Proceedings of the Second Biennial Conference of the South African Society for Engineering Education

11 – 12 June 2013

Vineyard Hotel
Cape Town, South Africa

Edited by Brandon Collier-Reed

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Message from the President of SASEE

It is my great pleasure to welcome you to the second biennial conference of the South African Society for Engineering Education (SASEE). SASEE was formally launched at its first conference held in 2011, and the two years have rolled around in a busy way. Two workshops were held in 2012, to keep the momentum going – one on curriculum and another on teaching large classes. We have been delighted at the attendance and engagement so far at SASEE events, and the emergence of this dynamic community.

We have had a very good response to our call for papers for this conference and we have an interesting three day programme lined up. This year we headlined our call with the theme of "Teaching professionals / Professional teaching: towards an ethical, efficient and engaged engineering education" and we look forward to discussions that respond to this challenge. We are aiming a focus towards the building of professionalism in engineering education, interrogating not only efficiency (the current focus on throughput) but also the ethical basis for our teaching and the need for engagement.

The stunning Vineyard Hotel will form the backdrop for our deliberations. We particularly welcome all out of town guests to Cape Town! We are hoping for critical engagement with the current challenges we face in engineering education as well as the presentation of innovative work that is designing and trialling new ways forward. The SASEE conference is an important coming together of both research and practice-based scholarly work, covering topics at all the levels of policy, curriculum, and teaching and learning.

We are particularly grateful to our sponsors who have assisted in making this event happen. ECSA (The Engineering Council of South Africa) has played an on-going role in supporting SASEE at so many levels and we are also delighted that this year they have sponsored the Welcome Reception. We are pleased to welcome a new sponsor in FNB Platinum who made a generous contribution. Finally, we would also like to thank our exhibitors, Oxford University Press and Juta, for their participation in this event.

Prof Jenni Case
President, SASEE

Conference Review Procedure

These proceedings are a published record of the Second Biennial Conference of the South African Society for Engineering Education (SASEE). The purpose of these proceedings is to disseminate original research and new developments within the discipline of Engineering Education.

All papers and extended abstracts accepted for this conference went through a multiple- review process *prior to publication*. Authors initially submitted extended abstracts which were double-blind reviewed by at least one member of the SASEE or Centre for Research in Engineering Education Executive. Based on the outcome of this review, authors were invited to either develop this extended abstract into a full paper, or were invited to revise their extended abstracts based on the reviewers comments for resubmission. The resultant papers and extended abstracts were then further reviewed by at least two reviewers using a double-blind peer review process. Authors were required to consider and implement the suggested changes where required.

The reviewers for the papers and extended abstracts were drawn from the SASEE Executive, SASEE membership, and the Centre for Research in Engineering Education (CREE) as appropriate.

The rejection rate for full papers was **14%** and for extended abstracts was **13%**.

SASEE Biennial Conference Organising Committee, 2013

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Dr Keith Jacobs (UNISA)

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Extended Abstracts

The strategic position of the architecture programme within the Faculty of Engineering and the Built Environment at the Durban University of Technology (DUT): towards interdisciplinary engagement - bridging the gaps between theory and practice.

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Architectural education, in the Faculty of Engineering and the Built Environment at the Durban University of Technology (DUT) occupies a strategic position which can be used to transform its curriculum in order to become more contextually responsive and bridge the gaps between theory and practice. This research paper examines the possibilities of interdisciplinary engagement within a constructivist educational paradigm that would ultimately produce relevant and meaningful architectural and built environment solutions. The intention is that education through collaborative engagement of the built environment and other relevant disciplines becomes the principle pedagogic approach of architectural education at DUT. This necessitates a review and re-conceptualisation of historical architectural curricula. The existing architectural curriculum at DUT is critically analysed against the theoretical framework of constructivism, critical theory and epistemological balance in order to conceptually develop a new integrated, interdisciplinary learning environment. Constructivist educational theory, which incorporates problem-based learning, will guide the concept of a new interdisciplinary learning environment for architecture and related disciplines. The paper concludes by proposing a conceptual structure to promote interdisciplinary learning for architectural education at DUT.

Introduction and outline of the research problem

The location of the Department of Architecture within the Faculty of Engineering and the Built Environment at DUT presents great opportunities for synergy and interdisciplinary integration which has yet to realize its full potential. Historically, the curricula and pedagogic approaches of the built environment disciplines at DUT developed autonomously within the confines of their disciplinary boundaries. This is somewhat necessary, as fundamental disciplinary knowledge has to be developed in order to ensure that professional competences are developed. In the built environment industry however, various professional and construction disciplines mutually engage in complex construction projects that often require interaction from inception of such projects. Furthermore, extensive collaboration is inevitable during the pre-tender project design stage, when issues of design concept, environmental sensitivity, structural integrity and project cost engineering result in a dynamic team approach. Although the initial design process is somewhat linear with the architect engaging with the client, other professional input rapidly becomes necessary – even more so with constantly revised regulations governing construction.

Young graduates however, trained within strong discipline-specific academic programmes find it difficult to work in interdisciplinary and multidisciplinary teams on real projects in practice. This in turn impacts on their ability to transfer their academic knowledge into practice. Most academic programmes in architecture at South African universities include interdisciplinary project work, albeit at the higher levels of study. It is argued however, that interdisciplinary collaboration should be fostered and inculcated much earlier in the education of built environment professionals in order to produce graduates who would be capable to work skilfully and efficiently in industry. Furthermore, a culture of interdisciplinary collaboration with professionals could implicitly review and strengthen the quality of built environment professional education. The current *status quo* however, sees academia and practice developing independently. Young graduates are perceived to be generally underprepared and lack the

professional and ethical standards demanded in practice and society. How then, can professional education be transformed in order to bridge the gaps between academia and practice?

Currently, content and process-driven curricula defined within rigid disciplinary boundaries stifle the development of critical and collaborative thinking, which in turn increases the gap between theory and practice. The main argument of this paper therefore is that interdisciplinary collaboration is vital in bridging the gaps between theory and practice. Such collaboration directly impacts on pedagogic approaches as well as learning space development. It is however, firstly necessary to determine the root causes of the current situation in architectural education.

Theoretical and conceptual framework

Architectural education has generally focused on internal concerns and procedural practices specific to the discipline of architecture. Architectural discourse historically, has therefore been understood to be simply about what the architect does (Borden and Rendell 2001). Architectural pedagogy traditionally hinges around the design studio as the principal learning space. Here, students of architecture creatively explore ideas and present concepts expressing their design ideas. All collaboration, hence, is confined to the students within the design studio. Architectural education therefore, has been historically developed around the design studio as the central space used in finding solutions to architectural problems. Whilst the design studio fostered collaborative learning through expressing one's design ideas and conceptual development, it also remained confined within the disciplinary domain of architecture. Furthermore, the concept of the design studio has a strong foundation in the artistic paradigm that has been prevalent since the inception of the Beaux-Arts in France. How did the discipline of architecture, which had historically been closely linked with the crafts and building, become separated from the crafts and the process of building?

Architecture is historically, closely linked to craft and the process of building whilst it expresses the aspirations and the identity of society. During the early 17th century however, the intentions of architecture shifted from the foundations of craft and building developed under the supervision of the master craftsmen, to a fine art discipline. Cret (1941) attributes this to the Renaissance in Italy, when architecture separated from the guilds and developed as a profession following the ideals of the courts and the aristocracy. The French tradition, however, was the most influential in architectural education in Europe, and later most of the developed and developing worlds. By the mid 18th century the *Ecole des Beaux-Arts* was formed, which formalised architectural education in France and developed the studio (*atelier*) as the principal learning space for architecture. This approach was adopted by most schools of architecture in the West as well as the developing world, including South Africa. The Beaux-Arts situated architecture within the domain of art. Whilst most architectural training prior to the establishment of the Beaux-Arts focussed on the disciplined apprentice-based system of emulating master craftsmen and master builders, the *Ecole des Beaux-Arts* claimed to reject dictation and regiment. A student-centred, liberal education approach was the intention of the *Ecole des Beaux-Arts*, to the extent that students had the freedom to choose their teachers and even had the choice of rejecting their advice, if they so wished (Cret 1941). However, the main medium of design assessment was the jury, who passed judgement on students' work. Students were inclined to present work that would please the jury and therefore, this contradicted the claimed liberal approach. Students focused on awe-inspiring renderings and presentation rather than good quality architecture (Cret 1941). This focus on the lure of the visual image and rendering thus created artistic works that became products themselves, rather than intelligent architectural design solutions. The Beaux-Arts system as such rather inhibits student thinking, ultimately resulting in the decline of the general level of design (Salama in Andjomshoaa *et al*, 2011). The Beaux-Arts pedagogy, skewed towards an artistic paradigm, fostered an introverted,

intuitive approach to architectural design which still remains the predominant method of architectural education. This form of studio as such, cannot bridge the gap between architectural education, practice and society. The epistemological balance of the architectural education is therefore questioned.

Studies based on Jungian psychological types confirm that architects and architectural students generally tend to be introverted and intuitive (Stamps III 1994). Architectural training within an introvert intuitive paradigm will thus produce architects whose predispositions tend towards producing architecture, primarily through the beauty of their personal visions. Historical data indeed reveals that architectural projects during the mid to late 20th century changed focus from that of social relevance to the expression of individual creative and artistic flair. Rybcznski (in Stamps III 1994) noted that the projects in the mid to late 1990s tended towards unusual buildings with little functional requirement and maximum emotive potential, in which designers were focused on self-expression and individuality, a predominantly introverted process. Stamps III (1994) takes a critical stance as he posits that: (1) Architectural education emphasises feelings and imagination, thereby socialising learners to a predominantly artistic paradigm, (2) current societal conditions demand skills other than those that exist within the artistic paradigm, particularly thinking, sensing and extroversion, (3) the development of other skills requires epistemological balance between the artistic and other paradigms, and (4) implementation of epistemological balance can be achieved at all levels of design education. This introvert, individualistic artistic endeavour that still prevails in the early 21st century is called into question due to the urgent need to respond to the current environmental, social and economic problems threatening the sustainability of the built environment and contemporary societies. It is therefore essential that architecture develops through the joint and collaborative endeavours of multiple professional disciplines in order to respond to the multiple layers of context; the ecological / environmental, social and economic. For this to happen, the architectural studio as a central space has to be transformed. The architectural studio will thus become a multi-disciplinary learning space that would foster interdisciplinary learning.

Furthermore, the global economy and information flow with the rapid development of information technology, open source resources, CAD, BIM and simulation software has exposed architecture to larger participatory platforms as well as social and cultural diversity. These technologies offer ease of networking between academia, professions and societies both in the local context as well as the global context. Stamps III (1994) posits that in order for architecture to function effectively in the information-rich, multicultural world, designers have to engage both the intuitive and analytical psychological paradigms in order to achieve flexibility in their approach to design within the broader context defined by the free flow of information and multiculturalism. This has implications on the current form of the architectural studio, as the primary learning space for architectural education. How then, can the contemporary architectural studio be transformed in order to re-integrate architecture with practice and society?

This paper argues that the architectural studio has much greater potential to develop relevant professional knowledge by including the allied disciplines, representatives of society and professional practitioners. The studio can then be transformed from an introverted, intuitive artistic-silo into a multi-faceted interdisciplinary environment. Borden and Rendell (2001) suggest that architecture engages with everyone involved in architecture. They consider this to be “simply everyone” as implicated in the wider world of architecture which all live in. Hence, an introverted approach is thus counter-productive. The implications thereof impact on the current pedagogic approaches of the traditional architectural studio as a learning environment. Furthermore, this requires a necessary review of architectural theory and literature which is traditionally based on discourse around single architects and practices. Architectural education

therefore, has to engage with concerns outside of the historic and hegemonic realm of specific architectural theory and practice in order to include a broad range of social, economic and environmental concerns. Hence, an interdisciplinary framework for re-conceptualising architectural education starts to emerge.

Interdisciplinary collaboration fosters critical and collaborative approaches to find solutions to built environment problems. This requires the ability to apply knowledge to real life problems. The architectural studio is positioned in a prime position to become an interdisciplinary learning space where real life problems and could be critically interrogated, discussed and debated. Panin (2007) posits critical theory as a framework for interdisciplinary critical thinking in order to bridge the gaps between theory and practice. Interdisciplinary critical thinking however, requires learners' active construction of ideas and knowledge through collaboration. This has implications on the 'learning-problem' which has to be able to engage multiple disciplines, the pedagogic approaches of academic facilitators and the design of the learning environment.

Reference is made to constructivism as a theory for pedagogic and learning space development. Constructivism posits that learners are active, situated constructors of their own knowledge. Learners within a constructivist learning paradigm generate knowledge as part of their own cognitive ideas as well as through interaction with peers, colleagues and facilitators. Piaget's cognitive / radical constructivism and Vygotsky's social / realist constructivism, although seemingly dialectically opposed, are both relevant to a learner-centred pedagogic approach based on interdisciplinary collaboration. Interdisciplinary interaction however, inevitably creates conditions of conflict resulting from different experiences and points of view. This implies that solutions must be reached by negotiation and consensus. Therefore, cognitive knowledge construction of individual learners must be interrogated through social collaboration, and then the process of negotiation and consensus, in order to develop acceptable solutions to appropriately situated problems.

It is essential that problems be appropriately contextualised in order to engage multiple disciplines. Furthermore, the stimulus for learning will be much stronger when such problems are situated in real life contexts. Such contexts are naturally complex and defined by difference and diversity – the places of incidental interdisciplinary engagement. These contexts naturally create conflict as well as constantly present new problems that challenge the existing cognitive schema of learners. The need to find solutions, which are deemed relevant in context, then drives learners toward learning. Savery and Duffy (1995) affirm that constructivist learning is driven by the learners' own goals which Piaget refers to as "puzzlement", arising out of social / environmental interaction. Learners therefore learn when there is self-directed motivation for learning that stems from the need to solve a problem which is perceived as relevant to a particular defined context. Whilst Piaget referred to this need for learning defined by a relevant problem as "puzzlement", Dewey referred to the notion of "the problematic" as a stimulus for learning (Glassman 2001). It therefore becomes evident that the quality of the problem determines the quality of learning. Hence, constructivist learning has to be problem-based and situated within the real life context to realise its full potential.

Problem based learning (PBL) which has historically been implemented as a pedagogic approach in many professional disciplines, was the method promulgated by the Beaux-Arts in architectural education. As mentioned previously however, the Beaux-Arts fostered an introverted, intuitive approach to problem-solving. Real life problems, on the other hand, are situated in contexts that largely require extrovert and analytical processes for effective resolution. This results in socio-environmental knowledge construction through both intra-subjective and inter-subjective engagement. This interpretation is confirmed by Hmelo-Silver (2004) who supports PBL as an instructional method based on facilitated learning through

complex problem solving in collaborative groups, based on well defined problems in context. Hence, knowledge emanates from interaction with the broader context defined by the interplay of multiple disciples. Knowledge and ideas may then become transferable to practice and society. As appropriate solutions are derived from contradiction, debate, negotiation and consensus, knowledge becomes flexible and adaptable and therefore applicable to different contexts. The discussion affirms a student-centred pedagogic approach, as learners generate knowledge and problems situated in experiential context, and become the focus of student-centred, self directed learning (SDL). Students are more intrinsically motivated when learning is situated in meaningful tasks. This has a positive spin – off for society as theory and practice starts to establish social relevance and ethical professional practice. This consequently requires a transformation of the traditional architectural studio which is largely introverted.

This research posits that the architectural studio can be transformed into a collaborative learning space for interdisciplinary problem-based learning that simulates real-life contexts. For this to happen though, interdisciplinary learning cannot be left to the "capstone projects" usually situated at exit levels of Built Environment programmes at DUT. The location of architecture within the Faculty of Engineering and the Built Environment at DUT presents a strategic opportunity for the transformation of the architectural studio into an interdisciplinary learning environment focusing on well contextualised problems in the form of simulated projects.

Analysis of the existing architectural curriculum at DUT

The notion of the "capstone" project features in the built environment programmes at DUT, albeit in the latter years of study. Historically, students learned the fundamental disciplinary skills and knowledge in their latter years of study which they would apply to these major integrated "capstone" projects. Whilst the "capstone" projects offer great opportunity for interdisciplinary synergy, it is argued that projects of such nature be included in the curriculum from the early years of study, at lower levels. This thus has implications on curriculum planning as well as learning spaces. The Department of Architecture at DUT is strategically positioned in order to reconceptualise its curriculum and transform its design studios in order to foster greater interdisciplinary collaboration. The current situation however reveals a predominantly discipline-specific curriculum structure, supported by dedicated architectural studios and ancillary learning spaces.

The existing curriculum structure of the DUT Architecture undergraduate programme, the National Diploma in Architectural Technology, outlines the various subject modules, their respective subject domains and the department / domain servicing such modules as well as the allocated learning spaces (refer to Table 1).

Table 1. Curriculum structure of the National Diploma in Architectural Technology at DUT.

Subject Modules	Subject Domain	Servicing Department	Projects	Learning Space
MAJOR MODULES				
Presentation I (Design I)	Architectural Design	Architecture	Architectural Design	Architectural Studio
Studio Work II (Design II)	Architectural Design	Architecture	Architectural Design	Architectural Studio
Principles of Architectural Design III (Design III)	Architectural Design	Architecture	Architectural Design integrated with construction technology and building services	Architectural Studio
Construction & Detailing I (Construction Technology)	Construction Technology	Architecture	Architectural Technology	Architectural Studio
Construction & Detailing II (Construction Technology)	Construction Technology Contract Documentation	Architecture	Architectural Technology integrated with architectural design	Architectural Studio
Construction & Detailing III (Construction Technology)		Architecture	Architectural Technology integrated With architectural design	Architectural Studio
Studio Work I	Law, Contract Documentation	Architecture	Basic architectural drawing conventions, Application of legislation affecting architectural documentation	Architectural Studio
Studio Work III	Law, Contract Documentation		Application of legislation affecting architectural documentation Contract and construction documentation	Architectural Studio
SUPPORT MODULES				
Survey and Landscaping III	Architectural Design Land Survey	Architecture	Site survey, landscaping layouts on design projects	Lecture Room

History & Appreciation of Architecture I, II & III	Architecture, Humanities and Social Sciences	Architecture	Architectural history papers, assignments and seminars	Lecture Room
Theory of Design II & III	Grand Theory Architectural Theory Design Theory	Architecture	Architectural history papers, assignments and seminars	Lecture Room
Applied Building Science I	Physics, Mathematics, Construction Technology	Architecture	Building Science Projects	Lecture Room
Practical Studies II	Construction Technology Construction Theory	Architecture	Documentation of Building projects and construction materials	Studio
Building Services III	Construction Technology	Architecture	Services layouts on design projects	Studio
Computer Applications I	Information Technology	Architecture	Wordprocessing, Spreadsheets, Digital presentation	Architecture Computer Laboratory
Computer-Aided Draughting I	Information Technology, Digital Graphic Communications	Architecture	Architectural design and technology presentation and documentation	Architecture Computer Laboratory
Advanced Computer-Aided Draughting II	Information Technology, Digital Graphic Communications	Architecture	Architectural design and technology presentation and 3D modelling	Architecture Computer Laboratory
Communication I	Language & Communication	Language & Communication	Business communication Projects	Lecture Room
Office Practice III	Law, Contract Administration, Project Management	Architecture	Test and assignments pertaining to the architectural professions act	Lecture Room

Table 1 illustrates the range of subject modules and associated learning spaces, which define the National Diploma in Architectural Technology at DUT. Note however, that although the curriculum seems interdisciplinary with reference to the multiple subject domains, neither its pedagogic approach nor its learning environment currently promotes interdisciplinary learning. Major modules and the projects thereof are contained within the domain of architecture and facilitated in dedicated architectural studios. There is evidence of integrated project work during

the second and third years of study, although still confined within the disciplinary domain of architecture. The existing curriculum of the National Diploma in Architectural Technology at DUT is defined by architectural design studio modules which tend largely towards a Beaux-Arts type, artistic paradigm. Support modules range from science and technology to law and business administration. These however, are serviced by the staff of the department of architecture, who are not trained to be competent in these fields. Whilst the current curriculum structure and allocated learning spaces, for architectural education at DUT, does not currently accommodate the allied disciplines, therein lies a the opportunity to transform the pedagogic approaches and develop learning spaces that foster interdisciplinary collaboration at all levels of study.

Table 2 illustrates the modules of the existing National Diploma in Architectural Technology within broader subject domains indicating discipline-specific modules as well as cross-disciplinary modules. It is evident that a large number of the modules fall into multi-disciplinary domains. However, these modules are almost entirely facilitated within the architecture programme, as illustrated in Figure 1. This highlights the fact that interdisciplinary interaction is virtually non-existent within the existing structure of the National Diploma in Architectural Technology at DUT. Table 2 further reveals that there are no modules from the Urban and Regional planning discipline which is of concern as urban and regional planning forms a vital part of architecture and environmental design.

Table 2. Current modules of the National Diploma in Architectural Technology situated within the relevant disciplines.

Architecture	**Architecture & Construction Management**	**Architecture, Construction Management & Other (Law, Business Economics, Communication, IT)**
Design I,II,III	Construction & Detailing I, II, III	Studio Work III
Theory of Design II & III	Applied Building Science I	Office Practice III
History of Architecture I, II & III	Practical Studies II	Communication I
Survey and Landscaping III	Building Services III	Computer Applications I
Computer-Aided Draughting I, II		

The analysis of the data presented in Table 1 and Table 2 clearly illustrate a disconnection of the architecture curriculum from the allied disciplines at DUT. Furthermore, it is evident that learning spaces are rather discipline-specific, largely in the form of the architectural studio. The following section attempts to develop a concept for an interdisciplinary curriculum that is facilitated as far as possible, within interdisciplinary learning spaces.

Proposed concept of an interdisciplinary academic programme for architecture at DUT

It is the intention of this paper to outline a conceptual structure that starts to integrate the multiple disciplines, to which the various subject domains belong, in order to develop an interdisciplinary learning paradigm for architectural education at DUT. As explained in the theoretical and conceptual framework, contextual awareness needs to be developed early in the built environment curriculum. It is therefore proposed that a broad range of multi-disciplinary

modules be offered in the earlier years of study, whilst the built environment discipline-specific knowledge and skills follow later on in the curriculum. Firstly, this requires the early exposure of all students to the social, economic and environmental realities facing the built environment, which will greatly assist in contextualising research problems in real-life situations. Secondly, integration of the different disciplines on problem-based project work early in the curriculum will foster collaboration and debate between students jointly resolving problems. The inevitable contradictions arising out of differing points of view and inter-personal experiences could then generate relevant solutions through the process of negotiation and consensus. This approach further develops a culture of flexibility and adaptability in students thinking and ultimately their professional work.

However, the current architectural curriculum is overwhelming discipline-specific and introverted, which goes against the intentions of an interdisciplinary learning environment. Architectural education therefore, has to epistemologically transform from an introverted, intuitive silo to expose itself in order to respond to the realities and challenges facing the built environment at the social, economic and environmental levels. This suggests extroversion in order to engage the allied disciplines as well as relevant representatives of society, in order to produce meaningful and relevant solutions to the problems plaguing the built environment. A re-conceptualisation of the architectural curriculum as well as learning spaces is necessary in order to achieve this epistemological balance.

The built environment cluster within the Faculty of Engineering and the Built Environment, comprising architecture, construction management, civil engineering and town and regional planning academic programmes, is ideally positioned to develop an interdisciplinary curriculum. Furthermore, other relevant disciplines such as mathematics, physics, law, economics and business studies input into the new curricula structure as servicing departments. Figure 1 illustrates a conceptual structure for the integration of built environment disciplines focusing on a common contextualised design problem.

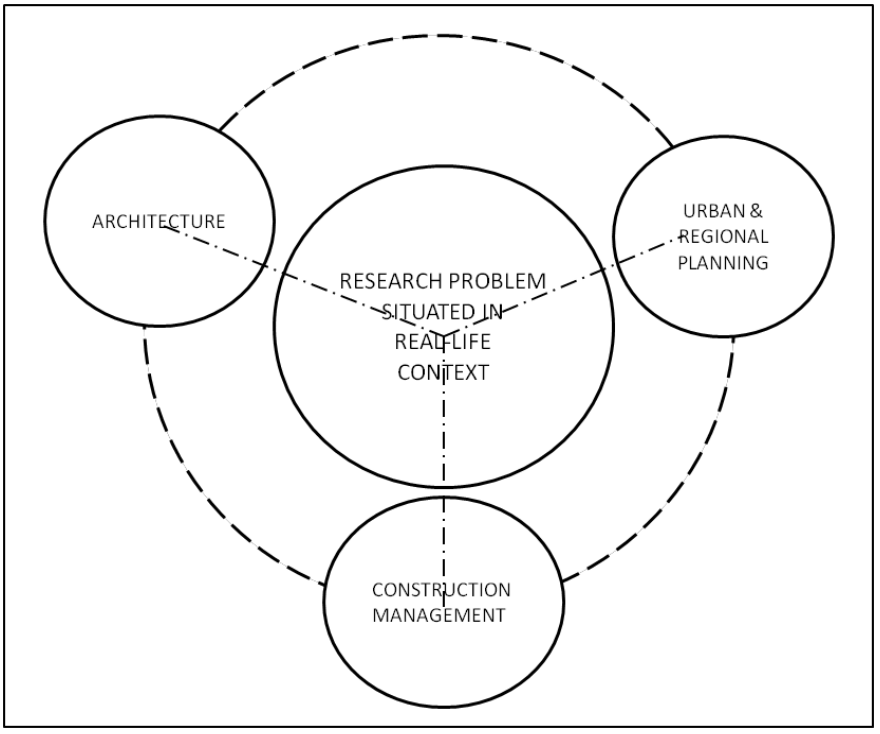

Figure 1. The integration of built environment disciplines focusing on a common contextualised design problem.

Interdisciplinary project work contextualised within well defined problems situated in real-life contexts is vital to an interdisciplinary learning paradigm (Figure 1). Each of the built environment disciplines at DUT currently engage with these interdisciplinary concerns within their own disciplines. By situating these built environment problems within common integrated projects it would be possible to collaborate between disciplines in jointly addressing the problems and develop relevant solutions to often complex problems that face the built environment.

It is further argued that in order to effectively engage on interdisciplinary project work there needs to be some collaborative learning of theoretical knowledge and fundamental principles during the early levels of study whilst concurrently learning discipline-specific knowledge and skills. It is suggested however, that the early years of study expose students to a broad range of contextual issues that relate to multiple disciplines. For this to happen, a significant redesign of the curriculum is needed in order to foster interdisciplinary learning early in the curriculum.

DUT has in its curriculum renewal endeavours, included a common general fundamental module that all entering students would register for. This module exposes students to multiple domains ranging from the liberal arts to humanities, development studies, science and technology. Within this system students registered for science and technology would benefit from modules selected from the humanities and liberal arts visa versa. This results in every student, regardless of their field of study, being exposed to the social, economic and environmental realities of his / her context. The Faculty of engineering and the Built Environment have been actively engaging in curriculum renewal and have established common modules, across all its disciplines, in mathematics and physics. The built environment cluster of the faculty has further developed an interdisciplinary structure that distinguishes its programmes from similar programmes at other universities in the country. Figure 2 below outlines the curriculum of the proposed undergraduate curriculum for architecture at DUT within the various subject domains.

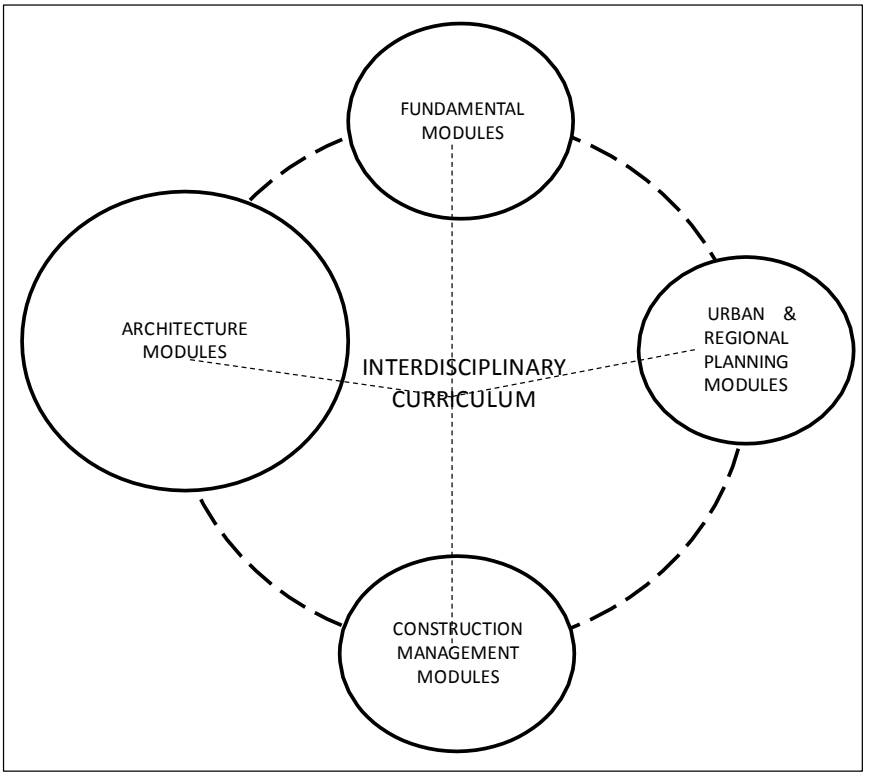

Figure 2. Conceptual structure for an interdisciplinary programme in architecture at DUT.

Figure 2 outlines a conceptual structure for an interdisciplinary undergraduate programme in architecture at DUT. The proposed new curriculum reveals a fundamental paradigm shift from a discipline focused current programme to an interdisciplinary curriculum. Interdisciplinary engagement is fostered at entry level and developed throughout the curriculum. Within this structure, all first year students of architecture are exposed to the multi-cultural university society as well as the multiple subject domains that influence the built environment. The introduction of science and technology modules would assist in achieving epistemological balance within the architecture programme whilst the integrated studio projects, on the other hand, would engage students of construction management, for example, in the creative design studio process. Table 3 conceptually illustrates modules within a proposed interdisciplinary curriculum structure for architecture at DUT.

Table 3. Conceptual structure for an interdisciplinary programme in architecture at DUT.

Fundamental modules	**General modules**	**Allied built environment discipline / interdisciplinary modules**	**Architecture discipline-specific modules**
DUT Fundamental Module	Academic Literacy	Construction Technology	Architectural Design
	Mathematics	Landscaping & Site Survey	History & Theory of Design
	Physics	Urban Settlements	Work Based Project
			(Design & Technology
	Business Studies	Law of Building Contracts	
	Principles of Commercial Law	Property and Land Economics	
	Research Methods	Professional Practice	
	Major Integrated Interdisciplinary Projects		

Table 3 illustrates the proposed concept of an interdisciplinary architectural curriculum for DUT. Whilst the curriculum may be interdisciplinary, effective collaborative learning cannot be realised without properly contextualised problems and the support of appropriate learning spaces.

Projects must be situated in problems based on real issues facing the sustainability of the built environment. A problem-based pedagogic approach, contextualized in studio projects will foster collaboration of all built environment disciplines as well as relevant other disciplines. Theoretical knowledge from discipline-specific modules may then be applied to relevant integrated studio projects. The studio further requires input from industry and professional experts as well as representatives of society. In this way the studio extends beyond the domain of the university and exposes itself to the broader societal context. The studio hence transforms from a disciplinary silo into an interdisciplinary learning space that simulates real-life situations (Figure 3).

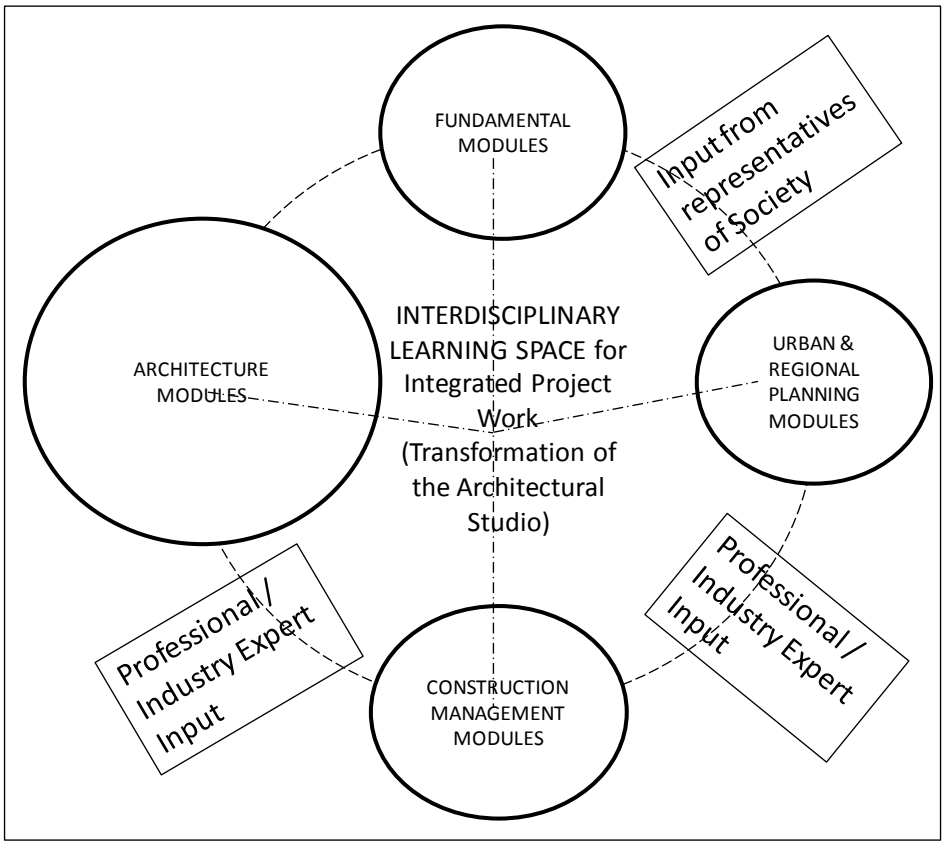

Figure 3. Conceptual structure of an interdisciplinary learning space for the Built Environment cluster at DUT.

The inclusion of expert industry mentorship and input adds a further dimension to the pedagogic approach as the theoretical and simulated academic projects would be supplemented by expert industry knowledge and experience. Industry and expert professional input further exposes students to the professional, legal and ethical frameworks in which professionals practice. Representatives of society, who are the ultimate inhabitants of the built environment, play a crucial role in the interdisciplinary studio. Representatives of society add valuable cultural layers of engagement to the interdisciplinary studio, and thereby stimulate the creation of regional identity in built form. It must be noted here that interdisciplinary learning environments include virtual learning spaces which afford limitless access to the broader local and global conditions that impact on the built environment professions. Learning space would therefore be defined by a mix of formal spaces such as lecture rooms, informal spaces such as the studio and campus social spaces, virtual learning spaces and work-based / industry-based learning spaces. Hence, an interdisciplinary learning space emerges, which integrates multiple disciplines, practice and society. This interdisciplinary paradigm could effectively bridge the existing gaps between theory, practice and society.

Conclusion

The intention of this paper was to determine how architectural education could engage with its allied counterparts within the Faculty of Engineering and the Built Environment at DUT in order to become more relevant in responding to the current issues plaguing the built environment. The conceptualisation of an interdisciplinary curriculum, supported by interdisciplinary learning space was determined as necessary in order to develop responsive architectural solutions to the problems of social, economic and environmental sustainability. This thus challenged architectural education to give up its introvert disciplinary silo and to start

engaging with the broader context. The epistemological balance in architectural education thereby shifted from a predominantly artistic paradigm, to an interdisciplinary curriculum defined by a high level of collaboration which is adaptable and flexible in response to a dynamic built environment. The proposed curriculum model supported by the appropriate pedagogic approaches and learning environments result in well prepared graduates who may engage in industry effectively and ethically. Architecture and the allied built environment disciplines, whilst maintaining professional autonomy, would ultimately engage in a more meaningful and relevant way in responding to the urgent needs of society through sustainable built environment solutions.

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