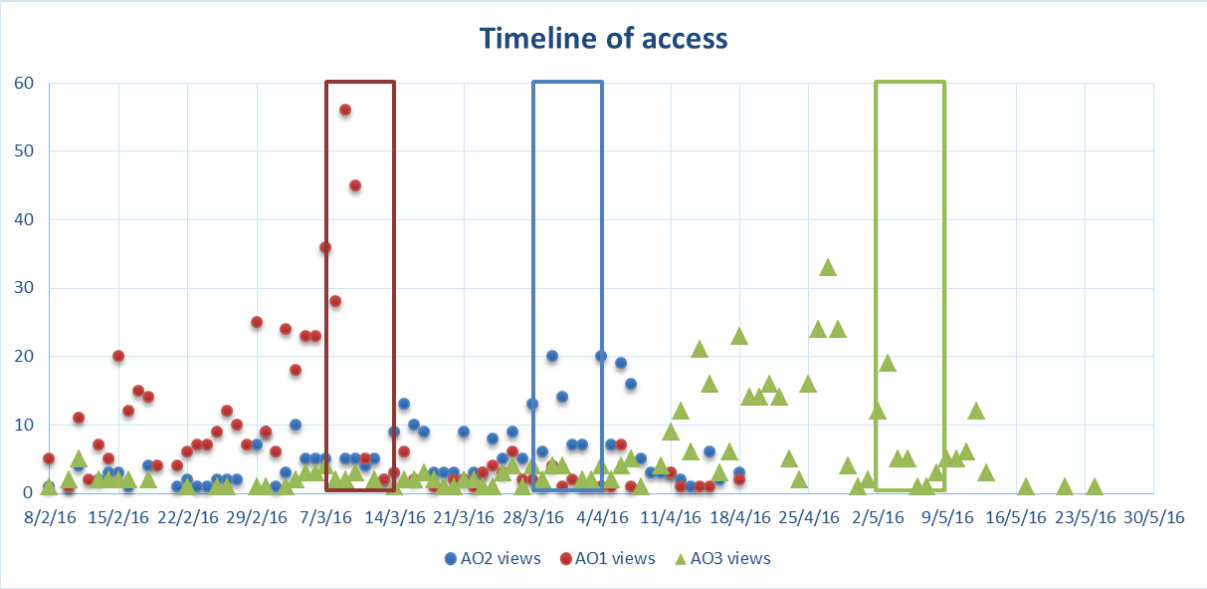

Figure 5 Timeline of access of Assessment Instructions.

STUDENT ACCESS PATTERNS FOR FEEDBACK

The previous section provides an overall picture of how students access information during the semester. This section looks more closely at how students access feedback. Formative feedback (or feed forward) was provided three times during the semester in studio using an online rubric on a handheld touch screen smart device (Figure 6). The students were provided both verbal and rubric feedback in class and given an additional week to improve their assignment prior to receiving a summative grade.

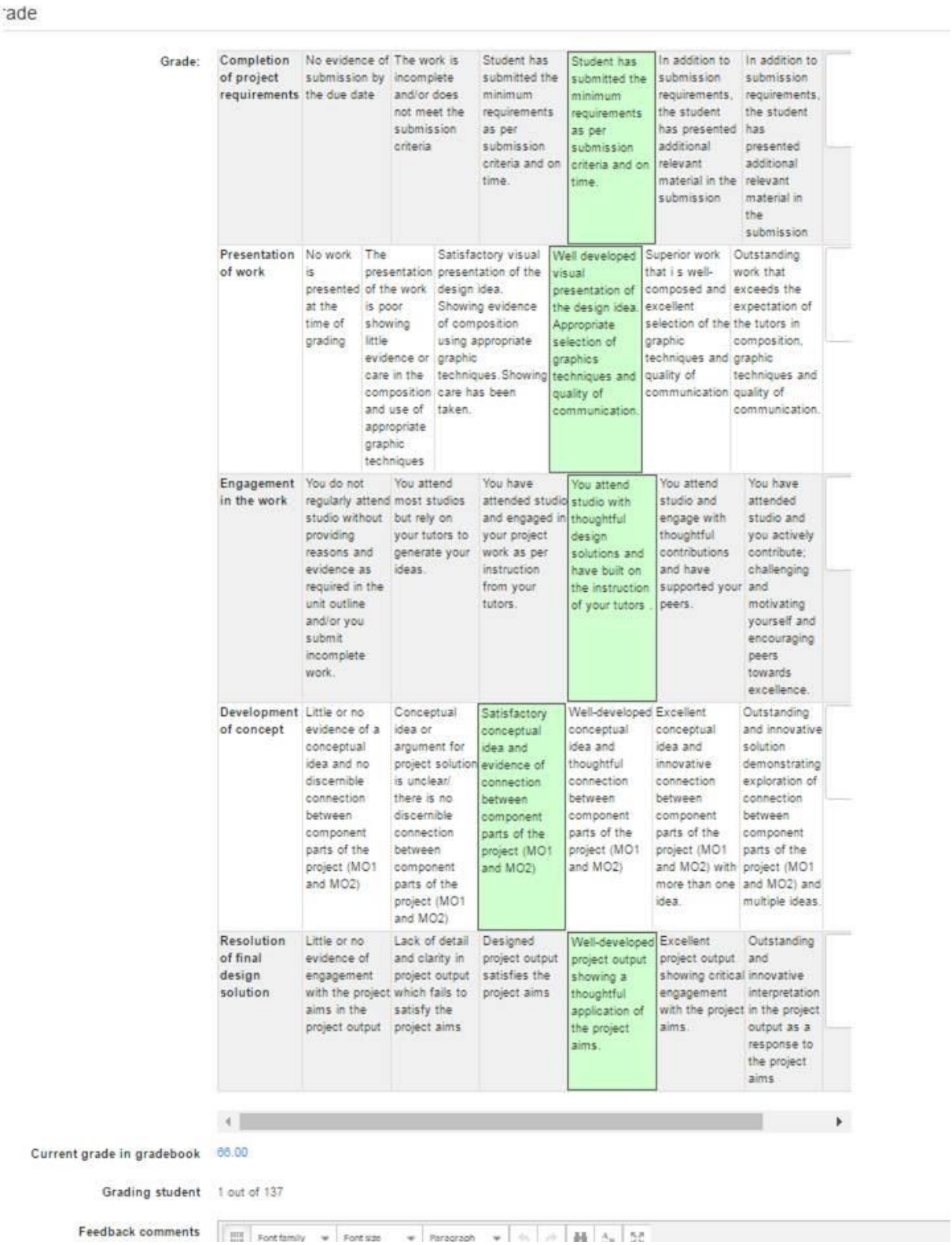

Figure 6 – Sample rubric from hand held device screen

Looking more closely at assignment 2, students viewed the rubric during the week between the formative and summative feedback did so in order to get as much feedback as possible for

improving their assignment. There were 91 views of the rubric prior to the submission of Assessment 2 after the in studio formative feedback. There were an additional 289 views of the rubric in total during the week between the formative and summative feedback. We can assume that students who viewed the rubric once were only looking for their results; however, there can be an assumption that those who viewed it more than once were reviewing the result and seeking further feedback from the rubric in order to improve their outcomes. Table 3 shows the relative improvement in grades. Tutor 1 gave rubric, comments and verbal feedback whereas tutor 2 relied on rubric only for formative feedback (Table 3). There is no evidence that the rubric by itself caused an improvement in results, as can be seen from the table below. Despite the demonstrated improvements from tutor 1 student outcomes, compared to tutor 2, is difficult to determine what caused the improvement, as students in both groups frequently accessed the rubric feedback in the week following the formative feedback. It may well be the combination of the 3 forms of feedback that is the most powerful, with the verbal on the day and the written and rubric feedback given online for students to refer back to regularly as they seek to improve their outcomes.

	AO2 Formative	AO2 Summative
Tutor 1 – verbal, written and rubric	57.62%	66.86%
Tutor 2 – rubric	62.74%	62.82%

Table 3: Average marks for Time 1 and Time 2 for Assessment 2 for each tutor

DISCUSSION

The aim of this research was to provide evidence of students' engagement with online information and feedback in a design studio. In addition, the team were interested in how the timing of feedback could coincide with the students' cognitive process of creative exploration (divergence) and design resolution and communication (convergence). The design of the curriculum followed a divergent/ convergent process broadly determined by the timing of assignments submissions and timeliness of feedback. The team consciously designed the curriculum to focus students' attention around points of convergence as they progressively developed their studio assignments.

The focus on points of convergence for data collection served two purposes. Firstly the students' patterns of access in terms of frequency and over time could be mapped. Secondly the students were required to progressively build on each assignment and in doing so creatively engage in a design process that involved both iteration and engaging (though not consciously) in the convergence divergence dynamic. It was hoped that by targeting feedback leading up to convergence points in the assessment rather than providing weekly feedback,

students would be more likely to undertake more divergent thinking in the weeks when feedback wasn't given.

While the evidence of convergence was clear, the evidence of divergence was more difficult to determine, but we suggest the student's execution of the assignments and scaffolding of each submission based on the previous assignment shows improvement in their ability to complete the assignments. Tutors also reported that the students were also prepared to make significant conceptual changes to their final submissions in the week between the formative and summative feedback in order to achieve improvement. This suggests students could comprehend the feedback and revisit their project in a manner that mimics a more iterative design process. As mentioned in the results we can deduce that the frequency of views of assessment instructions coincided with period of work for students that preceded an assessment event. Notably the periods of exploration following the launch of the projects coincide with relatively low levels of access to the LMS in order to read assessment instructions. We would argue that while the data may suggest the students were not engaged in the assessments during this period due to the low level of LMS access, they were engaged in a form of divergence and information seeking in other ways as part of studio practice. We would argue that the early phase of the design cycles allowed the students to learn divergently by exploring without the constraints imposed by assessment criteria. For the team this tentative finding would suggest future research should focus on when not to give students feedback or assessment information in order to encourage the risk taking and creative leaps consistent with divergent thinking.

Tonkenwise (2014) argues that students find the creative leaps required in design practice to be daunting. Therefore encouraging creative exploration through some form of strategic retreat from the student tutor interaction may prove to be useful in complimenting this research to achieve better student outcomes.

In the first phase of this research in 2015, we reported that students preferred verbal feedback; however students who received and accessed other forms of feedback demonstrated the greatest rate of improvement in their grades. Similarly, students who revisited the project information, including accessing previous assignments information for subsequent submissions also demonstrated the greatest improvements. This research is instructive for studio curriculum designers and tutors who want to maximise the efficacy of online information and student interaction with LMS. The concept of traditional weekly studio verbal feedback is both labour intensive and inefficient in terms of students and academic staff time. It could also be argued that the efficacy of all forms of feedback is most evident during period of convergence. Similarly, the points of convergence in the semester are relatively short and focussed leaving large period of time to allow students to explore different ideas and approaches. However, while the use of LMS allows students to access their feedback immediately and revisit the information outside of studio time, it remains to be

seen how this method can encourage students to progress their design process without accessing LMS when divergence is needed.

Tutors should take comfort in changing their patterns of feedback to allow students more time to indulge in divergent processes in between assignments. Similarly students have more flexibility in how they access assignment information and feedback. As Universities demand more flexible and intensive modes of delivery, studio tutors can make the most of face to face time leading up to assessment periods and rely more on LMS to support students learning at other times.

CONCLUSION

By 2013, nearly 18 percent of students in Australia studied off campus, with a further 9 percent choosing to complete at least some of their study online (Norton and Cherastidtham 2014). The implications of this growing trend and demand for use of LMS to support, enhance or replace the more traditional modes of face-to-face teaching at universities (Laurillard 2013) including the adoption of new pedagogies, increased demands on academics time, and changing student expectations, and are well established (Bonk 2009). It is unsurprising that university programs in design education are under pressure to expand the adoption of LMS into the design studio.

While this project doesn't explicitly teach students about creative thinking or design process, it engages students in a design process through a curriculum based on the convergent divergent dynamic. The value to design educators is that a curriculum designed around a creative thinking approach, such as the one we have used, does help students to better understand and adopt a creative process in learning about design. By consciously incorporating LMS into the learning process for students, they can achieve positive outcomes that enhance more conventional forms of face to face verbal feedback. Studio tutors can use LMS to gain a better understanding of how students engage in design outside of formal studio interactions and better target the use of feedback. The research suggests that design tutors should focus on the diversity and timeliness of project information and feedback based on the convergent divergent dynamic in order to achieve better result from students at the beginning of their studio learning journey.

This research focussed on the patterns of access to online data, it revealed levels of engagement in information but not their levels of comprehension of the assignment requirements. Further research to better understand how students comprehended both the words used in the instructions and feedback rubrics may help to improve our understanding of how student progress between convergence points.

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Journal of Problem Based Learning in Higher Education

VOL. 5, NO. 1, 2017 – Page 64-84
http://dx.doi.org/10.5278/ojs.jpblhe.v0i0.1556

Bringing the Classroom into the World: Three Reflective Case Studies of Designing Mobile Technology to Support Blended Learning for the Built and Landscaped Environment

Wally Smith, Hannah Lewi, Andrew Saniga, Lee Stickells, Dora Constantinidis *

ABSTRACT

We report and reflect on three projects, carried out by us as educators and technology researchers over a four year period, that explore the use of mobile technologies in the fieldwork of Australian tertiary students of architectural history, landscape history and urban design. Treating these as three case studies, our focus is on the emerging process of designing, developing and deploying different forms of mobile-inspired fieldwork to complement class-based learning. The first two cases involve the development of apps that work as guides for students to explore places of architectural and historical significance in Melbourne, while the third case invited students themselves to create designs for a mobile app intended to communicate the influence of urban design thinkers on a particular place in Sydney. We consider how the iterative development and deployment of the apps and field exercises, over successive semesters, became one of extended co-design between students, tutors and teaching staff.

* Wally Smith, School of Computing and Information Systems, The University of Melbourne.
Email: wsmith@unimelb.edu.au
Hannah Lewi, Melbourne School of Design, The University of Melbourne.
Email: lewih@unimelb.edu.au
Andrew Saniga, Melbourne School of Design, The University of Melbourne.
Email: ajsaniga@unimelb.edu.au
Lee Stickells, Faculty of Architecture, Design and Planning, The University of Sydney.
Email: lee.stickells@sydney.edu.au
Dora Constantinidis, School of Computing and Information Systems, The University of Melbourne.
Email: dorac@unimelb.edu.au

INTRODUCTION

Taking learning into the physical world and teaching students how to observe, how to experience and how to record, has long been a significant component of architectural history and theory teaching. As Hardy suggests, observation is important not just in terms of empirical perception, but in the deeper sense of conceptual and imaginative acts of open-ended re-creation and recall. To learn this kind of observation, he suggests, is to learn architectural 'interpretation' (Hardy, 1996: 187-188). But despite learning in the field remaining integral to teaching in the built and natural environments, there is surprisingly little critical discussion of fieldwork and mobility in architecture-related education, in stark contrast to other field-intensive disciplines, for example geography (e.g., Goh et al., 2012).

In this paper, we reflect upon three projects, carried out by us as architectural educators and technology researchers, that explore the use of digital mobile technologies as resources to foster the very skills of observation that Hardy and others advocate. This responds to calls for more case studies of mobile and blended learning applications in architecture (Bedall-Hill, 2011). Adopting a case-study methodology (Yin, 2014), we report and cross-analyse these projects as three distinct cases of designing mobile-technology inspired architectural fieldwork education. Our focus is on the nature of the emerging process of designing, developing and deploying different forms of mobile-inspired fieldwork to complement class-based learning. In each case, we trace the unfolding history of initial motivations and context, through design decisions, and their consequences. As part of this, we briefly report on student reception of the fieldwork exercises as an important aspect of these design histories.

The three case studies (see Table 1) were carried out through one Australian national teaching and learning project in the areas of architectural history, landscape architecture and urban design at the University of Melbourne and the University of Sydney. Each case centred on a particular existing taught subject and involved substantial reworking of learning activities and assessment. As educators, we were interested in the design of more effective learning in the field, especially at designated sites of architectural and historical significance. Further, we believed that mobile technology, if thoughtfully deployed and refined, would allow us to promote the value of history and theory and its relevance to design practice; and to inform the ongoing debate about this relevance that began in the 1960s and remains alive today (e.g., Keyvanian, 2011).

More generally, our investigations were motivated by the broader movement towards blended learning and in particular the use of mobile technology to augment and mediate the way people learn in new places; allowing not only for 'learning on the go' but also opening up new forms of learning that follow from direct experience of the built and natural environment

(Carvalho & Freeman, 2016). Blended learning is typically defined very broadly to encompass all styles of learning that result from 'strategic and systematic approaches to the use of technology combined with the best features of face to face interaction' (Bath and Bourke, 2010:1; Garrison & Vaughan, 2008; Picciano, Dziuban & Graham, 2013). Within this broad spectrum, we were specifically interested to explore how many of the materials of the lecture theatre and activities of the tutorial might be reworked into mobile formats and thereby juxtaposed against field locations. In this way, we aimed to invert the well-worn trope in educational theory of 'bringing the world into the classroom' (e.g., Nichols and Lewi, 2016: 220), to that of taking the classroom into the world.

As noted, our main aim in this paper is to use the three case studies as a focus for reflection on the process of designing and developing uses of mobile technology in teaching that are localised and situated in a particular context. While Cases 1 and 2 (see Table 1), were attempts to create mobile learning apps for students to use in the field, Case 3 inverted this approach and invited students to investigate an uban area and then design a sketch for a mobile app that presented their theory-informed analysis of that site. In all three cases, we followed an approach of research-through-design (e.g., Zimmerman et al, 2010); that is, we sought to better understand the nature of the challenge by designing and conducting real fieldwork activities. We drew a clear contrast with the high-profile on-line and distance course delivery modes that have tended to dominate discussions around e-learning in Australia at least (e.g., Lewi & Smith, 2010). Our highly customised, even 'boutique', uses of digital technology are not typically what university managers and educational technology providers foresee as the future of education, because they do not readily offer economies of scale and portability.

In the rest of the paper, we consider what our highly localised and situated approach to mobile field learning does offer. First, we describe each study in terms of its motivations, context, and observations of the fieldwork. This is followed by a discussion of emerging cross-case themes. A key theme that we return to is the importance of the co-creation of mobile field exercises as a contributor to the learning experience.

	Course	**Mobile Activity**	**Key Learning Aim**
Case 1	Architectural History, undergraduate	Individual and paired walking tour with iPod Touch app providing images and audio commentary.	Interpretation and recording of buildings in historical context.
Case 2	Landscape Architecture, postgraduate	Small group walking tour and extensive field activities, with iPad app providing a map of key locations and integrated resources and field activities.	Experiencing landscape design intentions and their changes over time.
Case 3	Urban Design, postgraduate	Group activity to design a mobile app to express knowledge about urban design.	Understanding and communicating the ideas and influence of key urban thinkers within an urban cityscape.

Table 1. Course context, mobile activities and key learning aims for the three case studies.

CASE 1: TAKING LEARNING TO THE STREETS – AN IPOD WALKING TOUR GUIDE FOR MELBOURNE

Motivation and Context

Case 1 is the development an iPod tour guide for fieldwork in the undergraduate subject 'Formative Histories of Architecture' in the Bachelor of Environments at the University of Melbourne (see Figures 1, 2 and 3). Concurrent with the iPod guide development, this subject was made a core degree requirement and also became available to cognate students across the university, which precipitated a growth in enrolments to over 300. The subject examines ideas and precedents in architecture from the enlightenment to early modernism in Europe and Australasia. An important learning component is the integration of off-campus guided walking tours into the formal lecture and tutorial program to gain first-hand experience of 19th-century architecture and urban history in Melbourne, and to show how international ideas and exemplars were imported and how they were translated.

Figure 1. Case 1: Students undertaking the app-guided walk in Collins Street, Melbourne.

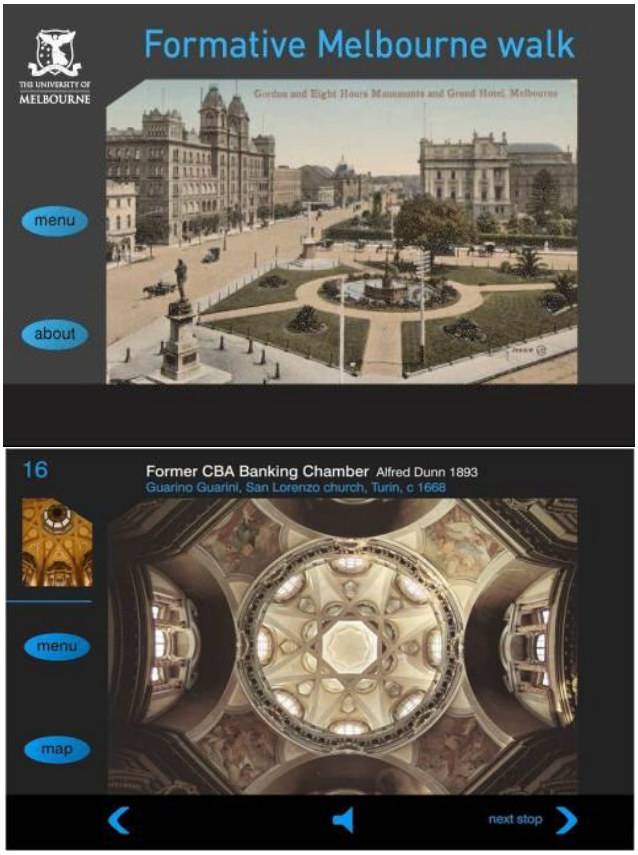

Figure 2. Case 1: 'Formative Melbourne' app: home screen (upper), and screen for Stop 16 (lower)

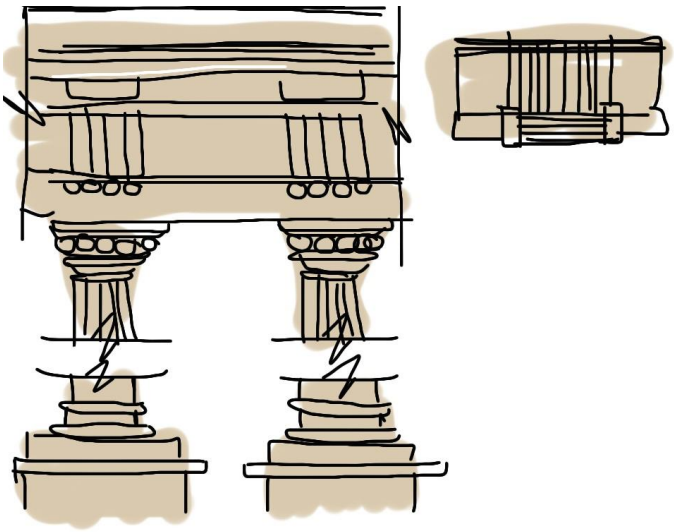

Figure 3. Case 1: Example of a student sketching created on an iPad.

The walking tour of the central city provides a local and vibrant setting for taking learning to the streets and showing the ongoing 'relevance' of history to the contemporary urban context. The development of an iPod App tour in place of a tutor or lecturer led guide was partly a pragmatic response to increased class sizes. Indeed, increased student numbers is a major factor affecting the maintenance of high quality, innovative teaching and learning in the higher education context and has motivated the introduction of blended learning tools into the conventional classroom (e.g., Dyson et al., 2009). Our aim was not to replicate the human tour guide, but to add value to the walking tour learning experience by developing digital visual and audio content, and by including a quiz-style activity that reinforced the learning content explored in lectures and the tour audio, and also to promote more open-ended observation through sketching. Discussion of the tour and quiz in subsequent tutorial groups further cemented this situated learning activity back into the academic setting.

In selecting appropriate technology options, our primary concerns were the need for equitable access and robust delivery. It was decided that the Apple iPod Touch platform was the best option when first launched in 2011. Thirty iPods were purchased for students to borrow, although they could use their own iPhone if they owned one. The interface was designed to be very simple from the offset, in the manner of a 'walk-up and use' interface, and concentrated on content delivery rather than interactive capabilities. The tour navigated a fairly linear walk with 20 stops in close proximity so as not to curate a daunting experience, especially for the many international students unfamiliar with Melbourne. Up to three comparative images and around three minutes of audio commentary, later reduced in length, were included for each stop along with a map and thumbnail photographs of the stops to assist in navigation.

In-the-field observation and interviews with small groups of students using the App and the quiz were conducted in the first two years of running the exercise. All students completed an evaluation questionnaire in the tutorial following the activity. It probed the retention of

information after the tour, the kinds of social interaction students experienced, and the perceived value of the exercise and of the different kinds of content provided.

Observations

Students carried out the activity alone (Year 1, 31%; Year 2, 47%) or in a small group of mostly 2 or 3 people. Most used their own iPhone or that of a peer (90%). Most reported completing all or nearly all stops on the tour (>95%), typically taking 2 or more hours (>85%). From direct observations, student interviews and the questionnaire it was clear that the guided walk fostered productive interactions and sharing amongst students who were encouraged to undertake the tour in pairs, or small groups, rather than as the whole tutorial class previously led by a tutor. Another advantage recognised by students was that the digitally augmented walk provided a flexible yet consistent experience to all (Sharples et al., 2002), where previously many students could often not hear the lecturer-guides due to background city noise.

Table 2 shows student survey ratings on their overall reception of the exercise. By the second year of delivering the guide, over half the students were positive about its value for the learning in the subject (rating 4 on a 5-point scale), while just over one third were neutral (rating 3). Interestingly, a clear majority were positive about its role in helping them to appreciate the city buildings in a new way (rating 5). This suggests that students saw value in the exercise that went beyond its direct contribution to their completion of the current subject. Among our other observations, students also consistently expressed preference more for detailed and focused content and less for general background histories of Melbourne.

Overall dimensions of reception		**Student ratings** (% of respondents shown)				
		1(low)	**2**	**3**	**4**	**5(high)**
Value for learning about the subject	Year 1 (N=295)	0	4.8	39.2	47.1	8.9
	Year 2 (N=153)	0	0	35.9	56.9	7.2
Enabling new ways of appreciating buildings	Year 1 (N=295)	0.3	5.2	4.5	32.8	57.1
	Year 2 (N=153)	0	0.7	1.3	36.6	61.4

Table 2. Case 1: Students' 5-point ratings of the value of the 'Formative Melbourne' history walk for their study of the subject, and its enabling of new appreciation of buildings.

The iPod guide became a tool for delivering what we have termed ‘directed looking’ (Lewi & Smith, 2011), meaning the close and guided alignment of digital interpretative content with the physical reality as seen by users. For example, the audio might 'point out' a detail high on a building façade and question students to think about its origins or purpose; or might ask students to compare what they saw with a drawing of a direct European precedent displayed by the app. Therefore the overriding pedagogical aim of the iPod tour, following the

sentiment of Hardy above, became for students to learn to look more closely at buildings in their local context and, importantly, to interpret them in the field so as to reinforce connections between architectural precedents and meaning in one particular context with broader international design ideas and histories. The content was therefore seen by students as most valuable when it did indeed direct and guide them to observe and interpret in a manner that resembled a more traditional tour with an expert human guide. The App's simplicity has meant that it has been robust enough to run for the last four years, with minor updates and extension to Android. Using the App-Store has also meant the tour has been available to the general public too. Despite a large investment in time in developing and curating the tour initially, it has been an invaluable addition to this subject.

CASE 2: LANDSCAPES IN TIME - AN IPAD GUIDE TO THE ROYAL BOTANIC GARDENS MELBOURNE

Motivation and Context

Case 2 focused on the design of digitally guided fieldwork for teaching landscape history to postgraduate students enrolled in the subject 'History of Landscape Architecture' also at the University of Melbourne. A pre-existing fieldwork exercise based on a lecturer-led tour of the Royal Botanic Gardens Melbourne (hereafter 'the Gardens') and surrounding parkland was redeveloped through the creation of an iPad app *Landscapes in Time* (see Figures 4 and 5). The app curated audio commentary, current aerial photography, plans, historic images and film footage relating to 13 designated stops on a walk through the gardens. Each stop reveals a different historic aspect, while the walking journey between locations was equally important in communicating larger historic narratives. The intention was to engage the students in aspects of physical change in the shapes and forms that constitute a historic landscape as well as the absences or hybridised forms that would otherwise remain elusive without some directed and conceptual learning. The aim of the iPad tour was therefore to promote new ways of learning in a group field activity conducted over a large land area.

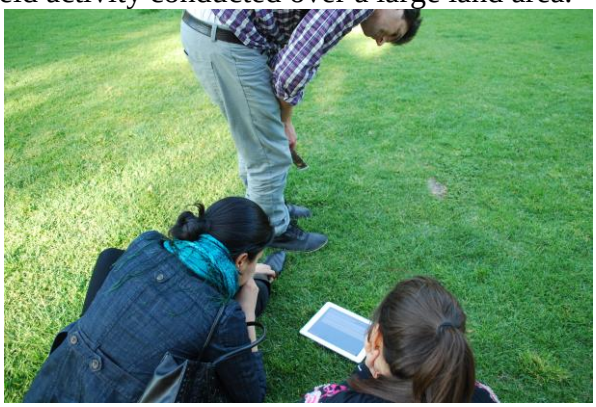

Figure 4. Case Study 2: Students using the 'Landscapes in Time' app to view images and listen to audio in the Royal Botanic Gardens, Melbourne.

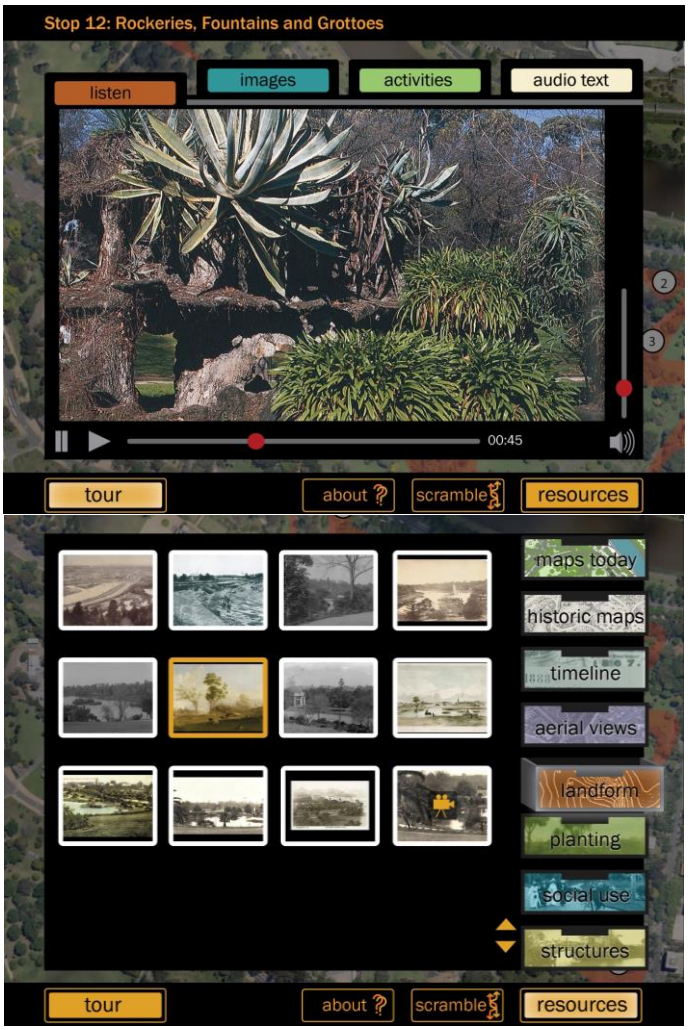

Figure 5. Case 2: Screens of the 'Landscapes in Time' app, showing main view for Stop 12 with tabs to key resources (upper), and supplementary information provided in archive 'drawers'(lower).

The act of walking was identified as of great significance in this learning activity. As has been argued elsewhere (Lewi, Saniga & Smith, 2014), walking through landscape combines physical and sensorial stimuli with way-finding and unexpected experiences. The Gardens are a nineteenth-century picturesque creation, formed around the idea of strolling through a romantic garden. Aspects of foreground, middle ground and distant background that underpin picturesque design principles guided the choice of stop locations; the directing of views and the spatial sequencing of stops attempted to reveal glimpses of garden elements and follies that beckoned students to further seek and explore. This echoed the original design premise for the Gardens. An 'aestheticised navigation' thus became the *modus operandi* for digitally augmented and situated learning that combined an awareness of the history of the design with the students' own experience.

In delivering this mixed–media resource *in situ* and in a historically inspired manner, we also identified the need to create a sensory dialogue rather than an academic monologue, or as Paul

Carter evocatively expressed in another context; 'the need to augment the eye with the ear: the fluctuating air that looks like a mirage may be vibrating with a message…' (Carter, 1992). This required a balancing act between cognition and affect, and an appreciation of the potential for landscape experience to be shaped by an array of natural materials and ephemeral environmental conditions (Knopf, 1987). There was a need to find a balance between harnessing the seemingly boundless content delivery capacity of digital technology while not dropping students in an encyclopaedic abyss, thus we attempted to curate the gradual release of data in line with the choreographed walk. A key aim was therefore to facilitate direct experience grounded in the multi-sensory information of the space, sounds, textures and smells found in the Gardens, whilst also instilling historical information and an appreciation of historical time.

Achieving this balance was a focus of reworking the mobile guide and associated resources over three years, and three deliveries, of the exercise. Central to this was the gradual development of a paper-based workbook of questions and drawing tasks to be used by each student individually in parallel with the group use of the app. Prescriptive instructions and tasks included prompts to aspects of the scene and how to record information in creative ways. This included drawing impressions of objects or materials in the landscape and the making of frottage, alongside more objective (yet equally immersive) tasks such as completing a measured drawing. These assignments were envisaged also as a decoy for chance encounters and serendipitous activities as students explored the picturesque setting. In the final analysis it became difficult to gauge the extent to which the digitised historical environment shaped personal experience or engendered imaginative experience, but students' work certainly indicated reflective appreciation.

Observations

Direct observations of groups of students at work in the Gardens were carried out, supplemented by informal interviews and a comprehensive questionnaire completed after the exercise. Table 3 shows the overall reception of the exercise in student survey ratings. Similar to the findings in Case 1, around half of student found it 'very' valuable while half found it only 'somewhat' valuable. The student focus group suggested that their answers to this question related to the perceived instrumental value of the exercise for completing the subject successfully. Students described finding a few aspects of the field exercise to be low in value in this regard, an inevitable feature of the practicalities of fieldwork. Responses were more positive about the exercise's role in helping them to appreciate the Gardens landscape in a new way, with roughly half of the students giving this the highest rating. Again, this suggests students saw value in the exercise that went beyond the instrumental completion of the current subject, and that they knew the difference. We tested this more directly in Years 2 and 3, where students were positive about its role for the assignment that had been strongly integrated into the tour and the app design. They were also positive about it being an

enjoyable experience, although for 32.1% this was only 'somewhat' enjoyable, underlining the challenge and risks of field exercises.

Overall dimensions of reception		**Student ratings** (% of respondents shown)				
		1(low)	**2**	**3**	**4**	**5(high)**
Value for learning about the subject	Year 1 (N=12)	8.3	0	41.7	41.7	8.3
	Years 2 & 3 (N=29)	0	0	40.7	55.6	3.7
Enabling appreciation of the Gardens in new ways	Year 1 (N=12)	0	0	16.7	41.7	41.7
	Years 2 & 3 (N=29)	0	0	6.9	41.4	51.7
Value for completing assignment	Years 2 & 3 (N=29)	0	3.6	14.3	57.1	25.0
Enjoyable	Years 2 & 3 (N=29)	3.6	3.6	32.1	53.6	7.4

Table 3. Case 2: Students' 5-point ratings of the value of the 'Landscape in Time' tour, its enabling of new appreciation of the Gardens, its value for the assignment work, and whether it was enjoyable.

An acute challenge that emerged through student feedback on the first iteration of the iPad guide was the lack of an engaging presence of the lecturer as a guide. This absence contrasted greatly with the lecturer's normal presence and depth of interaction in other class exercises. In response, and after some experimentation, we realised that the problem lay partly in the formal nature of the professionally recorded audio component of the lecturer's narrative. In later version of the guide, this was replaced with intentionally informal and somewhat 'rough' video and audio material at each tour stop, recorded directly in the Gardens by the lecturer, using the iPad. This technique succeeded in better invoking a sense of immediate presence – more so than the polished pre-scripted audio. Each stop's video narration also became a teaching tool for thinking about the variability of incidental on-site conditions, as each student's own personal views and environmental experience was different, and this heightened potential appreciation of the contingency and uniqueness of physical reality in the Gardens.

Ultimately, as with Case 1, the *Landscapes in Time* app succeeded insofar as it provided a key element in a package of resources to guide students' exploration of a landscape. Despite the challenges and difficulties it raised in development and use, it was generally well received by students and provoked a new dynamic mixing of modes of delivery, creatively experimenting and applying historical knowledge within the contemporary situation of the Gardens.

CASE 3: URBAN CONCEPTS IN THE FIELD – AN ACTIVITY FOR DESIGNING AN APP IN THE CITY OF SYDNEY

Motivation and Context

In contrast to Cases 1 and 2, Case 3 involved asking Masters students of urban design at the University of Sydney to conceptualise and propose a sketch design for a mobile app that would serve to express the ideas of a selected key urban thinker; by choreographing visitor activities situated in the city of Sydney (see Figures 6 and 7). This task was part of a larger 'Concept Guide' assignment for their chosen urban protagonist. Complementing the historic emphasis of Studies 1 and 2, the activity aimed to develop student reflection on the interrelationships between theory and its emplacement in the local urban environment. The intention was to foster students' appreciation of the descriptive, analytic and projective possibilities of theory (e.g., Dunphy & Spellman, 2009; Kent, Gilbertson & Hunt, 1997). Further, by asking students to themselves design a mobile app, based on their field investigations of an urban area, was intended to scaffold the ability to recall theoretical models and definitions, and to test student knowledge and critical reflection in real sites; a skill seen as pivotal for the broader field of professional practice education (Lee, Dunston & Fowler, 2012).

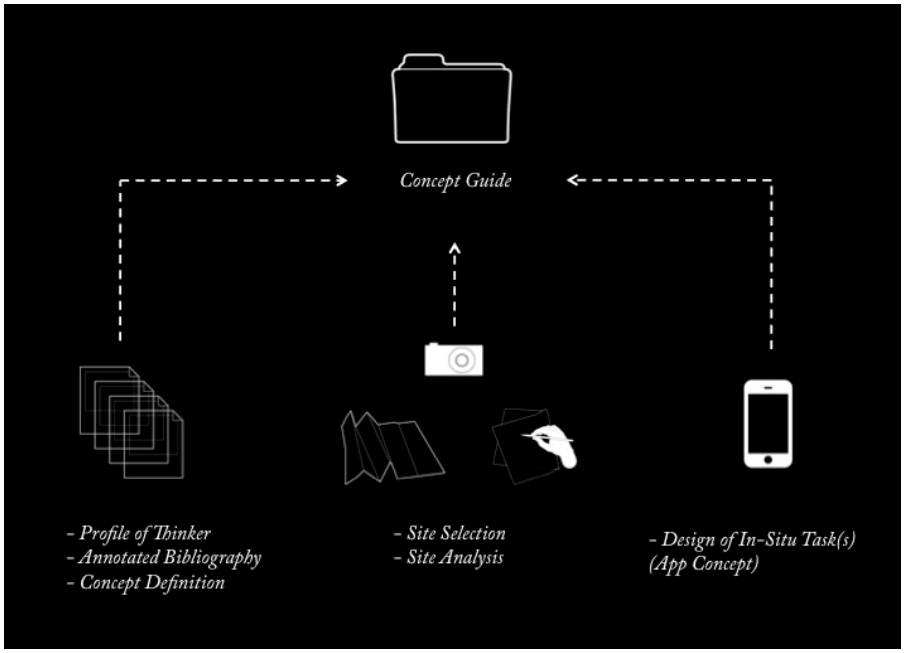

Figure 6. Case 3: Structure of the 'Concept Guide' assessment task.

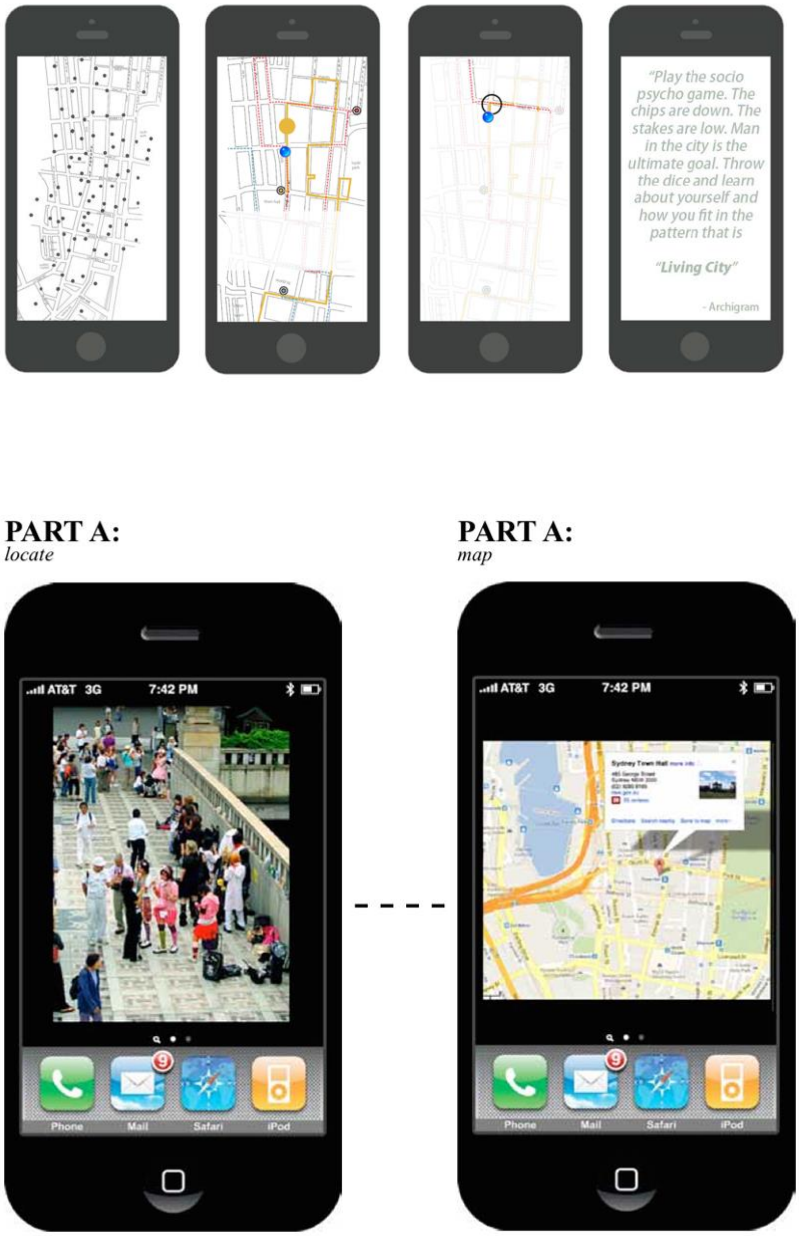

Figure 7. Case 3: Two examples of student work.

The method of the learning task was for students to create screenshot mock-ups of their proposed mobile app in action, a technique of early prototyping borrowed from the field of interaction design (e.g., Snyder, 2003). Framing students' thinking about content creation in relation to mobile devices, as part of a fieldwork activity, was introduced as a potentially powerful way to inculcate and reinforce the linkages and relevancy of theory, along with exploring new modes of design thinking outside their typical experience. With this in mind, we were particularly interested to explore an alternative to more conventional blended learning modes that deliver mobile technology as an adjunct tool already preconceived by the lecturer (Hall, 2013). Instead, this third case study aimed to develop an innovative technique

for fieldwork using the potential of mobile device design as a context for the development of deep thinking, rather than thinking of technology as simply a mode of delivery or a proxy instructor.

Students were given the task of designing a mobile tool and app that would reinforce a particular theoretical framing around their chosen urban thinker for field observations in Sydney, and build-in a mechanism of reporting their analysis back to the lecturer and peers. Each student conceptualised an app that could guide a user through a set of tasks in order to improve understanding of theoretical concepts in the field. Examples ranged from architects and landscape architects, to sociologists, planners and urban designers. These included Danish architect Jan Gehl whom students associated with concepts such as the categorization of 'necessary, optional or social spaces'; American activist Jane Jacobs, associated with ideas such as 'eyes on the street'; the Japanese architect Kisho Kurokawa's concepts of urban 'symbiosis' and 'flexibility'; and Archigram's speculative proposals for 'Instant and Plug-In Cities'. The fieldwork tasks involved directed observation as well as the production of multimedia interpretive or analytical materials to demonstrate understanding (via methods such as drawing, photography, writing, interviewing). Instructions and, in some cases, schematic designs for an app interface were developed by students that aimed to be readily usable, creative and relevant to the concept. An emphasis was placed on developing and testing text, image and diagram assemblages that would be effective in small-scale digital formats while moving around in the field.

Observations

Evaluation of the study was made through observational diaries, post-field reflections and analyses within a classroom setting, and student surveys and interviews. One of the challenges identified in the conception of a mobile app as part of the 'toolset' for the subject was the significant additional resources required; both expertise and time beyond typical curriculum development. In the focused questionnaire, students overwhelmingly felt that these components were 'quite' or 'very' important (Year 1: 75%, N=18; Year 2: 75%, N=14). One student commented: "the concept guide forced us to go beyond books and be involved in the project." Reinforcing this response, another student suggested that the most important aspect of the subject for developing a situated understanding of theory was: "The urban analysis and linking it back to today and how urban designers works."

Our observation over the two iterations of the study was that students found developing the "instructions"/app sketch helped improve their understanding of their chosen concept of urban thinking. They saw it as a challenging but compelling exercise. In the focused questionnaire, the majority of students found this part of the assessment task 'helped somewhat', while a small percentage (Year 1: 8%, Year 2: 25%) found it 'helped a lot'. No student reported finding the task unhelpful. One student observed that "The site analysis gave you the ability to assess whether the theory is appropriate/useful in Sydney." Another suggested that this

aspect helped with "gaining an understanding of how the concept works as a whole, serving as a eye opener to analysing parts of Sydney." In the broader evalution of the whole unit of study, one studen's comment about the innovative quality of the exercise expressed a reaction we observed more generally: "the final project was different and challenging – instead of another boring essay, we were challenged to produce an app – showing the digital and visual age we live in".

A key lesson learned was the importance of the activity as augmentation of the learning experienced in lectures and tutorials. Students almost unanimously found the app design and fieldwork to be "most relevant", and they felt strongly that "apps should be used as an additional layer of learning". The results of Case 3 also supported Farman's call for an approach that is 'less about the devices, and more about an activity... which is a practice of embodied space in the digital age' (Farman, 2012). Student feedback and staff observations during the study positively reinforced the assumption that there was great value in the intellectual, affective and physical intensity of engagement generated by imagining apps, rather than using actual devices enabled with data access or tours. The results point to the value of continually and creatively questioning the pedagogical framing of learning activities including those engaging new technologies.

DISCUSSION

We turn now to what our three cases reveal about mobile-inspired fieldwork in architectural education. The findings can be divided into two areas. First, we consider to what extent and in what ways the mobile tools, in the form of mobile guide apps in Cases 1 and 2 and in the form of design concepts in Case 3, enhanced an exchange between the classroom and the field. Second, we consider less anticipated findings about how the very process of designing and re-designing mobile-inspired fieldwork was itself a significant act of learning.

On the first area of findings, in all three of our studies we found that mobile supported fieldwork became, in different ways, a very valuable tool for assisting in the interpretation of the physical environment and the students' experience of it. And, consistent with much previous research (e.g., Sharples et al, 2002), our mobile activities did indeed encourage the sharing of students' interpretations of the environment through different mechanisms. The mobile-learning activities that we created became a 'coordinative glue' that connected formal face-to-face learning on the campus with more informal group and individual field learning activities (Siemens, 2005). In Case 1, this was seen in the adaptation of the traditional format of comparative illustrated lecture, from conventional art history education, to an iPod Touch guided walk that was directed towards interpreting specific places and buildings. In Case 2, the fieldwork notebook assignment that was embedded in the *Landscapes in Time* iPad app created a valued presence of the absent lecturer in the field, as a guide to observing and

experiencing landscape. While in Case 3, the task of designing a mobile tool was given to students themselves to create a theoretical scaffold for field observations and experiences, and to create a mechanism of connecting analysis back to both peers and teachers. On the immediate outcomes for learning, therefore, the overall findings confirmed our belief as teachers that mobile tools, serving as guides to places in Cases 1 and 2 and their use as objects of design in Case 3, can bring positive interventions in the place-based learning of architectural and landscape history, and urban theory and design.

Our second area of findings is more retrospective and contains insights that were more surprising for us. These concern the process of developing the three interventions, or what might be called the process of blending the various learning resources. Particularly in Cases 1 and 2, the development of the tool and related activities became an extended process over a period of three years, over which time both tools and techniques were iteratively evaluated and refined. Conducted as research projects into teaching, we realized in advance that the studies would involve a range of evaluative activities from informal piloting, technical support, impromptu student feedback, and also formal systematic evaluations carried out by us and by our institutions. But we did not anticipate that through all of this, the students, tutors, and teachers would effectively become *co-creators* of the blending learning. So while we had planned Case 3 as our attempt to explore students acting as designers within the frame of mobile technology, in practice students in Case 1 and 2 also took on significant elements of this role. And while this was productive in many ways, it also opened up tensions and differences of viewpoint about the value of the tool, and the value of fieldwork generally, and the learning objectives of the subject itself.

One of our earliest observations was that students got drawn very quickly into co-creation because their support was needed in solving various practical challenges; such as the management of procedures for borrowing and re-charging devices, ensuring consistency of data, and testing across different mobile operating systems. The input of students was not simply in pointing out problems, but was in suggesting fixes with detailed information about what was needed; for example, achieving appropriate audio volumes against background noise, a point that is hard to achieve until tested *in situ* under real fieldwork conditions; and, ensuring the legibility of text and image sizes against the glare of outdoors conditions and the availability of shaded areas in particular field sites.

Having been drawn into this pragmatic level of design, students were then well-positioned to advise on other aspects of the learning process, and thus the mobile technology quickly became a site of exploring not just usability but also pedagogy. For example, mobile devices offer the potential to present encyclopaedic volumes of information to the field task, and students generally expected this, and many in Case 1 were surprised to encounter our approach of providing only a small number of carefully selected images to compare with built realities. Our view was that great volumes of content may seem valuable, but they risk

distraction and over-focus on the technology relative to the field environment. This remained an ongoing difference of viewpoint and although we made adjustments in the volume of content, we retained our position based on observations of student behaviour with the apps; so while the iPad of Case 2 provided 'drawers' of supplementary image and video material (Figure 5), they were not used much by students who concentrated on the primary images that were relevant to the assessment tasks.

Student design input was not just through informally voiced feedback, but also came through the formal evaluations. In Studies 1 and 2, students were clearly most engaged by visual digital content that showed details that they could search for in reality, with intermediate engagement achieved by interior and historic images of the sites, and least engagement with comparison buildings or design plans from elsewhere. Similarly for audio commentaries, content was more engaging when it took the form of directions to look at present features, and less engaging as background historical information. Having observed this effect strongly quite early on, we were able, in subsequent iterations, to reinforce the approach of directed looking and listening through the apps, as opposed to less situated acts of informing.

Another example of co-creation concerned the chosen genre in which material was delivered, which might follow a number of established formation: traditional lecture, guided tour, museum display, heritage interpretation sign, or laboratory note-book. In the first version of the iPad app for Case 2, a formal lecture-style of rehearsed audio delivery was used unintentionally by the teacher who recorded them in a studio. This was received with some surprise and consternation by students who found it incongruous with the immediacy and variability of a field situation, and inconsistent with face-to-face interactions with the teacher. In the next more successful iteration, material was recorded by the same lecturer but now while moving through the field site, speaking in the informal style of a tour guide and recorded directly to the iPad using the video function.

A key area for contesting the form and content of our interventions was around the clarity and guidance for field activities. The experienced teachers in our case studies, who all recognised the need for clarity of instructions, were still surprised by the extent to which students could feel daunted by the perceived open-endedness of field exercises without a member of staff on-hand to clarify. And so the framing of field exercises was continually strengthened across all iterations of our studies. This included more briefings, demonstrations, in-device instructions, and so on. For Case 2, for example, later iterations included detailed instructions around the division of labour in the student teams. Critical also, was the need for debriefing of the field activity as soon as possible afterwards, so that uncertainties could be voiced and discussed. In Case 1, the walking tour was given a dedicated follow up tutorial in which student responses to the quiz were discussed. For Case 2, the debrief was through a focus group discussions held as part of the research, but it was realised that this needed to continue in future normal deliveries of the exercise. In Case 3, a later iteration of the exercise was improved by

providing new and very clear boundaries around what was to be included in the activities through guidelines and resources such as templates.

More significantly, during pre-briefings and demonstrations of the mobile tool and exercises, it became natural and productive to share with students the pedagogical thinking around the use of the mobile technology, including the teacher's beliefs and intentions about the value of the learning experience. In Case 2, the tour guide app was initially and mistakenly presented as an 'alternative' to touring with lecturer, and this created a more negative reception than subsequent deliveries where it was presented as the only option.

Although not completely prepared for the form of co-creation invoked by our investigation, we had nevertheless expected to learn and revise from student feedback. For this, we adopted a strategy, common in the field of interaction design (e.g., Snyder, 2003), of minimal technology development initially. That is, to start by delivering a form of a mobile tool that is just sufficient to evaluate if the teaching and learning intentions are viable; with simple content and a simple form of the target activity. In first iterations, students were given some materials in paper-based form, such as instructions or answer sheets, thus giving us plasticity to rework our materials. While generally appropriate, this approach had drawbacks and in both Cases 1 and 2 led to a proliferation of separate tools, both digital and physical, that students needed to have with them to complete the exercise. In Case 2, in particular, the use of a digital iPad guide plus a physical workbook was felt cumbersome by some students who called for more integrated digital support for their assignment work.

It was through these exchanges with students that we faced questions that were at once practical and profound, about the blending of activities between lecture theatres, landscapes and cityscapes. What reasons were there to juxtapose lecture-room slides against reality? How should different digital and physical tools be coordinated when documenting a landscape? What interaction style would best communicate urban design concepts to a public audience? And so, through an extended process of co-creation it became evident that the value of the mobile tools and apps was not simply in their function as learning resources, but lay more perhaps in them working to encapsulate and contest approaches to teaching and learning about architectural sensibility.

So, in conclusion, our three case studies confirm the view that digital guides and mobile applications can create valuable opportunities for students and teachers of the built and designed environment to 'explore new modes of interaction' and to extend traditional sources and approaches to learning (Coyne, 2009: 130). But more significantly, to return to the comments of Hardy (1996) reported in the Introduction, these three projects in mobile-inspired fieldwork witnessed deeper forms of 'observation', of awareness and interpretation of these historic and urban landscapes where the fieldwork was staged. This was partly through the intended use of the digital tools in field activities, but even more it was through a sense,

experienced by students, tutors and teachers alike, of participating in a collaborative design effort that led all concerned to confront the deeper issues about what kind of observation and interpretation is demanded when bringing the learning materials of the classroom out into the world.

Acknowledgements

Support for this project has been provided by the Australian Government Office for Learning and Teaching. The views in this paper do not necessarily reflect the views of the Australian Government Office for Learning and Teaching for Learning and Teaching.

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Journal of Problem Based Learning in Higher Education

VOL. 5, NO. 1, 2017 – Page 85-110
http://dx.doi.org/10.5278/ojs.jpblhe.v0i0.1542

Collaboration and Dialogue in Virtual Reality

Camilla Gyldendahl Jensen *

ABSTRACT

"Virtual reality" adds a new dimension to problem-based learning (PBL) environments in the architecture and building construction educations, where a realistic and lifelike presence in a building enables students to assess and discuss how the various solutions interact with each other. Combined with "Building Information Models" (BIM), "Virtual Reality" provides an entirely new opportunity to innovate and optimize architecture and construction in its early stages, which creates an iterative learning process. The analysis identifies several clear opportunities regarding extended use and involvement of the gamification mechanisms known from, e.g., video games software – like the principles behind quest, levels, dungeons, etc. – to support web 2.0 features in the future development of VR systems. The study clarifies the challenges of creating web 2.0 solutions with the complexity and robustness that supports a sketching, design-oriented, exploratory and investigative learning process, which is at the core of problem-based learning.

Keywords: Gamification, PBL, Innovation, Dialogue, Collaboration, Virtual Reality, web 2.0

INTRODUCTION

New social trends and technology contribute to increasingly complex collaborative interactional processes, where the concept of knowledge is transformed through the use of virtual and digital forms of communication (Selander, 2008). These new technological advances within web 2.0 offer the potential to create various interactional processes through virtual forms of communication, where users are linked together in collaborative communities

* Camilla Gyldendahl Jensen, Department of Architectural Technology and Construction Management and Aalborg University, Department of Learning and Philosophy.
Email: capo@ucn.dk

(Lane, Osborne, & Crowther, 2015; Selander, 2008). The web 2.0 technologies are therefore increasingly used in computer games to give the narrative history of a greater degree of social interaction. Particularly video games in the genre of Massive Multi Online Role Playing (MMORP) games are built around the use of avatars that are linked with chat systems through a virtual environment in real time (Golub, 2010; Chang & Lin 2014; McGonigal, 2011; Gee, 2003). In doing so, this particular kind of video game has managed to use the social communication tools that define web 2.0 to support the game's narrative challenges and problem solving. Video games, as a learning context, therefore, represent a new way of thinking within the educational system, as it allows educators to create teaching approaches that support the development of competences related to collaboration and problem-solving on virtual communication platforms through dialogue and interaction (Yeh, 2010; Selander, 2008; Gee, 2003).

Education that focuses on architecture and building construction is traditionally characterized by having a practical and professions-oriented approach, in which students in addition to a theoretical curriculum are also taught skills such as "learning to design" in order to develop practical designing skills (Schön, 2000; Knudstrup, 2003; Knudstrup, 2005). The use of Virtual Reality and "Game Based Learning" adds to the web 2.0 technologies an embodied and explorative dimension, so that the Problem Based Learning (PBL) pedagogic experimental approach can be supported, particularly within higher education in architecture and building design.

PROBLEM AREA AND RESEARCH QUESTION

This study aims to examine problem-oriented learning situations in a blended learning context where the academic focal points are architectural and technical topics when designing a building. Whereas a large number of studies have focused on different forms of virtual simulation tools based on predefined tutorials about collaborative processes, this study is addressing the problem from a new angle, as the virtual universe is created through the use of the students' own iterative design of a building (Knudstrup, 2003; Knudstrup 2005). The study design aims to identify the factors that are necessary for a "Virtual Reality" system that can guide its users through complex and collaborative processes in a virtual context generated by themselves.

> *What effect will the use of gamification principles have on collaborative and problem-based learning processes in user-created virtual reality environments?*

The next section describes the theoretical framework, which focuses on "Activity Theory" (AT) as a structure for analysing what effect gamification principles have on a Virtual reality

system's ability to mediate collaboration and dialogue. In section three, Design-Based Research is introduced as the larger, overarching framework, and AT would then count as the structuring, analytical tool within that framework. The argument for this choice is that it would be possible to let the perspective and aspects of gamification inspire and inform the design activities through an iteratively process known from Design-Based Research methodology. Section four contains an analysis of the collected data and sections five and six conclude with a description of the paper's findings and contribution.

PROBLEM BASED LEARNING AND GAMIFICATION

Within Problem Based Learning (De Graaf & Kolmos, 2003; Kolmos, 2004), John Dewey's theory (Dewey, 1986) about experience as something connected to experimenting and exploration, has been a great source of inspiration. Experience, as a concept in Dewey's thinking, is something more, and something different than just knowledge obtained through the acquisition of knowledge and past actions. Experience is about the relationship between thought and action and the relationship between humans and the environment. Dewey argued that we participate in a world where action and thinking are related, and experience is the concept that both describes our interconnectedness with the environment, and the relationship between action and thought – this is the transaction that is the experience (Dewey, 1986). Dewey's ontological understanding of experience is therefore based on an idea of humans as always being situated, and that the individual and the environment is transactionally related in a mutually constitutive and integrated whole (Buch & Elkjær, 2015; Elkjær & Wiberg, 2013). The learning process with respect to architecture and building construction is thus characterized as being situated through a practice-oriented project where social participation is essential for creating an iterative design and learning process.

Existing research (see e.g. Dau, 2015; Matzat, 2013) discuss pedagogical models for blended learning, which is used in a profession- and practice-learning context. However, these studies do not deal with educations where product- and design development is the focal point of the learning process. There is a big difference whether the educational learning goal is centred around professional training, literacy and dialogue instead of collaborative design processes where a concrete product is developed through methods such as sketching, design-oriented activities, modelling, prototyping, etc. (Schön, 2000; Knudstrup, 2003; Knudstrup 2005). An Australian study has investigated architecture students' perception of online learning (Lane, Osborne, & Crowther, 2015). The study showed that a negative perception of online learning is prevalent, due to the used technologies' inability to facilitate situated learning synchronously. If a virtual reality system should support a PBL environment within an architectural design process is, it is essential that the systems technological solutions contain the necessary educational tools. In particular, the degree of interaction, tactile experiences, and synchronous participation have been absent in the previous E-learning models (Ng,

Bridges, Law, & Whitehill, 2014). New opportunities in IT hardware and software are now opening up for interactive synchronous tools supporting PBL pedagogy and collaborative methodologies (Savin-Baden, 2014).

In recent years, gamification has emerged as a new concept (Gee, 2003). Unlike business and educational institutions, the computer game industry has found a model to get people to work together in a virtual universe. Across national borders, computer players can innovate and solve problems on specific issues while the activities are performed with a high level of motivation and energy. The high degree of socialization through the use of avatars and dialogue-based collaboration entails a high level of telepresence – the experience of being present in a virtual environment through communication. Combining web 2.0 with games creates a form of practice that draws on more than one modality with regard to communicating different types of meaning (Golub, 2010). Dewey's definition of "Aesthetic experience" can be used to explain the relationship between the virtual environment and the students' learning process. "Aesthetic experience" is about active participation towards a final goal, which at the same time is also experienced as a satisfaction through the interaction with the environment (Dewey, 2005).

The combination of PBL and Gamification is interesting, as the latter contains an indirect facilitation of processes and partly a playful and explorative aspect. Also, users receive reinforcement in order to promote behavioural persistence, the courage to make mistakes and social acceptance of new ideas (Erenli, 2013; Deterding, 2012; McGonigal, 2012; Morris, Croker, Zimmerman, Gill & Romig, 2013). Video games' ability to suppress their users fear of failure through a platform or framework that serves as a kind of safe zone is markedly different from the conditions that apply to problem- and process-oriented teaching, where errors often lead to a lack of motivation (Illeris, 2006; Deterding, 2012). In computer games there even is a culture in which a process is repeated until the goal is reached. This culture means that users continuously force the error and after that develop new solutions for building momentum in the game (Deterding, 2012; Erenli, 2013; McGonigal, 2012; Morris, Croker, Zimmerman, Gill, & Romig, 2013).

One of the game models that has been very successful in establishing a sense of collaboration in a virtual space is the genre of Massive Multi Online Role Playing (MMORP) games. This game type is defined through a network-based and virtual universe where people located in different geographical locations interact with each other in real time. MMORP games have built-in troubleshooting features through the quest, realistic scenarios, role play and collaboration mechanisms that stimulate the players' intrinsic motivation, group identity, social acceptance/approval, and "self-efficacy." Studies have indicated that these gaming activities facilitate the development of problem-solving skills of the users (Hou, 2011; Chang & Lin, 2014; Ang, Zaphiris, & Mahmood, 2006) along the way.

The coupling between virtual platforms and PBL processes linked through the use of design principles known from video games is interesting since it offers the possibility of synchronous and real-time participation in a situational context that is based on the students' architectural models.

THEORETICAL FRAMEWORK

This section addresses the study's theoretical framework, through a description of Activity Theory as an understanding of social collaboration in a holistic system. The structure of the study design and hereby a prototype, is based on an operationalization of the theoretical framework combined with a litterature review of existing research within the field of gamification and PBL. This section will close with a description of the drafted prototype of this study.

Gamification represents a significant shift away from the typical teacher-centred approach to a more activity-based approach, where social interactions are emphasized. A litterature review on web 2.0 shows that it is through activities humans transform learning and even embrace the possibility of problem-oriented learning.

Activity theory (AT), formulated by Vygotsky and Engeström respectively is a method that provides an understanding of social collaboration processes by analysing phenomena, finding patterns and making inferences across the interactions.

Activity theory is particularly suitable as a theoretical foundation in web 2.0, particularly due to the descriptive framework, which considers an entire system of collaborative activities (Said, Thair, Ali, Noor, & Abdullah, 2014; Widjaja, 2005; Kaptelinin & Nardi, 2012). The motive for the activity in AT is created through the tensions and contradictions between the elements of the system. This approach is particularly useful for studying a group that exists in a virtual form and its communication and collaboration. The use of activity theory as a theoretical framework, therefore, makes it possible to understand the VR system's complexities, in this context particularly the relationship between the students and the virtual environment as a learning artefact/tool.

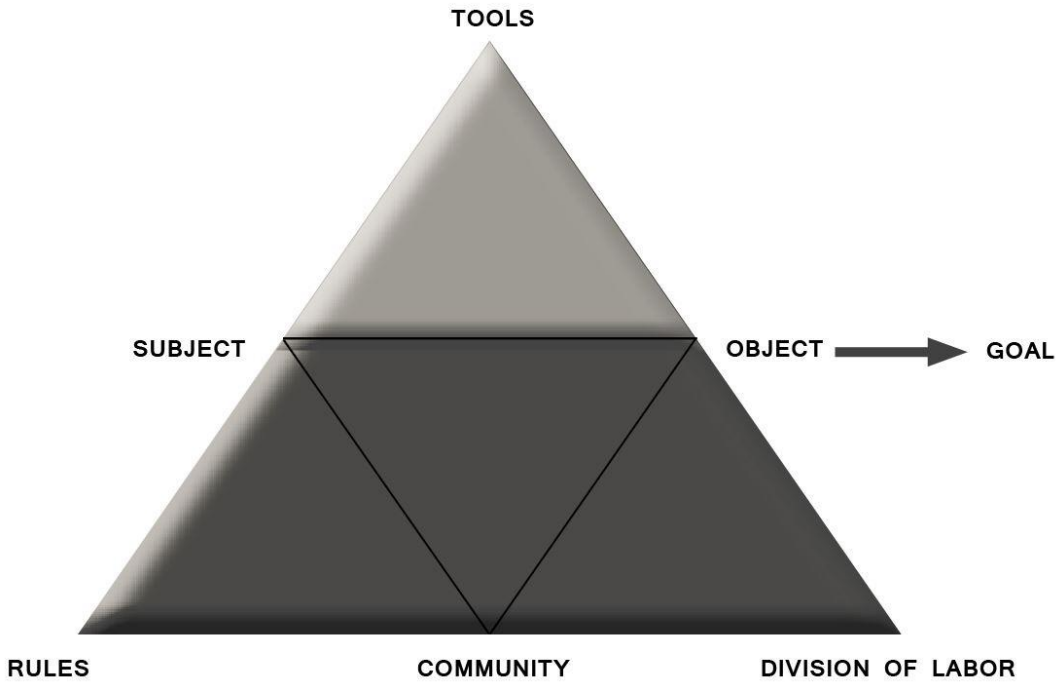

Figure 1: The Activity theory system includes the object, subject, mediating artefacts (signs and tools), rules, community and division of labour.

Wartofsky expands in the text "Models, Representation and the Scientific Understanding" on the way humans understand the perception of artefacts through what he calls a cultural epistemology. He argues that we perceive things in a historically determined way beyond our physical senses (Wartofsky, 2012; McDonald, Le, Higgins & Podmore, 2005).

Wartofsky connects a tool's user function with the mental models created by human comprehension when they are used. These connections create a movement from the practical and material to the theoretical and imaginary. All kinds of things can thus be considered as tools if their function and their impact are mediating. This mediating nature of an artefact determines the way in which humans transfer and preserve cultural changes, and consequently create new meanings and knowledge. According to Wartofsky, the artefacts contain a cultural function and thereby intentions and cognitive standards that create an agency of the activity (Wartofsky, 2012; McDonald, Le, Higgins, & Podmore, 2005).

Wartofsky is thus expanding the role and significance of the artefacts' non-material cultural dimension and opens up a new way of analysing complex activities through the division of the artefacts' use into three levels as a taxonomy (Wartofsky, 2012; McDonald, Le, Higgins, & Podmore, 2005).

The first level consists of the primary artefacts, which are tools seen as objects, as well as the necessary skills to use them. The second level contains the secondary artefacts, covering

representations such as maps or diagrams that can be perceived and that transfer skills and modes of action. The last level deals with ideas or possible worlds. For example, both can exist as a theory, creativity or play. With this separation of the artefact, Wartofsky expands the use of Vygotsky's original triangle by providing the possibility for a wider analysis of complex activities that involve more than one level of an artefact (Wartofsky, 2012; McDonald, Le, Higgins, & Podmore, 2005).

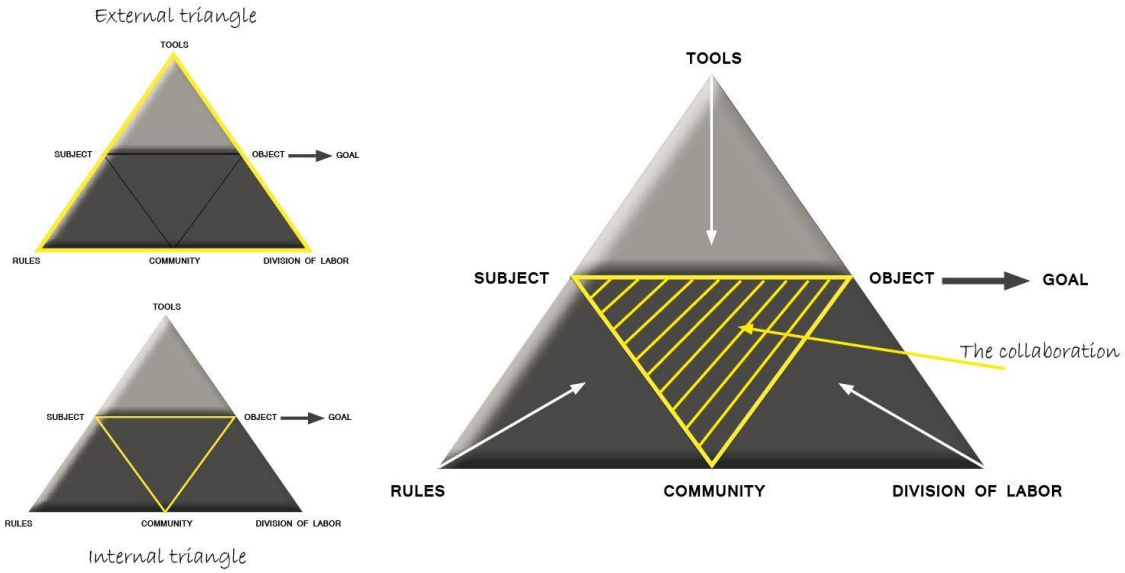

Figure 2: The external and internal triangle of the activity system

This relationship between the students and the virtual environment (VE) makes the Virtual Reality (VR) system an advanced collaboration and learning tool that can be described through terms such as experiencing an imagination, activities, and representations.

DEVELOPING THE PROTOTYPE

Based on the description of the theoretical framework, the following section relates to the operationalization of the "state of the art" into a holistic "Virtual Reality" system by the understanding of "Activity Theory" as the general design principles. The prototype was developed through a series of iterative workshops where participants with different professional building profiles and software developers participated. The prototype has been developed on two levels:

- The framing of software/hardware.
- The creation of the content and its gaming elements – the use of the system.

The inspiration from gamification is primarily focused on the genre of MMORP games. Here, it is particularly the gamifying of the collaborative learning process that is central when it comes to creating a virtual reality software that can mediate the dialogue. The software used has been developed on the "Unity Game Engine" which facilitates working modular. The software simplifies both the implementation process of the Virtual Reality hardware Oculus Rift Development Kit and the future development of the prototype. The "Unity Game Engine" therefore makes it possible to convert a 3D model from the professional building design tool Autodesk Revit into a virtual environment.

The construction of the prototype is based on the following three categories:

- The use of specific software developed by the design principles created by the theoretical framework of Activity theory and with the inspiration from computer games
- The application of hardware that supports Virtual Reality technology
- The use of dynamic 3D models from Autodesk Revit as virtual context

THE CREATION OF THE CONTENT AND ITS GAMING ELEMENTS

The gamification of the collaborative process is created through the outer triangle´s mediation of the inner triangle. This choice makes the notion´s tool, rules and division of labour key elements in the development of the design principles for the prototype's content and application.

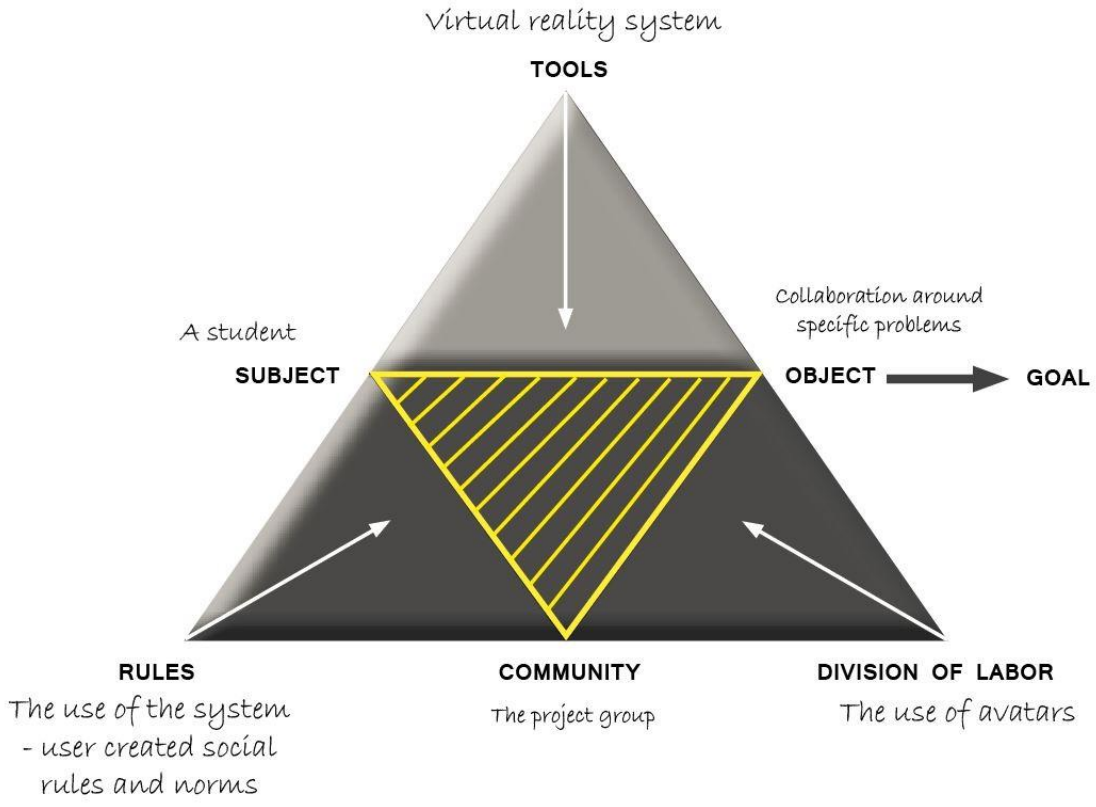

Figure 3: *The internal triangles three axes are mediated through the external triangle.*

The concept of **"tools"** represents the virtual system (software) as a digital tool that mediates the participant's collaboration in a virtual environment. MMORP games inspire the VR tool through the use of a network-based universe that allows its participants to interact with each other in real time. The concept of **"division of labour"** represents the roles of the participant through the use of avatars, while **"rules"** covers the system limitations and barriers and also their acceptance by common standards. The focus is the formation of group identity and social acceptance/approval of rules, as known from computer games.

DESIGN PRINCIPLES FOR THE OUTER TRIANGLE

The outer triangle's three points (tools, rules and division of labour) are the core design principles of the prototype. Combined, they describe the activity system's outer triangle, which mediates the gamification of the collaborative process.

The Artefact/Tool

The virtual system, as a mediating artefact, contains some elements that define the possible use and content of the system. These are divided by Wartofsky's taxonomy consisting of three levels:

First level of artefacts The objective use of the program, and the "know how" to do it	**Second level of artefacts** The system as a mental tool	**Third level of artefacts** Creativity, play, and imagination
Use of the individual user controlled Avatars. Individual adaptation is possible with respect to the choice of professional role, based on the field.	The student builds the VR environment through their work on the project – the 3D environment is changing continuously because of the students' iterative workflows.	Visible roles with respect to the task.
Avatar has to "spawn" for each new user created so that it is possible to be more users online at the same time. (Fig. 5)	Discussions about issues arising out of the virtual model.	Playing with the model and the creative use of the virtual environment
The model has to be partially transparent so that it is possible to see the building constructions.	The limitation of the system leads to rules about its application, as well as a shared understanding of the rules that apply.	
The Ability to "click" a laser pointer on and off that creates a laser beam extending from the avatar's viewing direction at head height. The laser also marks the area where the user is in focus.		
The use of dynamic 3D models from Autodesk Revit as virtual context.		
Overview of how individual users are located in the building, shown by the 3D plan details for the various floors.		

Figure 4: Displays the content of the virtual system.

Figure 5: Screenshot from within the Virtual Environment

The Division of Labour

Participants have the opportunity to choose between seven different roles visualized through the different colour categories. The Role descriptions are based on real life functions in the professional architectural building industry.

- Users and client advisor (white)
- The architect (yellow)
- The executive (Green)
- Engineering group, technical installations (orange)
- Construction Engineer (red)
- Group of "Building information model" (black)
- The Project Manager (blue)

Each role contains an accurate description of the primary functions and also provides an indication of the interdisciplinary collaboration.

The Rules

The rules of the system are primarily user-driven, without any procedure for using the virtual system. It is the participants themselves who create the framework around the task through their spontaneous dialogue and collaboration. Thus, the development of user-created social rules and norms becomes essential for the use of the system and thereby mediates the objective of the collaboration.

METHODOLOGY

Studying collaboration and dialogue in a virtual environment calls for developing designs to be tested and refined through several iterations in an attempt to understand the complexity of collaboration processes mediated by virtual reality. Design-Based Research is therefore chosen as the study methodology, as it is characterized by being a theoretically founded method to study learning and teaching in its reality through the testing of iterative designs (Van den Akker, Gravemeijer, McKenney, & Nieveen, 2006).

Interventions with practice play an active role in Design-Based Research projects, and new design principles are developed and subsequently implemented in a practical setting. A fundamental assumption in Design-Based Research is that only through the use of new design principles for intervention can better theories about practice be developed while attempts to improve practices are made. The Design-Based Research method is based on theoretical

positions (design theories), and also, the implementation of a given design contributes to the further development of theory (The Design-Based Research Collective, 2003).

The purpose is to develop new theories that do not solely aim to improve practice but also attempt to develop further the theories behind the design principles. The process is iterative, and it is not only evaluating the intervention, but it also seeks to implement systematic improvements to the design. Data is gathered continually in order to redefine problems and principles (Akker, Gravemeijer, McKenney, & Nieveen, 2006; diSessa & Cobb, 2004). This study is based on the test of the first iteration of the prototype. See the description of the process in figure 6.

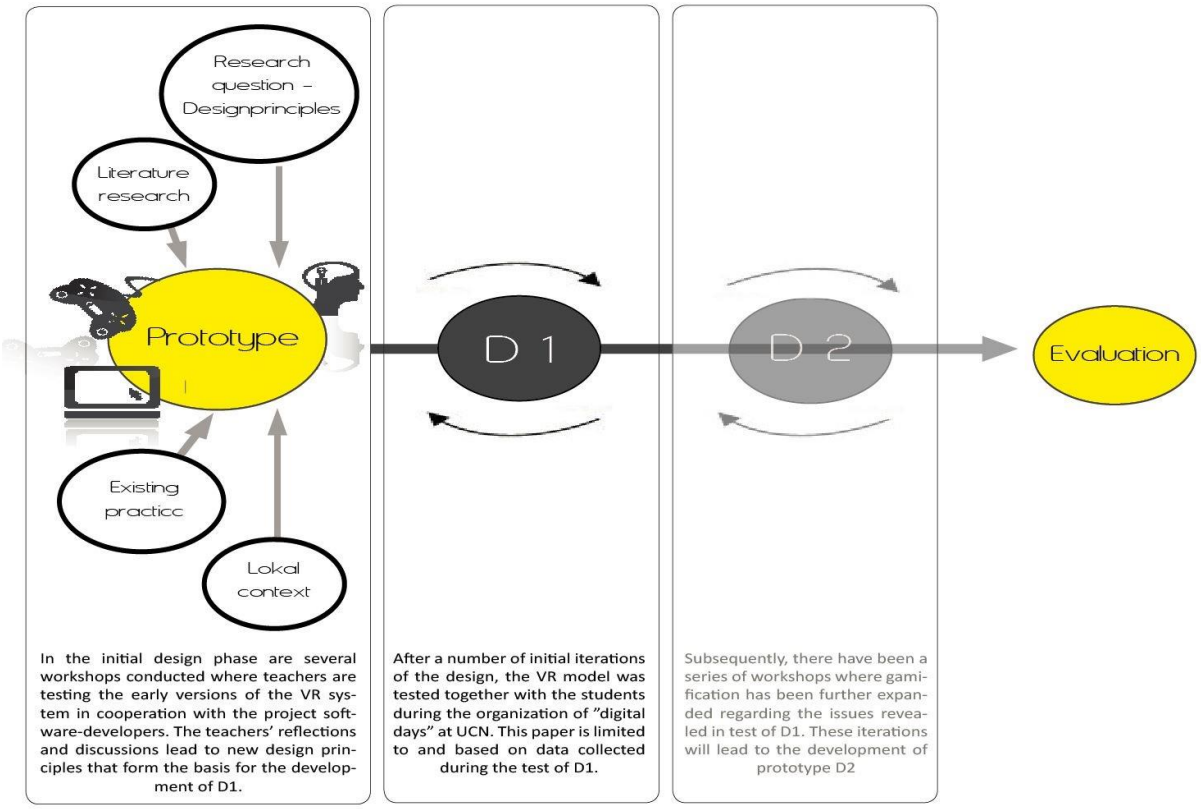

Figure 6: Displays the project structure through the method Design based research

DATA COLLECTION

The prototype was tested on the occasion of "The Digital Days" at the University College of Northern Denmark, Department of Architectural Technology and Construction Management, where two different project teams worked on a renovation of a real-life project. The project, which forms the basis for Digital Days 2014 is a revitalization and restoration of the museum Kunsten in Aalborg, Denmark. The restoration of the existing building, which was designed by Alvar Alto, must be implemented in a way that respects its architecture and cultural

heritage. The participants from 16 different educational programs of five educational institutions each represented different professions. During three days, the students explored and tested digital methods and processes in a practice-related experiment. The developed prototype was an integrated part of the workflow. The system was tested on the problems that arose spontaneously within the three-day design process. Through the creation of a virtual meeting room, students from the two project teams where regularly collaborating in a virtual simulation of the construction project around specific issues. The students were present in the same physical rooms during the experiment.

The data collection primarily consisted of field notes, participant observation, and video observation. During the experiment, two physical screens reproducing an overview map of the building's different floors was set up. Thus, it was possible to see how the students acted in the virtual environment and follow their patterns of movement. Based on the collected data, relevant persons were selected for subsequent qualitative focus group interviews.

Generel information about the case		
Number of cases	2 cases with Danish students and international students respectively. Each case consists of 20–25 students with different roles	
Participating educational programs	16 educational programs from 5 educational institutions	
Information about the participants		
The relevant role of the participants in relation to the VR simulations	Architectural Technology and Construction Management	Responsible for coordination, planning, project management and construction management.
	Energy Technology	Planning of plumbing and design of electricity
	Hospitality and Experience Management	Represents the developer role with tourism as the approach
	Engineer in Indoor Environment and Energy	The design of indoor climate and energy
	Cand. cient.techn. in Building Informatics	Specification, design, implementation and evaluation of ICT solutions in the construction industry.
	Engineer in Structural and Civil Engineering	The design of supporting structures
	Engineer in Architecture & Design	The design of the architectural design solutions
Information about the datacollecting		
Field observation	4 people from the development group of the prototype were observing the VR simulations	
Video cameras	2 cameras - 15 hours of recording	
Voice recorders	2 dictaphones - 15 hours of recording	
Number of simulations per case	12 simulations - Each group participated in two simulations of their project per day	
physical screens	Two physical screens that viewers participants activity inside the virtual environment	

Figure 7: Displays information about how the data is collected and the study-setup

RESULTS AND ANALYSIS

The testing of the prototype is designed to describe and document the collaboration processes, of virtual reality in a construction project. The experiment of learning activities around complex problems in virtual reality, is about how the environment mediates the participant's collaboration. The collected data shows some tensions in the activity system of the

experiment. The following part of the analysis address some of these tensions in the collected data, and the described prototype.

THE USE OF THE SYSTEM AND ITS NARRATIVE STORY

The dominant form of the dialogue consists primarily of a simple transfer of knowledge, including orientations and clarifying questions. A large proportion of the students are passivly listening and only when asked directly; they take an active part in the discussions. Situations where the students just stand passively inside the model while they are talking are prevalent. The following example shows a conversation about the project's file management, as well as a delegation of tasks. This situation is independent of the presence within the virtual model.

> Dennis: But I think it is the way we should do it because Michael is stressed right now. They're just announcing… so if you focus on the file analysis now, then Michael does the drawings you need. Moreover, you have to contact the architect group with your questions. Alice, you can contact Martin, and he will contact me.

The example shows that the students' use of the system on a mental level (Wartofsky´s artefact level two) are largely dependent on some form of facilitation. The students find it hard to create a systematic approach due to a lack of systemic restrictions and rules about the system is used. These lack of restrictions makes it difficult to grasp the opportunities and thus the selection of problem areas. The analysis of the data, therefore, indicates that the conditions for the use of virtual reality imply a collaborative learning process that is dependent on the system's ability to facilitate processes, including an initial framing of the task.

The analysis shows that if the utilization of the virtual environment should contribute and mediate a problem-based process, it is crucial to create a preselected route that provides some predefined "nodes" as the basis for learning – the narrative story. The students' use of the virtual model was often characterized by a spontaneous trip through the building, which forms the foundation of a discussion based on a series of coincidences, which never actually provided the students with a grasp of the problematic areas of concern.

> Dennis: The wall we just went through is going to be demolished and this wall is also okay? Yes, and this one? Moreover, the thing you have here is very strange. We are going to demolish that corner, and extend the wall, so it goes all the way down to the end wall. We just delete this corner here, and then we extend the corner to the end okay? Are you with me still?

With respect to the cases where the students could not move optimally around the virtual environment because of outright errors in the model, it is striking that the project group did

not considered it as a problem. One explanation may be that the students' lacked an understanding of their role, or it may be explained by the students' immersion through the use of avatars. The roles proved to be unclear, which mean that no one was taking action with regard to the issues that appeared along the way.

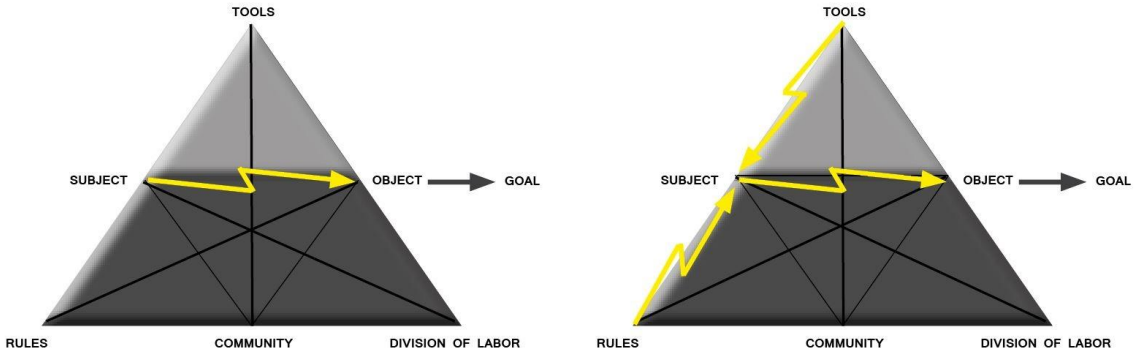

Figure 8: The participants were not able to use the VR system in an appropriate manner due to the system's inability to facilitate its user.

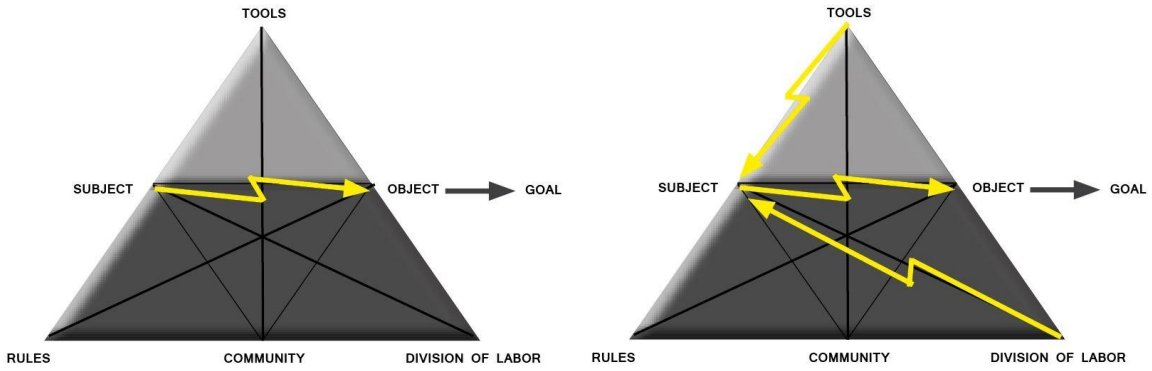

*Figure 9: T*he participants' lack of understanding of their role, or the immersion through the use of avatars, makes it difficult to use the system to establish collaboration and dialogue.

Here it may be crucial that the students do not on a very basic level have the necessary skills to use the system, corresponding to Wartofsky´s level one of an artefact. Another explanation for the observations may be that most of the students' mental energy were being used to be present in the virtual space, which leaves very little time to be reflective and engage in a debate regarding a specific issue.

THE USERS' OWN ITERATIVE AND UNFINISHED DESIGNS

The observations show, particularly, that the 3D model's level of detail affects the students' ability to navigate the virtual environment as it was greatly dependent on whether the building had a logical structure – no blocked areas, ghost walls, missing light/textures, holes, for

example. The students disappear from each other several times due to the model of the building.

Interviewer: Well, there was the opportunity to go through?

Peter: Yes somewhere, suddenly I went through a wall, so I was a bit like: "Where am I now?" Moreover, then you go back again, and then all the others, they are gone, and then you cannot find the others.

Interviewer: Well, very funny. Then the space experience with each other disappeared.

Dennis: It was the same at the stairs down to the depot downstairs, there was apparently some surface which made it so that once you went through it, then your fellow players disappeared, if one can say so. So you also lose a little thing with; okay he is down there, I do not know because I cannot see him, but I know that because he says he is down there.

Unlike computer games, "Virtual Reality" used in an architectural and construction professional context, leads to situations in the early design phases where the uploaded 3D model is prepared at a level of information where it appears unfinished. Video observations show some cases where the VR system's realistic representation of the building was a problem. The fact that the participants in the system are only aware of the current room on the specific floor they are on makes it difficult to understand and imagine the building as a geometric spatial model – also called the third level of the artefact. Particularly the student's discussions concerning issues about the static system and piping of the building are challenged. The students here chose to use the two overview screens for consistency, which could be seen as a creative alternative to the system's intention.

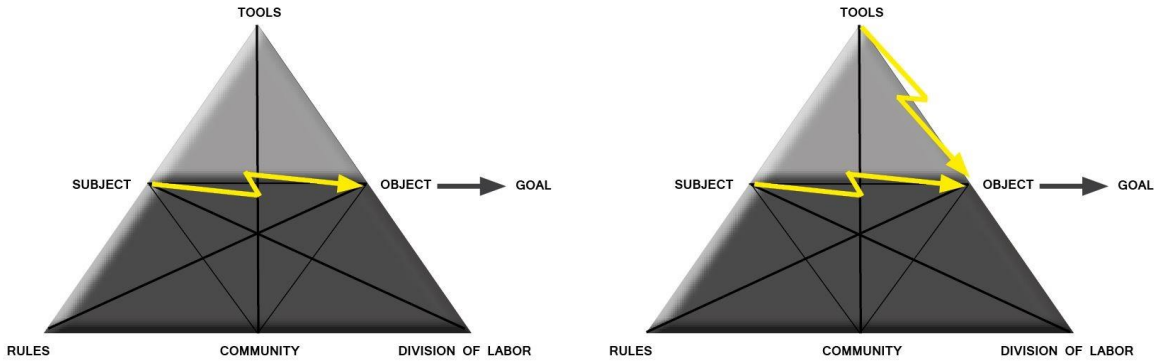

Figure 10: Because the 3D model is created by the users' iterative and unfinished designs, it was difficult to navigate inside the virtual model.

They point out, however, that the VR system visualizations of the building components contributed positively to a deeper understanding of the context and thus allowed for development processes and new answers to detected problems. The students' statements thus indicate that the virtual universe was what mediated the development of a problem-based

learning process. They emphasize an example where the building's ventilation system, with a graphical selection in a grey tone, triggered a discussion about the construction of the pipeline.

> Dennis: I can certainly do ... we had a case at the last meeting about ventilation in the model, and it worked well. You see the tubes; they are a greyer shade so we could see where the ventilation should be, well, the pipes runs here and there. So that it worked well.

If virtual reality is to contribute to a conversational reflection it is crucial that the consequences, arising in connection with the dialogue, can be incorporated into the VR system so as to maintain the iterative transformation of the building. This reflective process is just an example of Dewey's thoughts about the link between thought and action, which the traditional web 2.0 technologies have difficulties facilitating. The virtual environment helps to maintain and mediate the iterative process while the students are acting through their avatars actively in response to the challenges they encounter.

ESTABLISHING RULES OF ACCEPTABLE BEHAVIOUR

The tension generated by the human interaction with the system is especially evident. The technical difficulties with the use of the system were filled with so many problems that it was beyond the ability of the participants to maintain a dialogue within the group, and it pushed the student's spontaneous use of the system in a new direction, which would shift the focus from the original topic.

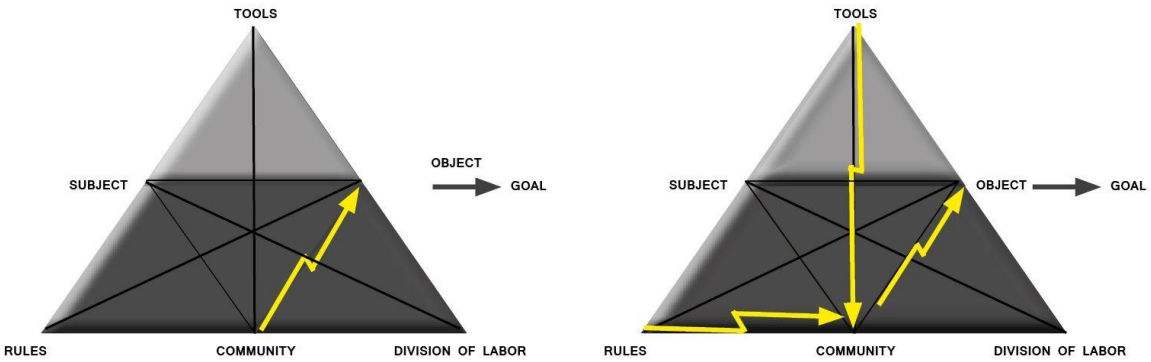

Figure 11: Unclear rules of acceptable behaviour inside the virtual universe gave the participants problems in terms of concentrating on using the system.

The clearest example of Wartofsky´s third level of an artefact appeared in the direct parallel to the MMORP game, which resulted in the students playing with their avatars on several occasions. The example below shows how the laser pointer suddenly became a light sword, and the student started to run around inside the virtual environment trying to catch each other.

Student 1: I think it will be fun, I believe he has gone hunting. I will see if I can find Michael quickly.

Student 2: Try to go in there

Student 1: I cannot go any further

Student 3: Hell, that is the Aalborg Tower!

Student 2: Does it look like that?

Student 1: There he was. There is too much play in this. I think we have got it working.

Student 2: Shut up, you are a kid.

Student 1: I may be 23, but that does not change anything

Student 2: Why is he running faster than you?

Student 3: It is a sprint.

Student 1: I will shoot you…

The spontaneous play within the system occurred primarily during start-up periods where the students were waiting for each other to join the world. Playing with the system is an example of how VR can support exploring and curious behaviour, which according to Dewey is what initiates and supports reflection processes. The surroundings thus offer the chance to play, which creates affordances when it comes to investigative behaviour. The students explained that they were able to find a serious focus on the task as soon as the project leaders announced that the meeting was ready to start.

Peter: I think our first trip there, it was like; now I shoot you, and now I will shoot you. It was the very such first time. Ah, well, I had to see how it worked, which was great, and now you are dead and stuff. However, when we started to take it seriously, it was an excellent tool, I think.

Another important aspect that proved crucial to the establishment of the student's collaboration inside the system is the fact that it is hard to follow each other inside the virtual building. Looking more closely at MMORP games, this situation is not an issue. There are three main reasons for this: (1) The virtual universe has a natural frame that leads the computer players in the right direction. (2) Computer players have built a strong discipline to prevent people going their way, as it often leads to the game punishing the participants with new, unforeseen challenges – it is not effective. (3) Gamers have a predetermined target they all pursue and have an interest in reaching.

Using VR for the visualization of a building has been challenged on the following three grounds. The building is not a linear structure where there is a starting point and an end point.

Also, a building does not contain clear and unambiguous logistics. The unclear logistics means that without a predefined route that all students know of, or an agreement saying that everybody should follow the supervisor, there is a significant risk that the users will get away from each other. The observations repeatedly show that the participants chose to pursue their curiosity of wanting to "discover" the virtual model. This behaviour consistently lead to the students getting lost and away from each other.

The students in this experiment had no previous experience with the use of virtual reality in their studies, and they had not had the opportunity to build a set of standards for how to act. The observations, therefore, revealed several examples of the students spontaneously rebuking each other to maintain focus on the task and also preventing getting away from each other inside the model.

Peter:	You should not go too far away!
Morten:	No no, it was because we were upstairs. You rebuke me constantly Peter (blue avatar)
Peter:	Yes, it is because you are running around like that.
Morten:	Yes, I don't just want to stand there and stare.

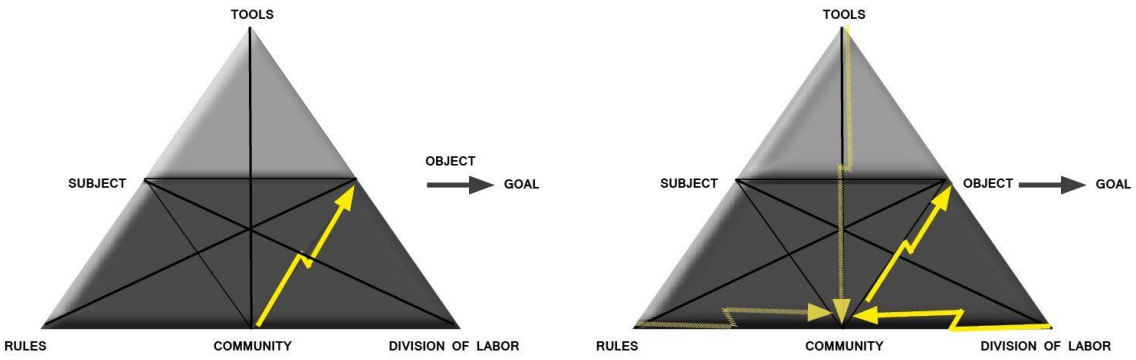

Figure 12: *The definitions of roles and who has the right to decide.*

The example shows that there was no clear standard for how they should act inside the model and this led to a spontaneous dialogue about behaviour and an argument about who had the right to decide. Here, it is especially the definitions of roles that initiated the spontaneous creating of social rules, where the leader of the meeting, represented by a blue avatar, was trying to take control. In the cases where the students were able to navigate inside the three-dimensional universe, as well as keep all the participants online, some observations showed incipient tendencies to a focused dialogue. Marked differences could be observed during the three days. The processes on day 3 were clearly more organized and focused.

FINDINGS

The project's aim has been to describe and document the processes that the involvement of virtual reality, as a collaboration and communication tool, leads to in terms of problem-oriented work. The objective was also to get localized relevant focus areas to optimize the current design principles towards the development of the next prototype.

The physical experience of being present in the building provided students with a greater understanding of the complex issues their projects deal with and the ability to create inquiry. The group's own investigations of the building design are what creates the right conditions for problem-based learning processes in a virtual environment. Particularly the students' spontaneous and personal "tour" inside the building supports Dewey's concept of exploration, which is essential when it comes to creating processes of reflection that contribute to learning. The students experienced first hand when the building was designed in inappropriate ways, such as having closed areas and holes, or areas that have not been acted on or discussed. These experiences created meta-reflections during the VR experience and in the follow up group discussions.
The strength of VR combined with web 2.0 is mainly related to teamwork, as VR provides an opportunity for the students to be synchronously present in the same room. When this "room" is based on the students' own iterative design, a much more experimental, physical and lively dialogue is supported, something the traditional web 2.0 technologies have difficulties facilitating.

The analysis shows, however, that the use of the three gaming elements – "Avatars," "Real-time environment" and "Social acceptance/approval of rules" – in the study are not enough to facilitate a problem-based learning process. Increasing the use of gamification principles is therefore essential if VR shall add some seriously new opportunities to web 2.0 technologies. Especially design thinking and sketching methods will require much more active and interacting opportunities in the virtual environment. The analysis showed several examples of passive dialogues, only slightly mediated by the VR system. Therefore, an increased use of gamification principles could be yield results with respect to creating active actions that are more situated, experimental and collaborative.

The following four points are examples of gaming principles that may support Dewey's concept of **exploration,** as a way to create emotional tensions that lead to changes in the direction and content of the students' experiences through processes of reflection.

- **Quest:** A defined task or activity that triggers a reward.
- **Level:** The way an MMORP game categorizes their player's overall effectiveness and possibilities.

- **Dungeon:** An adventuring area where the players carry out scenarios or missions that have its own history in the game.
- **Wipe:** A Wipe is a situation where the entire group is killed. Wipes may occur for many reasons; the team is failing to do their job or unexpected issues when challenging content have to be "learned."

In addition, the learning potential in the application of virtual reality can be strengthened by improving the system's ability to support the avatar's role through specific tools and options for action.

The use of Wartofsky's taxonomy shows that it is crucial that the participants in the virtual system, have the necessary skills to let the system mediate their collaborative process. Through the use of Wartofsky's definition of the tool at level 1 in the analysis, there are indications that the lack of a knowledge base and competence led to challenges with respect to level 2 (the mental level) and 3 (imagination) of the artefact. One example involved the participants having a hard time fulfil their role descriptions, as their primary energy was focused on getting the virtual tool working in the most core areas.
One thing is the participants' qualifications and competence; something else is the system's limitations in facilitating the collaborative process. Wartofsky's definition of level 2 as the mental level showed that without a systematic approach to the model, it is difficult for participants to start up a dialogue. The analysis demonstrated that the use of virtual reality requires a very precise framing regarding the participants' tasks and activities within the system. Improving the system's ability to facilitate this increases the possibility of the establishment of a collaborative dialogue.

New design principles should, therefore, address the facilitation of the participants' navigation in the environment and frame the relevant activities through various graphic effects and user interfaces. Here it would be natural to look at existing navigation solutions known from, for example, computer games software.

It is estimated, however, that participants with a longer habituation period will be able to take far greater advantage of virtual reality because of the expected improvement in the agreement upon the rules. This expected improvement requires constant access to the software to develop new cultures, norms and methodologies for the use of the system.

Furthermore, the potential of a graphical upgrade of the participants' avatars with respect to different forms of expression, allows the system's visual side to support a deeper understanding and collaboration with respect to the building's problem areas through dialogue. The analysis, therefore, points to the advantage of adding some features to the system that can support the participants' opportunities to see who is talking, and partly upgrade the avatars' ability to visualize simple body language.

The conclusion of this study, therefore, suggest that the described development opportunities in the software can strengthen the collaboration process to a much greater extent and thereby strengthen the collaborative and problem-oriented learning process.

CONTRIBUTION

The project contributes to the existing knowledge by examining the challenges and opportunities that the use of VR offers blended learning in professional and practice-oriented educational programs – particularly the possibility of incorporating physical and explorative learning processes on the distance in future web 2.0 technologies. The project represents an idea of a VR design that can subsequently inspire further developments, especially regarding the use and inclusion of gamification as a way to facilitate blended learning.

The project contributes to showing how new technologies, such as VR and video games, can provide both a new vision and also new opportunities for strengthening the involvement of a practice related dimension in problem-based learning environments. The study clarifies the complexity and robustness that web 2.0 solutions must contain to support a sketching, design-oriented, exploratory and investigative learning process, which is at the core of problem-based learning in architecture and design education.

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Journal of Problem Based Learning in Higher Education

VOL. 5, NO. 1, 2017 – Page 111-125
http://dx.doi.org/10.5278/ojs.jpblhe.v0i0.1550

The 'Tutorless' Design Studio: A Radical Experiment in Blended Learning

Glen Andrew Hill *

ABSTRACT

This paper describes a pedagogical experiment in which a suite of novel blended learning strategies was used to replace the traditional role of design tutors in a first year architectural design studio. The pedagogical objectives, blended learning strategies and outcomes of the course are detailed. While the quality of the student design work produced by the blended learning design studio was independently assessed as being of a high standard, the student feedback on the course was mixed. Given the equivocation evident in the student feedback, the paper concludes by speculating on factors beyond the educational strategies that may have led to the high quality of student design work.

Keywords: Blended Learning, Problem-based Learning, Design, Design Studio, Architecture, Education, Pedagogy, Foucault, surveillance, Hawthorne Effect.

INTRODUCTION

University administrators often grumble that the traditional design studio model of teaching used in architecture programs is expensive compared to the teaching modes commonly employed across rest of the university. The largest component of the cost is the salary paid to design tutors who teach for relatively long periods to relatively small tutorial groups. We therefore asked the question: 'Is it possible to use contemporary blended learning strategies to dramatically reduce, or even eliminate the role of design tutors in the studio, while still maintaining the quality and character of the traditional design studio?'

* Dr. Glen Andrew Hill, Faculty of Architecture, Design and Planning, University of Sydney, Australia.
Email: glen.hill@sydney.edu.au

With the assistance of an Education Innovation Grant provided by our university, we developed a course that integrated various blended learning strategies to deliver a studio project that required no design tutors. The studio ran as a stand-alone design studio for the first 5 weeks of the 13-week semester. Students working in the normal physical studio setting engaged in large numbers of small design tasks that were delivered online and were supported by daily lectures. The tasks were intended to develop their 'generic' design skills while also building incrementally toward a single final design outcome for the studio project. The only individual, one-on-one feedback the students received was given by a design jury on the final afternoon of the 5-week studio project.

The quality of the students' design work, independently assessed by the jury, was considered high. Feedback from the students who experienced the experimental design studio was mixed. The financial saving from not employing design tutors for the duration of the experimental design studio was substantial. This saving was reinvested in employing more tutors in the second half of the semester for this same cohort of students, allowing the studio group size in the second half of the semester to be reduced from the standard 18 students per group to 10 students per group for the remainder of the semester, which students greatly appreciated.

This paper details the blended learning strategies employed in the design studio, including novel approaches inspired by aspects of the traditional design studio, itself a variant of problem-based learning. The learning management system and e-Learning platforms are explained. The feedback from students, describing their perception of the strengths and weaknesses of the blended learning experiment, is summarised. The paper concludes by speculating on how issues of power, control and surveillance might have operated in this e-Learning environment; these, it is suggested, might help explain a conundrum raised by the whole experiment: given the student feedback was mixed, what led to the high quality of design work?

THE TRADITIONAL DESIGN STUDIO PEDAGOGICAL MODEL

Currently, architectural design studios undertaken at our university are normally timetabled for one seven-hour day per week for the 13-week duration of the semester. The design studio day generally begins with a one- to two-hour lecture, followed by five to six hours of design tutorials. Tutor group sizes are stipulated to be as close as possible to 18 students, and are taught by either an academic with architectural experience or an external architectural practitioner employed casually.

Historically, the relatively high cost of the design studio pedagogical model has led to ongoing attempts to achieve financial savings in studio teaching. For many years, the number of tutorial hours has been gradually diminishing, tutorial group sizes have been gradually increasing, and reduced pay rates for tutoring in the studio have resulted in more junior practitioners being employed as design tutors. A comparison with the situation a number of decades ago highlights the change in studio resourcing: in 1973 the design studios in our architecture program had two full days of studio teaching per week with

no greater than 12 students per design tutor group, and tutors tended to be experienced (and sometimes eminent) practitioners.

In terms of the content of a typical design studio, at the beginning of the semester students are given the brief for an architectural project of a complexity and scale suited to their point of progression in the program. Over the course of the 13-week semester, students develop a design solution for the project, most often working individually, but occasionally working in groups of 2 or, less commonly, 3. On each design studio day, tutors give students feedback on the progress of the development of their design. At intermediate points within the semester and at the end of semester a small jury of practitioners and academics assess the student's work and provide formative or summative feedback to the student as appropriate.

The traditional design studio pedagogical model is effective for *deep learning* because students learn by 'doing' design. The design studio pedagogical model is a unique variation on problem-based learning and teaching, where the student is set a problem and then develops a solution to the problem with varying degrees of guidance from an educator. In educational environments such as health and medicine, problem-based learning is a well-established pedagogical method (Neville, 2009). In medicine for example students may be given a set of patient symptoms, and asked to undertake research to determine (i) a diagnosis and (ii) a treatment regime. In the medical context there is a generally a relatively small set of 'correct' (best practice) answers to the problem that has been set. By contrast, the equivalent problem-based learning task in the design studio produces a potentially infinite number of 'correct' (workable) design solutions. Because every student's design develops along a unique trajectory, every student's design requires unique feedback, giving rise to the need for students in the design studio pedagogical model to have intense face-to-face, real time engagement with a design tutor.

BLENDED LEARNING

'Blended learning' combines digital and online media with traditional modes of educational content delivery. In our case, traditional lectures were combined with pre-designed course content delivered online to students in the physical setting of the traditional design studio.

The most radical goal of this teaching/learning experiment was to find a way to use blended learning to *replace* design tutors *without* compromising the traditionally successful method of students learning to design by 'doing' design. The difficulty of course, and the most challenging and exciting aspect of the experiment, was finding an answer to the problem of how a course using primarily pre-designed content rather than tutors could be responsive to the unique trajectories that each and every student's design would inevitably take. Providing formative feedback to each student's unique design development has been the traditional role of tutors; so how could the individual feedback normally given to students by tutors be provided in a tutor-free, blended learning, design studio?

This central challenge of replacing the role of tutors in providing feedback on the unique trajectories of student's design development was ultimately addressed in three ways:

(i) Students themselves were taught specific skills for critically reviewing design work. Students were then asked to provide critical reviews of their peers' designs. Time was allocated for peer-to-peer design reviews, which were carried out in groups of 4 (3 students critiquing one student's work at a time, in rotation). Participating in the peer-to-peer reviews was an assessable component of the course.

(ii) A portion of the lecture at the beginning of each studio day was used to give feedback to the whole cohort on common design issues that had been identified in students' developing designs. The success of this process was dependent upon the fact that students were required to digitally upload their current designs the evening before the design lecture, allowing the coordinator time to identify issues and use images of the students' own designs to illustrate common problems and possibilities.

(iii) The traditional jury panel of architectural practitioners provided feedback on each student design on the final afternoon of the 5-week blended learning design studio.

As well as trying to draw pedagogical insights from the traditionally effective studio model of teaching design, we also looked for opportunities to address any weaknesses we recognized in our current pattern of design teaching. One issue we identified was the failure of design studios to consistently provide a rigorous explanation of how designers design. Here we were working with the understanding that while every designer designs in a unique way, there are common skills/understandings that are used regularly in the design process that can be usefully learned by students. In this experiment we focused on the following common areas:

- Understanding place (site analysis/context analysis)
- Understanding and prioritising the desires of clients/users/stakeholders
- Understanding that design always take a position (designs are political)
- Understanding where design ideas come from (use of precedents/analogy/metaphor)
- Understanding the use of diagrams/partis/concepts
- Understanding that design is endlessly iterative
- Understanding passive solar design principles

Because students' understanding of the design process is currently gained piecemeal from successive tutors, the student's learning depends upon the often the variable understanding of the tutor and their ability (and time) to articulate key skills in the design process. Ultimately therefore the blended learning design studio had two key aims that were mutually reinforcing: to enhance the student's design skills through the process of *developing student's own unique solution* to a design project; to use the unfolding steps in the their own design process to *help students understand key 'generic' skills required during the design process*.

THE BLENDED LEARNING EXPERIMENT

The blended learning design studio was piloted on the full cohort of 160 first year architecture students. It ran in their second semester as the first 5-week phase of their major design studio unit of study — a 13-week unit that constitutes 50% of the load for the semester. With the assistance of an Education Innovation Grant provided by the university, course material was developed and delivered online in their familiar studio spaces.

The pattern of the 5-week blended learning design studio course was as follows: each day would begin with a 1-2 hour lecture, followed by a tutorless design studio of up to 5 hours in which online tasks were undertaken in small groups. On the final afternoon of the 5-week blended learning design studio a traditional jury panel of architectural practitioners provided feedback on the students' designs. The financial saving from not employing design tutors for the duration of the experimental design studio was reinvested in employing more tutors in the second half of the semester for this same cohort of students. This allowed the studio group size in the second half of the semester to be reduced from the standard 18 students per group to 10 students per group for the remainder of the semester.

THE DESIGN PROJECT

The design project used as the vehicle for the blended learning design studio was a small architectural intervention sited at the interface between the university and a large public park . On the university side of the public park a grand set of steps leads down toward the park, but the steps terminate at a fence separating the university from the park. There has long been an intention to create an entrance to the university from the park at this point. The student project imagines the removal of a section of the fence and the creation of a new entry to the university from the park.

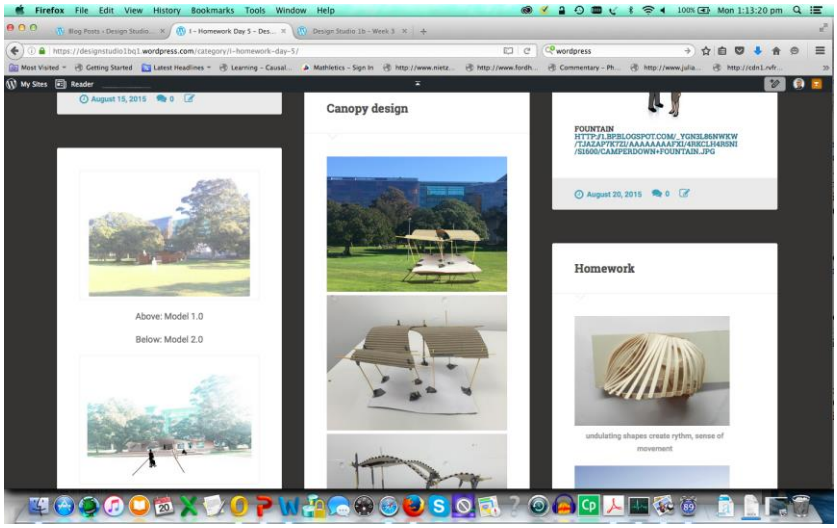
(Image of the site for the studio project: Public Park in the Foreground; Fence, Stairs and Law Building Beyond) (Francis-Jones Morehen Thorp Architects)

Over the course of the 5 weeks of the blended learning design studio students were led through a four-stage design development process:
Stage 1: A park bench that 'makes strangers talk to each other'
Stage 2: A cluster of park benches that encourage interaction (and also allow meditation)
Stage 3: A solar canopy over the park benches to admit winter sun and exclude summer sun
Stage 4: Transformation of the solar canopy to also act as an entry canopy signaling the threshold to the university
(The final 8 weeks of the semester used the same site for the design of a small café.)

THE LEARNING MANAGEMENT SYSTEM

All educational content, all tasks to be undertaken during design studio time, as well as all homework tasks, were made available online and accessed by the students using laptop computers, tablets or smart phones. Blackboard Inc. was our university's principle eLearning environment. However it was decided that Adobe Captivate was most appropriate as the primary e-Learning platform. Students therefore logged-on to Blackboard and navigated to a Captivate file containing each day's educational content and tasks. The educational content on the Captivate slides was communicated in succinct written language with supporting images and graphics as required, and was also voiced-over to assist students from non-English speaking backgrounds.

When students working in Captivate were ready to respond to a discussion question, or wished to submit a small design task or a larger homework design task, they uploaded their completed task via a link in the Captivate interface which took them to a Wordpress website set up to accept images of their designs as well as descriptive text. Each task had its own unique web page, thus when all students had completed a task there were 160 student posts for that task. Students were encouraged examine other students' posts as part of the learning experience.



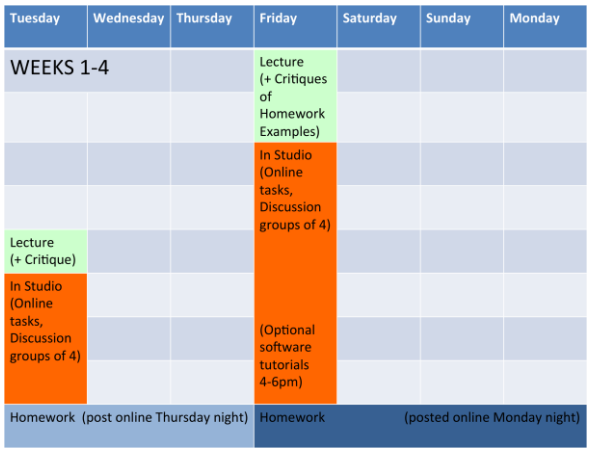
(Photo image of student posts on Wordpress: By Author)

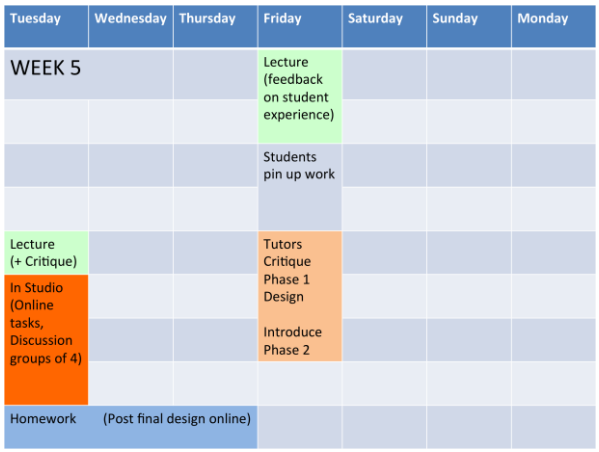
For the lecture presentations prior to the studio sessions, the coordinator used selected posts of student designs to assemble a PowerPoint presentation in order to give feedback on the common design issues to the whole student cohort.

TIMETABLING OF THE DESIGN STUDIO

Unlike other design studios in our architecture program, which are only timetabled for one day per week, it was decided that the 5-week blended learning design studio could be timetabled for two days per week: Tuesday afternoons and all day Fridays. This was possible because the design studio had no casual design tutors and there was therefore only minimal extra cost in adding more studio time to the weekly program. This was an unanticipated opportunity offered by the blended learning program and reversed the decades long trend of trend of reducing design studio hours.

The standard weekly timetable therefore had two studio days, each beginning with a lecture that included the critique of examples of student work that had been uploaded onto the Wordpress site the evening before, followed by a design studio session in which online tasks were undertaken in the studio environment. At the end of each studio session, homework design tasks were communicated through the online Captivate interface and students were required to post their homework designs the evening prior to the next design day.





(Weekly timetables: By Author)

STUDENT EFFORT AND GRADING

The 5-week blended learning design studio was worth 35% of students' overall grade for the Semester. The assessable components of the blended learning design studio were broken down as follows:

- Online tasks and homework tasks: 40%
- Critiques (written and verbal) of other students' designs: 20%
- Final design (physical model and A1 panel): 40%

At the end of the 5 weeks students had completed:

- **65 small studio tasks** (discussed in groups of 4, posted individually):
    - These tasks related to the process of designing, and paralleled the progress of their own designing.
- **12 major homework tasks** (completed individually):
    - A design for a park bench that 'makes strangers talk to each other'
    - An AutoCAD section through the site
    - A site analysis plan using Illustrator
    - A design for a cluster of benches
    - A sun control canopy (excluding/admitting sun from the equinoxes)
    - A physical model 'Photoshopped' onto real site photograph
    - 1:50 working model of design
    - 1:20 section of detail component
    - 1:100 site model
    - 1:100 working model
- **2 critiques** of other students' projects
- **Final design** presented to jury on last day (completed individually):
    - **1:100 model of final design**
    - **Final A1 Panel**

The cohort of 160 students produced in total 13,000 assessable outcomes that were posted to the Wordpress sites. Because of the large number, it would have been impossible to give formative or summative feedback to all of these design tasks. Students were therefore advised in advance that for the 65 small tasks, the 12 major homework tasks and the 2 peer critiques, we would be looking at only two simple criteria when we assessed their work:

i. That the student had attempted the task (i.e. we were not assessing the quality of the work)
ii. That the student had taken the task seriously (i.e. that there were no blank or frivolous posts)

If a student's work met these two criteria, they would receive the full grade for that component of the course. This was considered fair, as the students were doing what appeared to be a significant amount of work for a relatively small proportion of their grade. Also, because the online tasks represented a fairly small percentage of the whole semesters grade (60% of 35%) it did not excessively distort each student's overall grade for the semester.

This 'liberal' approach to grading appeared to encourage a high level of student compliance with task completion. This was a positive outcome in two ways: from the student's perspective they felt it was an 'easy' way to get a good grade for that component; and from our perspective as educators, both the student feedback and the quality of the final designs indicated that students benefited from undertaking all of the tasks.

A SAMPLE OF THE BLENDED LEARNING COURSE

Online teaching and learning commonly utilizes the following sequence of pedagogical steps:

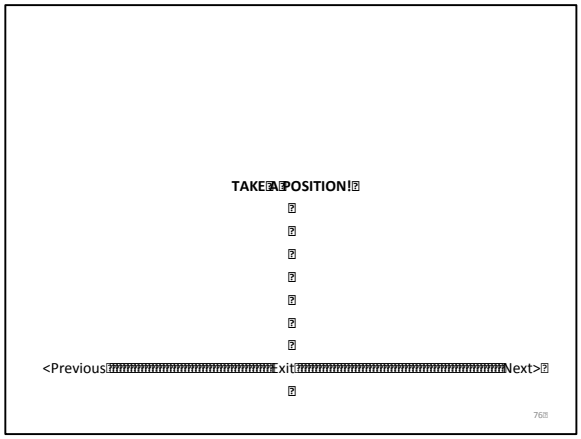
1. Provide the learner with the information necessary to answer the question or task in step 2 (below)
2. Set a task or question based on this the information in step 1 (above)
3. The learner responds to the task or question
4. If the response indicates satisfactory learning, the learner moves to the next module of information

The deep learning achieved by problem-based pedagogy (which includes the design studio pedagogical model) is achieved through a different sequence of steps:

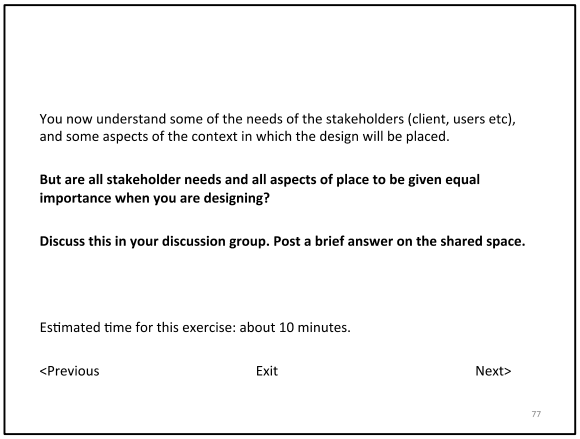
1. Set a task or problem
2. The learner researches and develops a response to the task or problem
3. Feedback is given on the learner's response

Rather than utilize the more common online pedagogical steps, all of the tasks set in the online component of the blended learning design studio use the problem-based pedagogical steps, where students are first asked to contemplate a question or issue *before* being given information relating to the issue or question. To encourage students to engage with different views on each issue, students were required to discuss/debate each question or issue within a group constituted by four of their peers. This debate/discussion occurred in the physical setting of the design studio. Only when students had posted their own answer/response were they given a 'guide answer'. It was made clear to the students that the answer provided was not definitive and that they may have in fact developed a better answer.

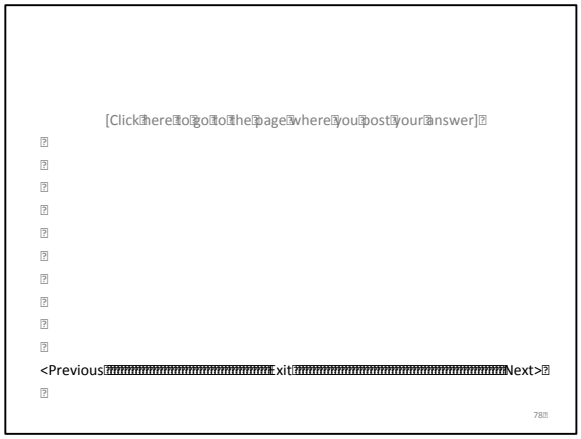
The following extract from the online Captivate slides demonstrates how students were encouraged to discuss and develop their own position on an issue before being given a 'guide answer'. The issue in this case was the way in which designs always 'take a position.' Students were asked to discuss whether a design could satisfy all stakeholders' needs equally or whether designs inevitably privileged particular stakeholders needs over others.


TAKE A POSITION!
<Previous Exit Next>
76

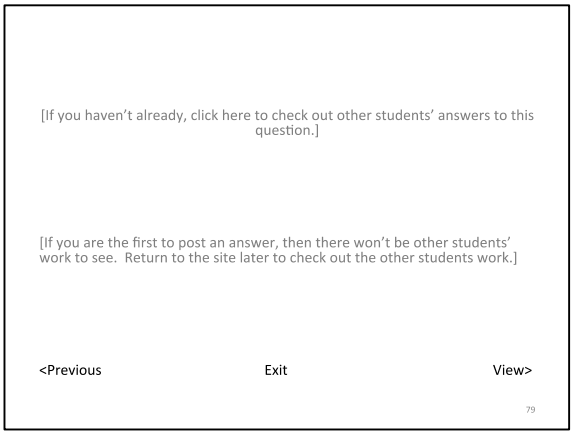
1.


You now understand some of the needs of the stakeholders (client, users etc), and some aspects of the context in which the design will be placed.
But are all stakeholder needs and all aspects of place to be given equal importance when you are designing?
Discuss this in your discussion group. Post a brief answer on the shared space.
Estimated time for this exercise: about 10 minutes.
<Previous Exit Next>
77

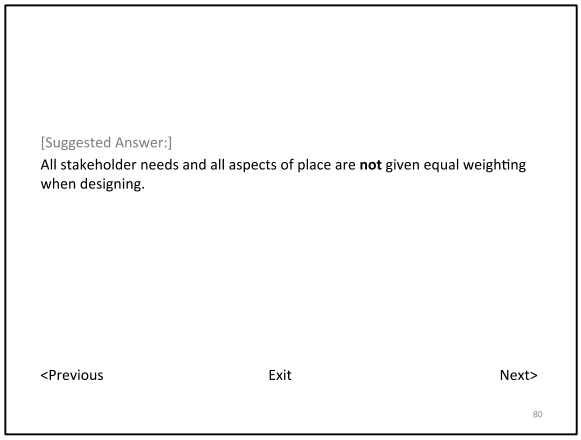
2.


[Click here to go to the page where you post your answer]
<Previous Exit Next>
78

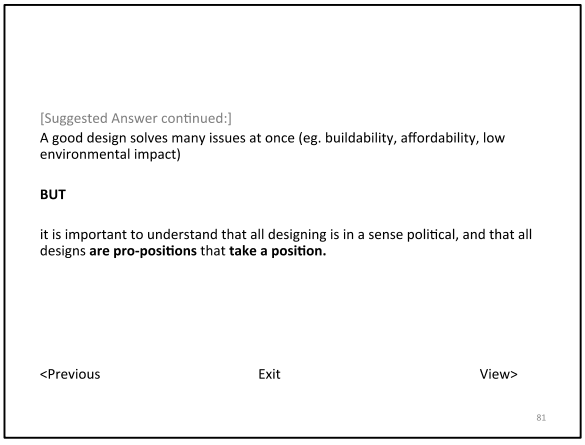
3.


[If you haven't already, click here to check out other students' answers to this question.]
[If you are the first to post an answer, then there won't be other students' work to see. Return to the site later to check out the other students work.]
<Previous Exit View>
79

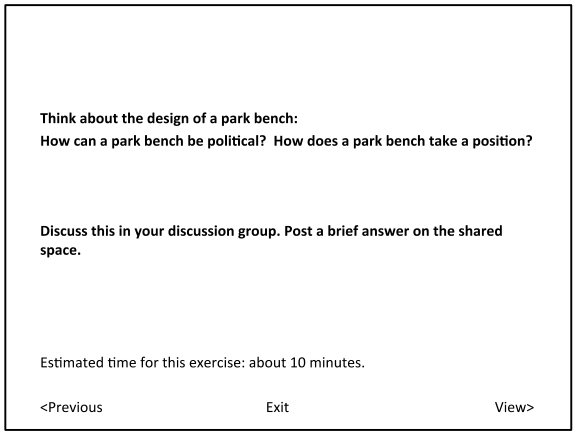
4.


[Suggested Answer:]
All stakeholder needs and all aspects of place are **not** given equal weighting when designing.
<Previous Exit Next>
80

5.


[Suggested Answer continued:]
A good design solves many issues at once (eg. buildability, affordability, low environmental impact)
BUT
it is important to understand that all designing is in a sense political, and that all designs **are pro-positions** that **take a position.**
<Previous Exit View>
81

6.



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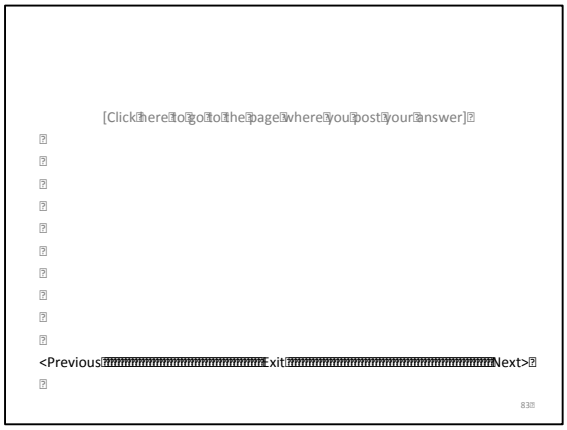

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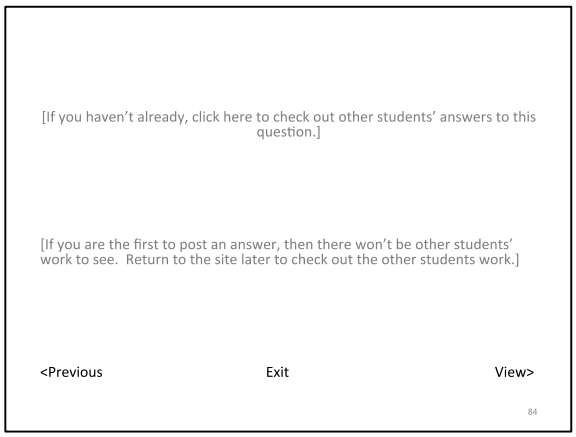

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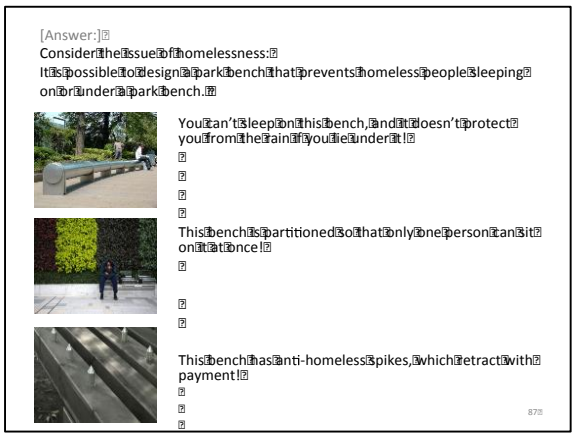
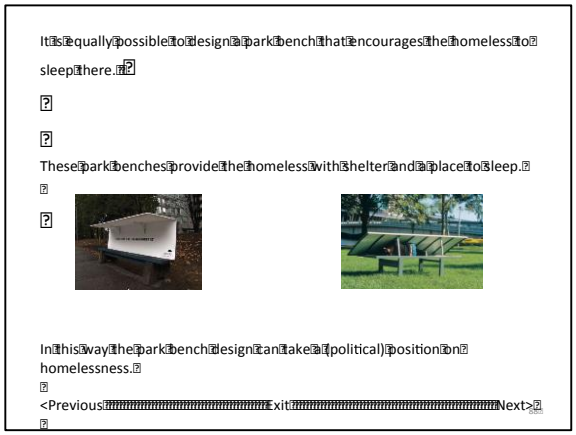


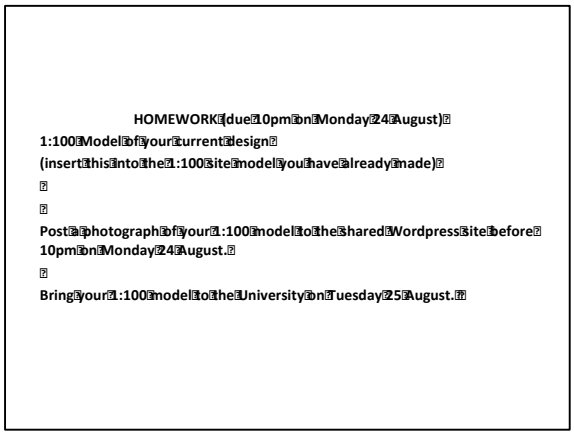
10.



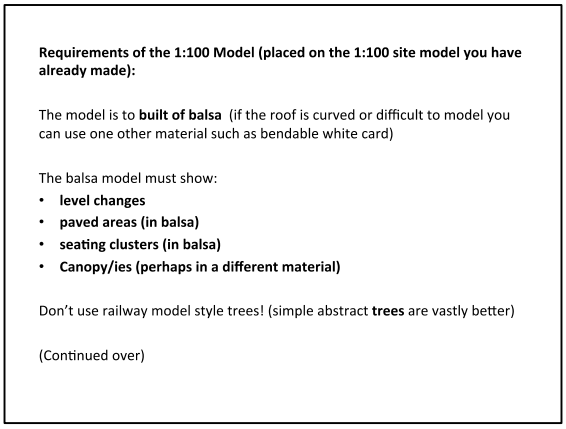
11.

(Screenshots of Captivate Slides: By Author)

At the end of each design studio day students were allocated a homework task that was to be completed individually and posted on the Wordpress site on the evening before the next design studio day. The homework task was communicated online via Captivate. A typical homework task is shown below:



1.



2.

(Screenshots of Captivate Slides: By Author)

THE QUALITY OF STUDENT WORK AND STUDENT FEEDBACK

On the final afternoon of the 5-week blended learning design studio, students presented their designs to a jury of architectural practitioners and academics who were independent of the team who developed the blended learning studio.[1] Jurors gave verbal and written feedback to the students and grades for each student design. The feedback from jurors along with the student grades indicated that the design work produced by the students was, on average, of a high quality relative to comparable cohorts. The median grade (for the final design only) was a Distinction (on a scale of: Fail, Pass, Credit, Distinction, High Distinction), and the mean numerical grade was up to 5 marks higher than the previous 3 comparable first year design studios.

Students were invited to provide feedback on their experience of the blended learning design studio in a number of ways:

- An open forum on the final day of the blended learning design studio
- A specially designed, confidential survey instrument asking about the student's experience of the blended learning design studio
- A standard unit of study survey form that allowed comparison to previous student feedback for comparable design studios

The feedback indicated that students *really liked* some aspects of the blended learning design studio, and *really disliked* others. Key points of the student feedback were as follows:

- In response to the lack of tutors:
    - Students *disliked* lack of individual feedback;
    - Students would have *preferred* to have more access to tutors;
    - However student *really appreciated* the small tutors groups (of 10 students rather than the standard 18) that they had in the last part of the semester as a result of the financial

[1] Many of the these jurors were employed as design tutors for the subsequent phase of the design studio project that ran for the remainder of the semester.

savings made not employing tutors in the blended learning design studio in the first 5 weeks of semester. It should be pointed out however that the financial saving on the first iteration of the blended learning design studio was in one sense artificial, in that the $32,000AUD development cost of the course was via an external grant and not part of the calculation of the financial saving. It would therefore not be until the second iteration of the unit of study in the following year that an actual financial saving could be claimed.

- In response to the online tasks delivered via Captivate in the physical studio setting:
    - Students felt that the flow of the discussion was disrupted by the presence of a computer screen in front of every student.
    - Having a discussion in a group of 4, then having to post the outcome of this discussion individually was found to be annoying. A future iteration of the learning management system would attempt to make it easier to post group responses to a task.
    - The physical studio space was cramped, which resulted in groups being squeezed together, also impeding the flow of discussion. A future iteration of the studio would permit student groups to roam rather than be tethered to the physical studio space.
    - Some students were able to hack the captivate program and jump ahead to the task answers before posting their own answers. This both undermined the pedagogical goal and annoyed students who were 'doing the right thing.'
    - Students preferred the larger 'fun' design tasks (such as spending an afternoon as a group designing a park bench that made strangers talk) to the smaller more theoretical tasks.
- In response to giving and receiving design critiques from their peers:
    - The level of student appreciation of this strategy appeared directly related to the quality of the criticism the student received.
- In response to the homework design tasks and the design feedback to the whole cohort in the lecture theatre:
    - Students thought homework tasks helped their learning.
    - Students found lecture theatre feedback to homework tasks useful.
- In response to students being able to see other students' work posted on the Wordpress site immediately upon completion of a task:
    - Students' responses indicated they greatly appreciated this facility.
    - Students found it helpful in terms of their own learning.
    - Students found it reassuring to know in real time that other students were progressing (or struggling) in similar ways to themselves.

CONCLUDING SPECULATION

Overall, this experiment in using blended learning to create a 'tutorless' design studio can be seen to have had mixed results. Deriving pedagogical strategies from the traditional design studio and reinterpreting them for an e-Learning environment indicates sufficient promise to warrant further

development of the pedagogical method. However student feedback indicates that they did not appreciate the 'tutorless' teaching environment and would have preferred more face-to-face tutoring. Nevertheless the quality of the design work produced by the students was independently assessed as being very high. The outcome of this experimental blended learning design studio thus presents a conundrum: given that the student feedback regarding the pedagogical strategies was mixed, what led to the high quality of design work?

As there is no way of establishing a causal relation between the individual strategies used in the blended learning design studio and the quality of the student design work, we can only speculate on what may have contributed to the high quality of the final design outcomes based on our observations in the course of the running of the studio. It may have been some particular aspect, or multiple aspects, of the pedagogical approach of the course, but it is also possible that something beyond the particularities of content and pedagogical strategies may have been in play. We suggest two such speculative explanations: the 'Hawthorne effect'; and Foucault's 'Panopticon'.

The Hawthorne Effect

From 1924 onwards, time and motion experiments were carried out at the Hawthorne works of the Western Electric Factory outside Chicago to determine if certain changes to indoor environmental conditions (particularly lighting levels) would improve worker performance. Oddly, the experiments appeared to show that worker performance often improved even when the changes to the conditions were negative. Later researchers suggested that simply the novelty of being research subjects and receiving increased attention might have contributed to the increased productivity (Mayo, 1945).

In the case of the blended learning design studio, the project team contacted the students prior to the commencement of the studio to inform them that they would be part of a novel experiment in design education. During the running of the studio, the project team continued to impress upon students that they were the subjects of special attention, welcoming feedback on the progress of the course at any stage. The so-called 'Hawthorne Effect' suggests that the degree of attention given to the students, not simply (or even) the nature of the blended learning studio itself, might have contributed to the students' diligence and therefore the high quality of their design outcomes.

Foucault's Panopticon

A slightly more disquieting explanation of the high quality of student design outcomes relates to Foucault's use of Jeremy Bentham's panopticon prison as a metaphor for the increasingly ubiquitous surveillance in modern societies (Foucault, 1977). In the panopticon prison layout the guard tower was located centrally to allow guards to see directly into every prisoner's cell. The guard tower was kept sufficiently dark that prisoner's could not tell whether or not they were being surveilled. Foucault suggests that the prisoners' uncertainty about whether they were being surveilled led them to assume they always were, and modify their behaviour accordingly. In other words the particular nature of the surveillance, which is not unlike ubiquitous contemporary CCTV installations for example, led subjects to self-discipline.

In the blended learning design studio, students posted every answer to every task and every item of homework to a Wordpress site that may (or may not) have been viewed by other students as well as the course coordinators. Students were told that while they would not be graded on the quality of their responses, the coordinators would check that they did the required items of work and that there were no frivolous postings. In reality having 13,000 student tasks to check meant that scrutiny was very cursory. However, following Foucault's logic, the very possibility that their work may be scrutinized might have led students to 'self-discipline' and act as though it would. This too may have contributed to the students' diligence and therefore the high quality of their design outcomes.

The blended learning design studio is currently being modified to address the weaknesses and reinforce the strengths identified by the student feedback, in preparation for a future iteration.

Acknowledgements

We would like to thank those who contributed to this project:

Blended Learning Project Team: Michael Tawa; Michael Muir; Martin Tomitsch; Rob Saunders; and Lian Loke.

Research Assistance and Technical Development: Fiona Chatteur.

Assistance with the University of Sydney eLearning Systems: Susan Atkinson; Ruth Weeks.

Studio Co-Coordinators: Simon Weir, Matthew Mindrup.

We are grateful to the University of Sydney for supporting the project through an Education Innovation Grant.

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Journal of Problem Based Learning in Higher Education

VOL. 5, NO. 1, 2017 – Page 126-137
http://dx.doi.org/10.5278/ojs.jpblhe.v0i0.1553

Integrating Blended and Problem-Based Learning into an Architectural Housing Design Studio: A Case Study

Yasemin Alkiser Bregger *

ABSTRACT

This paper presents how a blended learning pedagogic model is integrated into an architectural design studio by adapting the problem-based learning process and housing issues in Istanbul Technical University (ITU), during fall 2015 and spring 2016 semesters for fourth and sixth level students. These studios collaborated with the "Introduction to Housing" collaborative learning space carried out in the EU OIKONET project are also evaluated through the content and the process of ITU design studios.

Keywords: Blended learning, problem-based learning, architectural design studio experience, housing, OIKONET.

INTRODUCTION

In architectural education the main aim is to evoke in architects and designers of the near future, imagination, a sense of humor and curiosity while educating them as creative, flexible, sensitive, open-minded, and questioning students. As opposed to popular belief Groat and Wang (2013) state that design is a learnable process even if that learning does not always guarantee good design.

The ITU Department of Architecture "provides a positive and respectful learning environment that encourages the fundamental values of optimism, respect, sharing, engagement, and innovation among students and faculty in all learning environments both traditional and

* Yasemin Alkiser-Bregger, Dept. of Architectural Design, Istanbul Technical University, Taskisla-Taksim, Istanbul, Turkey.
Email: alkiser@itu.edu.tr

nontraditional" (NAAB, 2014). This program allows design studios to apply blended learning pedagogic models, and the problem-based learning process.

In the ITU 2015-2016 academic year, current squatter settlements and middle-upper residential areas were the main subjects for fourth and sixth level architectural design studios, which embraced the problem-based learning model. In both semesters, collaboration with the OIKONET "Introduction to Housing" (IH) learning space, contributed to the blended learning model of these ITU studios. "OIKONET, a global multidisciplinary network on housing research and learning" (www.oikonet.org) is an Erasmus Network project co-financed by the EU to foster pedagogic innovation in the field of housing studies (Madrazo et al., 2017). The implementation of the learning activities takes place in the OIKODOMOS Workspaces (www.oikodomos.org/workspaces), a web-based learning environment which enables the collaborative design and implementation of learning activities structured in sequence. The participation in the OIKONET network offers students a new perspective on their design process, insofar as they were encouraged to learn in a global context, both collaborative and competitive.

In each semester, relevant tasks were shared by ITU students and teachers in the "IH" learning space through the OIKONET network and in collaboration with international architectural schools including the School of Architecture of Valencia, Spain (ETSA-UPV), Lisbon University Institute. Portugal (ISCTE) and Gebze Technical University, Turkey (GTU). This case study aims to present the integration of blended and problem-based learning pedagogic models into a housing design studio in ITU. It also addresses how blended learning and problem-based models affect the performance of an architectural design studio dealing with housing issues. The methodology is based on evaluation of ITU architectural design studio students' performance and productivity considering tasks and problem-based housing projects implemented by using virtual platforms and the physical environment. It is also based on students' evaluation of the studio process.

THEORETICAL BACKGROUND

The aim of architectural education is to ensure students' awareness of their creative potential and to enrich it. Students thus can see problems under various combinations of circumstances and produce designs to be able to cope with them. Students should also know that architectural education and experience are life-long learning processes (Yurekli, 2009). Contemporary architectural education provides diverse creative opportunities. The virtual and the actual are synthesized into a new and growing environment. Students are expected to be technologically, culturally, socially intellectual, creative and experiencing. Intuitive and accidental design approaches also add spirit, inspiration, and uniqueness to experimental design processes (Alkiser and Ayiran, 2009). Architectural education seeks to develop

teaching and learning methodology and advanced technology. Problem-based learning and blended learning are ever-developing pedagogic models in architectural design.

Schön (1985) thought that architectural design studio itself is a model for education in all other professions. Design is a creative (Groat and Wang, 2013) and generative (Cross, 2011) process, which is beyond simply finding solutions. "Problem-based learning (PBL) educational model has important pedagogical benefits". It is founded on problem-based project work. The project is an integral part of the model and hence project-oriented and problem-based learning are interwoven in the terminology (McLoone et al, 2014). Graaff and Kolmos (2003) summarize seven common pedagogical principles related with all kinds of PBL models: An existing problem principle is the starting point of the learning process and more motivating. Self-directed principle gives freedom to students to orient and formulate the problem and solution. The experiential learning principle is necessary to build on students' previous experiences and interests. The activity-based principle engages students in their research, decision-making and designing. The interdisciplinary principle lets students go beyond traditional subject boundaries in order to find solutions. Exemplary practice principle helps students how to learn for future challenges. The group-based principle encourages students to develop their competencies, communication, and teamwork skills.

The design process is motivated by facing a certain *problem*, through *conceptualization*, *experiencing* in different ways such as coincidences or sketches, and *communication* through inspiration or suggestions by others. (Groat and Wang, 2013). In the PBL studio, the culture of learning together is a dialogue between teacher and students, and a creative process that occurs spontaneously in a learning platform, giving the skill of "learning-to-learn" to both students and teachers in an intellectual environment. "Learning-to-learn leads to "life-long learning" formation (Aydinli and Kurtuncu, 2014).

Blended learning (BL) is a pedagogic model to advance architectural education and make the design process more effective, creative, and easier for architectural students and teachers by using different communication tools and environments. Evolving collaboration technologies allowed international virtual studios and the BL pedagogic model to become more commonly used. A blended learning course, described in the Online Learning Consortium, integrates online with traditional face-to-face class activities in a planned, pedagogically valuable manner; and where a portion of institutionally defined face-to-face time is replaced by online activity (Picciano and Dziuban, 2007).

There are *advantages* and *disadvantages* to blended learning programs. Advantages in terms of incorporating the strengths of synchronous and asynchronous learning are greater flexibility of time, meeting different needs, and learning styles, (Ho et al., 2006, and Vaughan, 2007). Earlier technologies, extended new modes of collaboration and sharing of information, social media and other ICT tools (Madrazo et al., 2016) in design practices.

The disadvantages are potential struggles with technology, lack of motivation, insufficient time management skills and the expectation of less work (Vaughan, 2007). Fear of losing control in an online environment or lecturing identity may be disadvantages for course teachers. There are three factors affecting the success of blended learning courses: course design, communication (student-student interaction both in physical and virtual environment), and motivation (teacher encouragement and course organization) (King and Cerrone-Arnold, 2012).

Both blended and problem-based learning architectural design studios can address design problems. Housing is a popular problematic theme in architectural design studios. Combining BL and PBL pedagogic models in collaboration with housing studies is believed to contribute to architectural design education as well as to housing issues.

COUPLING OF HOUSING WITH A PROBLEM-BASED AND BLENDED LEARNING MODEL

Housing design is a comprehensive learning tool in architectural education due to its large-scale challenges and complicated, complex and multi-dimensional features. The housing theme is easily addressed in a PBL pedagogic model in a design studio. It helps students to work in multidisciplinary collaboration and focus on architectural concepts such as sustainability, affordability, and density.

Blended learning can also support an architectural design studio by adapting PBL pedagogy and housing issues. More complex and blended methods, programs, platforms, and networks can support housing education.

“Introduction to Housing” is one of the collaborative learning spaces carried out in the OIKONET project. Its pedagogic purpose is to initiate students to the basic principles of designing what a house represents in contemporary cultures. It is based on a blended-learning philosophy, which intertwines face to face (f2f) instruction with computer-mediated using a variety of teaching methods and learning (Madrazo et al., 2017).

ITU 4th and 6th semester architectural design studios addressed different housing themes through integrating a problem-based and blended learning model. Computer-aided design software and online communication technologies were used in the design process. These ITU studios introduced an online “IH” learning space in the OIKONET network, which provided a collaborative virtual learning environment with an interface for users to share their tasks, ideas, and comments.

In brief, housing issues, PBL, and BL in which online workspaces were introduced into traditional f2f and technology-based activities, all contributed to the dynamics of the design studio process through extensive international collaboration of distant learners of both teachers and students.

EVALUATION OF ITU ARCHITECTURAL DESIGN STUDIO

Housing in Istanbul offers architectural students extensive opportunities to understand, discover, and overcome hidden and exposed housing and environmental problems through both traditional and online design mediums.

The architectural design studios in ITU in collaboration with "Introduction to Housing" workspace addressed two different housing topics: "New Directions In Urban Housing: Fikirtepe Squatter Settlement Case" (fall 2015) and "Self-Made Neighborhood: Along Bagdat Street" (spring 2016). General themes, housing, and transformation in the syllabi were the same for different scales for both levels. There were one teacher and thirty ITU students with seventeen in the fall and thirteen in the spring in collaboration with three international universities in each semester during the activity period of the OIKONET network. Although ITU students are very familiar with computer-based drawing techniques and communication systems in the various virtual environments, experiencing an online network system, "IH", was new for all.

The content of two ITU studios are discussed in reference to the pedagogical principles of problem-based learning. These were derived from seven common principles by Graaff and Kolmos (2003), principles of communication-based and conceptual-based learning by King and Cerrone-Arnold (2012) and Groat and Wang (2013) and the process-oriented principle by Aydinli and Kurtuncu (2014). These principles were harmonized with the housing theme and the BL pedagogic model including traditional and computer-based environment according to learner’s skill, talent, background, and point of view. The content of the two architectural design studios was evaluated in the context of “what is learning design”. Below, the learning design process is analyzed according to specified PBL principles and by the BL approach under the housing theme. Table 1 shows ITU design studio activities and tasks delivered in different mediums.

PBL	**HOUSING**	**BL**		
Pedagogical Principles of the Studio	**Tasks and Activities in the Studio**	**Physical Environment**	**Virtual Environment**	
		Traditional f2f	**Computer-based (national)**	**OIKONET network IH & TD (international)**
Problem-based	First Impressions	Class	Dropbox	IH
	Background of the Area	Class	Dropbox	IH
	Environmental Analysis	Class	Dropbox	IH
Self-directed	Design Approach	Class	Dropbox	
Experiential learning	Creating Storyboard	Class	Dropbox	
	Making Section-Model	Class		
	Making Video	Class	Dropbox	IH
Activity-based	Preparing Survey	Class	Dropbox, WhatsApp, Facebook	
	Visiting the Area	Project Site		
	Conducting Survey	Project Site		
	Evaluating & Discussing Results of Survey	Class		IH
Interdisciplinary	Lectures	Class		Skype
	Provided Documents	Class		Dropbox
Exemplary practice	Housing Profession	Project Site		
	Example Analysis	Class	Dropbox	IH
Group-based	Making Shared Model	Class		
	Various assignments	Class	Dropbox	IH
Conceptual-based	Architectural Concepts	Class	Dropbox	
	Meaning of Dwelling	Class	Dropbox	TD
Communication/ Interaction-based	One on one interview	Class	E-mail, Facebook	
	Commenting on other students' work	Class		IH
Process-oriented	Juries for initial designs	Class	Dropbox	IH
	Commenting on Initial and Final Design	Class	Dropbox	IH
IH: Introduction to Housing TD: Thinking Dwelling				

Table 1 – ITU design studio activities and tasks delivered in different environments.

Problem-based: Housing was the main theme of both studios but the contexts were distinctive. While Fikirtepe was a squatter settlement, Bagdat Avenue was a middle-upper income housing area. Urban transformation was an actual agenda in both. Students focused on various housing design and urban transformation models. Students explored the right question to formulate the problem in the physical and social context through analyses. First impressions were based on their site visit and individual observations to perceive and understand about the area through concepts. The background of the area was researched through literature review. In-depth environmental context analysis was done through the "swot" technique. All work was presented and discussed in class and shared and commented on in the workspace.

Self-directed approach: Students were supposed to figure out and formulate the main problems themselves. They needed to come up with a cause and effect relationship about the potentials and problems of the area. Design was not dictated and they decided on their own the design approach and directed their development of solutions in the studio through discovery, experience, discussion, and knowledge exchange among the students and teachers.

Back and forth movement in the process was the key. The main focus of the studio was the interactive relation of ideas and actions between teacher and students. The final product was not an imagined result which the teacher or student previously had but a result of interwoven thoughts (Uluoglu, 1990), which was created by interaction in the studio.

Giving independence to students is important. Yurekli (2009) carried this idea forward saying architectural education could be considered a "black hole", that is to say, "the output was as important as the input." There should not be a perpetuation of a type of education with its rigid curriculum restricting and making students inconspicuous.

After a literature search, presentation, and discussion of design approaches in the class considering sustainability, affordability, re-densification etc., students were set free to find their own designs and social approaches.

Experiential learning: Experiential learning is based on one's life and interests in order to understand the world better. Davis (2006) stated that the best teacher for architectural students is reality itself. "A community of inquiry" stressed by Garrison and Vaughan (2008) allows learners to have "deep and meaningful educational experiences".

To raise interest and curiosity about design issues among ITU students, one-day workshops such as preparing storyboards, sectional models and/or videos were created. Students could create a useful, utilizable, and re-producible knowledge through their experience regarding their one-day lifecycle to reveal their routine daily life experiences to "re-think" and "re-

understand" a housing design. They shared their work for an in-depth discussion in class and on the workspace.

Activity-based: In design, the impetus is commonly referred to as a "problem" for an unmet need that prompts the development of a designed artifact as a solution for the future. Whereas in research, the impetus is typically framed in terms of a "question" to be answered at least in part by examining current and/or past evidence. (Groat and Wang, 2013).

ITU students designed a questionnaire to use with residents to gather information about user profiles, existing problems, and area potentials. They visited the area to make face-to-face interviews. The analysis of the survey was discussed in the studio and shared on the workspace.

Interdisciplinary: Workshops were conducted by specialists from different disciplines and provide students with new perspectives. Professionals and professors from Holland, Iran and Turkey coming from different fields gave lectures in the ITU studio and on Skype. ITU students asked questions regarding different fields and perspectives and shared in Dropbox.

Exemplary practice: Students do learn about learning and this equips them for success in future solutions. They are expected to develop their professional identity and responsibility (Graaff and Kolmos, 2003). Examples provide learners a way of exploring the architectural world.

In the studio, and online workspace a precedent analysis from published and online sources related to environmental characteristics, building program and conceptual approach was submitted as individual work.

Group-based: Peer-learning is facilitated and encouraged, as this is also central to the effective development of communication and teamwork skills (McLoone et al., 2014). Students learn how to handle the process of group cooperation in different stages (Graaff and Kolmos, 2003).

At the beginning, students made a shared model of the whole area to understand the city pattern used it to develop their initial design. Group work for various assignments enabled them to communicate, coordinate teamwork, and decide on the material, color, and technique of the model.

Conceptual-based: A concept is not an isolated, changeless formation but an active part of the intellectual process constantly engaged in serving visual communication, understanding, and problem solving. Students generally have extreme difficulty with conceptualization as much as transferring theoretical/ principles to the project work (Graaff and Kolmos, 2003).

Mental abstraction, integrity of form, function and technology, inner and outer space relationships and space organization were considered through conceptualization related to requirements and environmental parameters. Students participated in the OIKONET "thinking dwelling" program uploading the pictures upon the concepts.

Communication/Interaction-Based: The main idea of the design studio is the interactive relationship of ideas and actions between teacher and students. Communication and participation can lead to an increase in student motivation (Ho et al., 2006). The high quality teaching experience comes from the ability of blended courses to provide opportunities for increased interaction between students and faculty (King and Arnold, 2012) through juries, criticism, and reviews. These opportunities create effective discussion mediums, interactive environments to enhance, accumulate, and articulate the ideas, critiques, and even debates among students. With these interactions students can find their way during the design process. Yurekli (2009) claimed that students should learn correct knowledge through visiting the existing environment, reading a book, or surfing the Internet.

In the studio one-to-one interviews were another way for students to communicate with each other and teacher. This was a communication technique that students mostly preferred. Students were also encouraged and engaged interactively by involvement in commenting on other student's work in the class and on the IH workspace.

Process-oriented: The process-oriented approach needs "culture of learning-together and learning-to-learn" (Aydinli and Kurtuncu, 2014) among the learners in the design studio process. Learning is a never-ending process and bloomed by the synergy of the participation to the learning environment. The studio represents a "holistic process" including all kinds of assignments, experiences, and a lot of intermediate products as well as final projects. It concerns a whole process instead of a "finished/final product".

Design process and multiplies knowledge is as important as design project to evaluate student success. In studio students shared their initial designs and final products through juries, one-on-one discussions in class and comments from students in the studio and on the IH workspace.

RESULTS

Learning design in ITU was based on PBL with the principles mentioned above in collaboration with BL pedagogic model and housing theme during two semesters. At the end of the each semester, ITU students were asked to evaluate the design studio process in terms of PBL, BL, and the housing theme.

During the fall semester more than half of the seventeen students (53%) who submitted their projects performed highly, 23% had medium success, 18% were under achievers, and only one failed according to their grades. During the spring semester seventy percent of the thirteen students who submitted their final projects performed highly, 23% had medium success and one student failed. All thirty students evaluated the design process as below.

Evaluation of problem-based learning approach: A great majority of the students believe that the project site had a positive influence on their design due to its, unique, visible, physical and social characteristics, the possibility of visiting and learning and working with real lifestyles.

Evaluation of blended learning approach: Half of the students said that one-on-one interviews with their professor motivated them and one third of the students were motivated by group discussion. This shows that students prefer the physical environment and having someone with whom to discuss their ideas. Half of the students think that they worked in the studio environment efficiently and liked sharing and working together and learned a lot from the presentations. The other half thought that they did not work in the studio environment efficiently as it was crowded and noisy and they preferred to work alone. The students who found the OIKONET network effective were satisfied to share various examples, comments, and work with other universities. Twenty nine percent of the 45 ideas of the students on the online network were about more direct communication and group working with international students. In other words, their feeling was to make the platform more real, interactive, and visible by using Skype discussions and shared activities. More than 42% of the proposals suggested the need for an easier interface and uploading system. These results showed that overall, students were satisfied with being a part of an online network. The most common communication tools among the ITU students were WhatsApp, Facebook, and e-mail.

Thirty ITU students were given 23 various tasks and activities, shown in the Table 1, to implement individually or in groups to share either in the physical or virtual environment. Students were responsible for doing five tasks in the fall and eight in the spring on OIKONET "IH" workspace. They uploaded 33 (fall) and 71 (spring) tasks to the network. During both semesters more than half of the students completed all tasks in the network. Forty percent completed sixty percent of the tasks during the fall and more than one third of the tasks during the spring. This can be considered an encouraging completion rate of tasks showing their performance, given the difficulties of motivating and engaging the students in the online network.

Evaluation of housing theme in architectural design studio: All of the students agreed with the positive impact of the housing theme in terms of importance of daily life, opportunities for gaining extensive housing knowledge, requirements for different people, various typologies, housing legislation, and housing research.

CONCLUSIONS

Housing issues, problem-based learning and blended learning can be integrated to create a dynamic and creative pedagogic model in an architectural design studio. Although online education is sweeping through architectural education models, traditional education systems in architecture do not seem to be sacrificed as long as the experiential dimension of architecture is considered. Blended learning offers a wide range of flexibility to use available technologies and it is mainly affected by motivation, communication, and course design. The learning design process in a studio can be defined in advance and organized by the instructors. The key for being creative and innovative in the design process is to be open-minded, make a sensation, and raise curiosity using all kinds of traditional and online design tools in face-to-face and virtual design environments.

As a result PBL is very compatible with BL in which different ratios of traditional face-to-face learning and online learning can be adopted into architectural education. In addition, integration of problem-based learning, blended learning and the housing theme can help students to gain extensive information, interactive creativity, technology skills, socio-cultural awareness, and foreign language experience by using both physical and virtual environments and be applied to pedagogic models in architectural education and in a dynamic design studio process.

Acknowledgements
OIKONET is an Erasmus Networks project co-financed by the Education, Audiovisual, and Culture Executive Agency (EACEA) of the European Union with project number 539369-LLP-1-2013-1-ES-ERASMUS-ENW. I would like to thank project partners who have contributed to the work reported in this paper.

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