



# Higher Education Curriculum Ecosystem Design

A Thesis submitted by

Christopher Cheers MEd, Grad Dip ICTE, Grad Cert TESOL, BEd

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## Abstract

This study focuses on the development of a Design Framework for Higher Education Curriculum Ecosystem design. The study views the world as a digital ecosystem where the physical and the virtual are fully intertwined and function through integrated social and technical architecture working together in a seamless mesh that is persistent and pervasive. This digital ecosystem is an open, flexible, demand driven, self-organising, collaborative environment. It has enhanced individuals' abilities to connect with other people, share ideas, work collaboratively and form communities. This has inevitably impacted on educational practice in Higher Education.

The thesis draws together educational theories, curriculum designs, and concepts drawn from ecological psychology, cognitive apprenticeship, distributed cognition and activity theory, and extends them through the application of a Complexity Science lens. A Complexity Science perspective views the world as comprised of Complex Adaptive Systems. This study explores how authentic learning processes can be scaffolded within a Complex Adaptive System. The iterative development and refinement, through three iterations over six years, of a curriculum ecosystem for a Built Environment Degree Program is used as a case study for the development of a Higher Education curriculum ecosystem exemplar. A Design Framework for a Curriculum Ecosystem for Higher Education which has emerged through this process is presented.

## Certification of Thesis

This thesis is entirely the work of *Christopher Cheers* except where otherwise acknowledged. The work is original and has not previously been submitted for any other award, except where acknowledged.

Student and supervisors signatures of endorsement are held at USQ.

Professor Glen Postle  
Principal Supervisor

Professor Chen Swee Eng  
Associate Supervisor

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# 1. Introduction

## 1.1 *The Problem*

The dynamics of contemporary lives have changed. Senses and cognitive processes have been extended and supported beyond physical selves. The world has become a 'digital ecosystem' where the physical and the virtual are fully intertwined and functioning through well-designed, well-integrated social and technical architecture working together in a wireless mesh that is persistent, pervasive, and mobile (Suter et al, 2005). This digital ecosystem is an open, flexible, demand driven, self-organizing, collaborative environment. It can, has, and will continue to enhance individuals' abilities to connect with other people, share ideas, work collaboratively and form communities (Pew Research Center Report 2014).

Many students have become comfortable with this digital world, increasingly at home with its tools and processes. Increasingly learners have access to, and use a broad range of social networking tools and technologies that provide a constantly evolving multiplicity of opportunities for communication, and availability of interactive resources for information. As such, learners expect to see this diversity reflected in their educational experiences. These new technologies are having a disruptive impact on how people live, learn and work (Bower & Christensen, 1995). If educational practices are to remain relevant higher education institutions must also embrace the dynamics and opportunities of this evolving digital age which can support a rich, learner centred approach to education (JISC Web 2.0 Report 2009).

However, traditional transmission models of education (reinforced by widespread use of instructivist teaching approaches and top-down management structures) seem to still dominate our educational institutions (Garrison et al, 2003).



This situation is mirrored in the ongoing corporatisation of Higher Education institutions, through the implementation of corporate management structures and calls for educational activities and research to contribute to growth in revenue, with an emphasis on throughput, and the catch cries of branding, marketing and intense competition. And where the implementation of technology is seen as a way to improve the 'bottom line' rather than a rich opportunity to improve educational practice.

“Technological innovation in higher education has been largely restricted to administration and research. The significant technological innovations in teaching and learning have been confined to addressing issues of access and convenience. However, addressing the relevance and quality of the learning experience demands that higher education take a fresh look at how it approaches teaching and learning and utilizes technology.” (Garrison & Vaughan, 2008, p.10)

Virtual learning environments and social networking solutions have the capacity to cater for a diverse range of learner initiatives and interactions. Higher Education practices have yet to evolve and reflect the dynamics of the digital ecosystem that the world has become. Educators have an obligation to provide students with educational experiences that will enable them to develop the attitudes, skills and knowledge needed to meet the challenges they will face as professionals in this constantly evolving digital age. Some researchers have even gone so far as to comment that:

"Deep, radical and urgent transformation is required in Higher Education ... models of higher education that marched triumphantly across the globe in the second half of the 20th century are broken" (Barber, Donnelly & Rizvi, 2013)

There are also strong concerns in regards to graduate employability and that current higher education curriculum design does not reflect the required outcomes for professions in the increasingly complex world of the 21st century (Bennett, Richardson, Mahat, Coates, MacKinnon & Schmidt, 2015).

While the world has moved from industrial to knowledge based, our educational institutions, to a large extent, seem to have yet to reflect this change. Industrial age models instead of the complex dynamics of the digital age still seem to drive curriculum design and educational practice. The adoption of the new technologies so far seems to have been more about the preservation of the status quo than any real fundamental change. Laurillard, Oliver, Wasson and Hoppe (2009) argue that educational practice needs to include the development of expertise in the skills of knowledge negotiation, taking the skills of inquiry, critique, and evaluation beyond the understanding of ideas to the development and representation of the new knowledge that comes from being a practitioner in a field.

Current curricula are not designed to mirror the complex dynamics of the contemporary world in which students are expected to be able to function and succeed as professionals. Higher education practices have to meet the needs of a changing world as it evolves and as new technologies are integrated even more broadly across professional practices. Curricula and educational practice need to be guided by a paradigm that reflects the dynamics, challenges and opportunities of the 21<sup>st</sup> century.

A paradigm is embodied in exemplars that model roles, responsibilities and tasks, and define and guide related activities. Exemplars based on this emerging alternative paradigm can be developed to provide concrete models relevant to the real world as it is now, not as it was in the past. Recognition of a fundamental paradigm shift needs to occur throughout Higher Education and this alternative paradigm has to be at the core of curriculum design if there is to be a fundamental change in educational practice.

## ***1.2 Purpose and Significance of the Study***

Current literature points to Complexity Science as holding at least part of the answer to this challenge (Doll 2005, 2012; Barab & Roth, 2006; Smitherman, 2005). A complexity paradigm views the world as complex and unpredictable, and relationships as non-linear and dynamic. A world made up of Complex Adaptive Systems (CAS) where intelligent agents anticipate the behaviour of others and the external environment, and modify their behaviour accordingly.

When curriculum design is viewed from a complexity science perspective the focus shifts from curriculum content to the underlying processes of the complex adaptive system that is a discipline, a profession (Abel, 1998). Curricula can then be designed to enable the facilitation and support of educational practice within a dynamic, evolving ecosystem. An ecological view of the world requires a shift of focus in education to learner's interactions with others and the environment within which they live and work, rather than the dissemination of information. Exemplars based on a complexity paradigm can be developed to provide concrete models to support change in educational practices (Kuhn, 1970; Imershein, 1976).

### ***1.3 Scope and Aims of the Study***

The central aim of this study is to develop a set of guiding principles and a design framework for curriculum ecosystem design for Higher Education. It explores current literature using a Grounded Theory approach (Glaser & Strauss, 1967; Bryant & Charmaz, 2010), where the literature is seen as a source of data (Strauss & Corbin, 1990 as cited in Bloomberg & Volpe, 2008), drawing together educational theories and curriculum designs, and interpreting and extending them through the application of a Complexity Science lens and related concepts drawn from ecological psychology, distributed cognition and activity theory. This approach is intended to provide a perspective that can inform curriculum design, curriculum ecosystem design and the development and refinement of a Higher Education curriculum ecosystem exemplar.

The literature is approached through a lens of educational practice within a Complex Adaptive System (CAS). The literature review explores the dynamics of a Complex Adaptive System, learning processes, and how that learning can be scaffolded within a Complex Adaptive System. Key guiding principles are then articulated through this process.

A case study of the iterative revision and redevelopment, based on these guiding principles, of the Holmesglen Built Environment Degree Program (BEDP) is used to gather insights into design and development of a Higher Education curriculum ecosystem exemplar and the development of a Design Framework.

An educational design research approach is used to trace and explore the evolution of the Built Environment Degree Program curriculum ecosystem through three iterations over six years. Each of these iterations is initiated by the implementation of an intervention to support and scaffold interactions and processes

within the BEDP curriculum ecosystem. Activity Theory is used throughout this process both as a method for informing design decisions and as an evaluation tool.

### **1.3.1 Limitations of the Study**

This study focuses on one case study, a Built Environment degree program, which can be seen as a limitation. However the aim of the study is to expand theories not to undertake statistical generalisation (Burns, 1997). The case study is employed to gain an in depth understanding of processes in context rather than a specific variable (Merriam, 1998). It is foundational research which provides a tool, a framework, for exploring possibilities within other Higher Education programs and curricula.

More broadly, it is acknowledged that some researchers may view the study's melding of grounded theory, design based research and case study as potentially being a limitation, in that it does not do justice to each of these well-established research methods. By contrast, I contend that the fusion of these three methods has added methodological strength to the study, by mobilising the respective affordances of each method and thereby enhancing the accuracy, relevance and rigour of the study's findings and the associated implications of those findings.

### **1.3.2 Research Questions**

The study is guided by the following research questions:

- What guiding principles for curriculum ecosystem design can be drawn from current literature?
- What affordances are central to such an ecosystem?

- What design framework can be defined through the iterative redevelopment, informed by these guiding principles, of a Built Environment Degree Program as a curriculum ecosystem?

## **1.4 Researcher**

This study has grown out of 15 years work by the researcher with technologically enhanced educational design, development and implementation across a wide range of Higher Education programs. These experiences started with multimedia development. Throughout this time it became clear that a key component in the completed product was missing and that any learning triggered by video, rich media or other materials had to be supported and guided beyond the passive viewing of the materials.

These realisations led to further development in projects where learning resources were embedded into an elearning platform with discussion forums and other functionality to support learning. However, when implemented, if these were all treated as supplementary to teacher led classroom based activities there was limited engagement of learners and minimal impact on learning.

These projects and work on other technologically enhanced educational design projects re-enforced a realisation that a fundamental shift in approaching the design of elearning and curriculum was required. A shift in paradigm was needed if elearning designs were to achieve their full potential. The Built Environment Degree Programs at Holmesglen Institute in Melbourne, with the requirement for seamless integration of on-line and off-line learning, provided the test bed for development of an exemplar reflecting such a paradigm shift.

The researcher, a qualified construction carpenter, also has extensive experience in the building and construction industry, having been immersed in the

culture of the industry while working in a range of roles off and on since the age of fourteen.

## **1.5 Overview of Thesis**

The structure of the thesis is as follows:

- Chapter 1 – Introduction
- Chapter 2 – A review of literature in the areas of complexity science, learning theory, curriculum design, online learning, activity theory, ecological psychology, distributed cognition and related fields. This provides a basis for an initial set of guiding principles for curriculum ecosystem design.
- Chapter 3 – Articulates the research design used in the study. Grounded theory, design based research, case narrative, activity theory and their application to the Built Environment Degree Program case study are outlined and discussed. Methods of data collection and analysis are described.
- Chapter 4 – Provides a description of the Built Environment Degree Program case study.
- Chapter 5 – Describes the evolution of Built Environment Degree Program through three iterations over six years as a curriculum ecosystem. The collected data are presented, analysed and interpretation of the findings provided and discussed. The guiding principles and a design framework for higher education curriculum ecosystems are articulated.
- Chapter 6 – Draws conclusions from the study and suggests a way forward for further research.

## **2. Literature Review**

### **2.1 Overview**

This literature review is conducted leveraging on a grounded theory approach where the purpose of the review is to place this study in context and to define and clarify concepts and the relationships between those concepts to inform the development of a theory (Bloomberg & Volpe, 2008) of complex adaptive system design for educational purposes, in the form of a design framework (Reeves et al 2011; Van den Akker et al, 2006) for curriculum ecosystem design for Higher Education.

The concepts gathered from this literature review are then developed into a conceptual framework with a set of guiding principles are drawn from it. These guiding principles are in response to the research question:

- What guiding principles for curriculum ecosystem design can be drawn from current literature?

The review draws on current literature related to learning theories, learning processes, online learning practices, ecological psychology, distributed cognition, and curriculum design, and expands on this through a complexity science perspective. It is a perspective that views the world as one made up of interconnected ecosystems, which are complex adaptive systems ever changing, and ever evolving. This literature review explores the nature and dynamics of the learning process in a Complex Adaptive System (CAS) and how that process can be scaffolded in the form of a curriculum ecosystem to achieve appropriate educational



outcomes, including professionally relevant attitudes, skills and knowledge for a digital age.

The literature is organised under the following headings:

- Dynamics of a Complex Adaptive System
- Learning in a Complex Adaptive System
- Scaffolding Learning in a Complex Adaptive System
- Curriculum ecosystems

## ***2.2 A Paradigm Shift***

The design of curricula should mirror the complex, dynamic, evolving world we live in with the expectation that our students will be able to function and succeed in it as professionals. It has been argued that individuals do not learn a set of rules or abstract theories that they then apply to their interaction with the world. They in fact internalise a common set of practices, roles and ways of thinking that are provided by the current predominant paradigm (Imershein, 1977). Knowledge is structured within a paradigm, supporting a particular worldview that defines an understanding of what can be achieved; the paradigm itself guides activities along particular directions. All knowledge is inextricably a product of the activity and situations in which it is produced (Brown, Collins, & Duguid, 1989).

There has been a gradual emergence of a new paradigm, a shift in the worldview of those involved in educational practice with moves to broaden the educational approaches used in Higher Education. These include Jonassen's Constructivist Learning Environments (1999), Taylor's Novex Analysis (1994), Laurillard's Conversational Framework (2002), and Garrison and Anderson's Community of Inquiry model (2003). In terms of Kuhn (1970) and Imershein (1977) these can be

seen as “anomalies” in the predominant industrial age paradigm, the beginning of the emergence of an alternative paradigm. This new paradigm is still evolving.

Higher education curricula have their roots in Europe in the 1500's. They are based on a reductionist paradigm. Petrus Ramus, Regius Professor of Logic, first used the term ‘curriculum’ in an educational sense of a course of study at a university in the late 16<sup>th</sup> century. Ramus’ ordering and classification of courses and knowledge is fundamentally reductionist and is still echoed in current educational practice (Doll, 2005, 2012).

Reductionism is the belief that the whole can be understood if you understand its parts; that dividing something under examination into as many parts as possible is the best way to understand that thing. It is the belief that by reducing everything to its simplest parts universal laws can be discovered and/or applied. It has been the foundation of scientific method since the time of Descartes and Newton (Mitchell, 2009; Smitherman, 2005).

This situation has led to a prevailing view in education that curriculum design should be based on the categorisation and organisation of content to be delivered and learned. This approach has taken the form of what is in effect static curriculum designs constrained by pre-defined, pre-digested content, timetables, word counts and delivery hours. A mechanistic, linear process used to achieve easily measured, prescribed, and standardised outcomes (Doll et al, 2005).

In the sciences it has however been realised that while reductionism has its place as a scientific method it does not provide the means to explain much of the world.

“Many phenomena have stymied the reductionist program: the seemingly irreducible unpredictability of weather and climate; the intricacies of and adaptive

nature of living organisms and the diseases that threaten them; the economic, political and cultural behavior of societies; the growth and effects of modern technology and communications networks; and the nature of intelligence and the prospect of creating it in computers” (Mitchell, 2009, p. x).

The paradigm that has enabled explanation of these phenomena has emerged from Complexity Science (Doll, 2005, 2012; Barab & Roth, 2006; Smitherman, 2005). A complexity paradigm views the world as complex and unpredictable, and relationships as being non-linear and dynamic. It is made up of complex adaptive systems (Abel, 1998) where intelligent agents anticipate the behaviour of others and the external environment, and modify their behaviour accordingly.

A complexity paradigm focuses on the dynamics, flow and interactions within a complex adaptive system. When educational practices are viewed through such a paradigm learning can be explored as something that occurs and evolves within a learning ecosystem that is non-linear, fluid, dynamic, and constantly evolving (Barab & Roth, 2006). Such an ecosystem can be comprised of three interacting elements:

- Intelligent adaptive agents (tutors & learners)
- The environment which these agents interact with and within
- The relationships, processes and interactions between individual agents, and agents and the environment

In a higher educational context such an ecosystem could be described as a curriculum ecosystem.

## **2.3 Dynamics of a Complex Adaptive System**

### **2.3.1 Complexity Science**

When educational practice is viewed from a complexity science perspective the focus shifts from curriculum content to the underlying processes of the complex adaptive system that is a discipline or a profession (Abel, 1998) and its underlying culture. This focus facilitates the discovery of a world where the whole is greater than the sum of its parts. Through the use of concepts associated with complexity theories, new visions for educational practice and curriculum design can emerge (Smitherman, 2005). Curricula can be designed to enable the facilitation and support of educational practice within a dynamic, evolving ecosystem. When designing a curriculum ecosystem it needs to be viewed as a complex adaptive system and developed from a complexity science perspective (Barab & Roth, 2006).

Complexity science is not one theory but a combination of theories and concepts informing a wide range of disciplines including physics, biology, chemistry, mathematics, economics, sociology and a growing number of others.

According to Mitchell (2009), the common properties of complex systems, in terms of Complexity Science, are:

1. *Complex collective behaviour*: They consist of large networks of individual components (eg. ants, neurons, stock-buyers, website creators) each typically following relatively simple rules. It is the collective actions of large numbers of components that give rise to the complex, hard-to-predict, and changing patterns of behaviour.
2. *Signaling and information processing*: All these systems produce and use information and signals from both their internal and external environments.

3. *Adaptation*: All these systems adapt – that is, change their behavior to improve their chances of survival or success – through learning or evolutionary processes.

In an educational context, this involves individuals interacting with each other and their shared environment in complex and non-linear ways, communicating with and adapting to each other and that environment.

Complex adaptive systems (CAS) generate unpredictable and non-linear behaviour. They are dissipative structures that take their form and structure through a self-organising process that is a result of flows of energy through the system. This energy is developed through actions and interactions, communications, information, and resources flowing through the system. The processes in the CAS involve complex and at times chaotic dynamics between intelligent adaptive agents within the system. The drivers of these dynamics in an educational context can include the related learning objectives, the processes and structures of the target profession's, or discipline's culture, and the competitive and/or co-operative behaviour of the agents.

Concepts drawn from Complexity Science that enable the description of the dynamics of a complex adaptive system and that are relevant to educational practice include:

- *The whole is greater than the sum of its parts*: a complex system cannot be understood by dividing it into parts.
- *Non-linearity*: actions can have more than one outcome and can generate non-proportional outcomes.
- *Emergence*: the process by which new patterns, features, qualities or products result from the non-linear interactions of agents within the system.

Emergence is driven by the self-organising nature of a system far-from–equilibrium.

- *Self-organisation*: the tendency of many systems to generate new structures and patterns over time on the basis of its own internal dynamics – order emerges from patterns of relationships among individual agents.
- *Far-from-equilibrium*: systems in far-from-equilibrium states evolve and adapt to changing conditions and spontaneously self-organise with structures of increasing complexity.
- *Butterfly effect*: the phenomenon of ‘sensitive dependence on initial conditions’ where small changes can have a large impact on a complex adaptive system
- *Co-evolution*: the process of mutual transformation that takes place for both the agent and the environment in which it exists.
- *Adaptive tension*: the catalyst, the driver that initiates a dynamic state that leads to emergence.
- *Feedback loops*: a process by which change in a variable results in either an amplification (positive feedback) or a dampening (negative feedback) of that change
- *Dissipative systems*: systems that maintain themselves in a far-from-equilibrium state by dissipation and consumption of energy.
- *Edge of Chaos*: The region between order and chaos, where systems are regarded to be the most innovative and adaptive.
- *Fitness landscape*: a concept where the ‘fitness’, a collection of attributes, of an individual, can be positioned on a topographical description or landscape

of possible fitness conditions. The stronger fitness levels are expressed as peaks separated by valleys.

A complexity perspective sees every structure as the manifestation of underlying processes. Living form is more than shape, more than a static configuration of components. There is a continual flow of energy through living systems; there is growth and decay, regeneration and development. This perspective views the world as an inseparable web of relationships, and living systems as self-organising networks whose components are all interconnected and interdependent (Capra & Luisi, 2014).

Educational practice and curriculum designs that guide that practice should reflect this complex, chaotic real world. A world that is not static or linear, in equilibrium, rather a world that is dynamic, in a state of constant change, evolving and far-from-equilibrium.

### **2.3.2 Metaphors and a Complexity Paradigm**

Metaphors and related mental models are created to guide understandings of the world. They influence how that world is seen and interpreted. The metaphor of the machine from the Industrial Age has influenced people's thoughts, actions and organisational systems for more than three centuries (Laroche et al, 2007). Systems influenced by this metaphor have been described as being closed systems as compared to the open systems of complexity. Doll (2012) describes a closed system as being a mechanistic, equilibrium-oriented system (such as a heat engine) where imbalance and disorder are to be avoided, lessened, negated. Whereas an open

system is a living, far-from-equilibrium system (life itself), where there is an orderly disorder, which he describes as the very source of creativity.

Complexity concepts provide metaphors, meaningful descriptors of patterns that emerge in human systems.

"Complexity science is full of rich and engaging metaphors ... they are poetic and easy accessible terms for the lay person. They can also be meaningful descriptors of patterns that emerge from human systems dynamics ... Using descriptive metaphors one can think about how 'butterfly effects' name patterns that appear commonly in human systems. For example, the descriptive metaphor can represent small deviations in team procedure that may generate a major shift in direction. Such descriptive applications of the complexity concepts can help build shared mental models." (Eoyang, 2004)

These mental models enable educators to apply complexity concepts when designing and developing an ecosystem for educational purposes. Such an ecosystem is an open system.

"Open systems ... function to keep just the right amount of imbalance, so that the systems might maintain a creative dynamism. The human body, democratic social systems, and the cosmos itself are all illustrations of open systems. Whereas closed systems 'exchange energy but no matter', open systems 'exchange both energy and matter' (Prigogine, 1961, p.3) and thus can transform matter into energy, as in an atomic explosion. In simple terms, ones important for education, closed systems transfer and transmit, open systems transform. Analogously, direct instruction, with its simplicity, would exemplify a



closed system while interpretative inquiry, with its complexity, would exemplify an open systems approach." (Doll, 2012, p.19)

Curriculum design when viewed from a complexity perspective is flexible, open, disruptive, uncertain, and unpredictable, and accepts tension, anxiety, and problem creation as the norm.

According to Iannone, (1995), such a curriculum design should include:

- coherent but flexible structures
- tolerance of change
- open communications
- responsiveness to new ideas
- tolerance of conflict
- a sense of community

When viewed from a complexity perspective Higher Education is process-oriented with students, within a learning community, actively engaging with the real world, a world that is made up of interconnected, interdependent complex adaptive systems. Learning, knowing and meaning making are part of the dynamic interplay between individuals with each other and their environment. While individuals actively engage with and respond to change and disruption within that environment, the dynamics of changing patterns of relationships and interaction provide energy for the emergence of innovation and creation from this interplay, in a dissipative system on the edge of chaos.

## **2.4 Learning within a Complex Adaptive System**

### **2.4.1 Ecological Psychology**

Complexity Science provides the language and concepts to describe the nature and dynamics of the world as an evolving ecosystem, and professional practice as a complex adaptive system. To build further on this when designing for educational practice, it is crucial to be able to describe how human beings as intelligent agents within such a system find meaning, know and interact with and within an ecosystem. Developments in ecological psychology have provided the means to do this.

Barab and Plucker (2002) state that many contemporary thinkers from a variety of domains describe knowing not simply as a psychological construct existing in the head but as an interaction of individuals and physical and social situations. An ecological view of the world requires a shift of focus from the dissemination of information to the learner's interactions. An ecological view of psychology takes as fundamental the interaction of agent and environment. Rather than explain things as all inside the head of the learner, explanations emerge from learner-environment interactions that are whole-body embedded in lived-in world experiences. Interaction is dynamic, non-linear and continuous, not static or linear (Young, 2004).

Ecological psychology is based on the premise that perception and knowing is a property of an ecosystem, not an individual, and is co-determined through the individual–environment interaction. All environments have certain affordances that allow an individual to perform an action or actions and achieve a goal.

“Gibson (1979/1986) introduced the relational terms affordance and effectivity ... an affordance being a specific combination of properties of an environment, taken with reference to an individual, that can be acted upon—opportunities for

action (Gibson, 1977). Reciprocally, an effectivity is a specific combination of properties assembled by an individual, taken with reference to the environment, that allow for the dynamic actualisation of a possibility for action (Shaw & Turvey, 1981)". (Barab & Plucker, 2002, p.169)

Professional practice when viewed as a complex adaptive system, can be seen as an affordance network, that is a collection of facts, concepts, tools, methods, practices, and even people, taken with respect to an individual, that are distributed across time and space and are viewed as necessary for the satisfaction of a particular set of actions or goals (Barab & Roth, 2006). An affordance is a possibility for action by an individual and an effectivity is the dynamic actualisation of that affordance. An effectivity set constitutes those behaviours that an individual can produce so as to realise the potential of an affordance network.

Many educational practices implicitly assume that conceptual knowledge can be abstracted from the situations in which it is learned and used. This assumption inevitably limits the effectiveness of these practices. Knowledge is situated, being in part a product of the activity, context, and culture in which it is developed and used (Brown et al, 1989). Knowing and meaning, and therefore learning, are part of the dynamic interplay of individual and environment.

When designing curricula at the core of curriculum ecosystems there is a need to recognise this and design to support the dynamics and requirements of a profession or discipline as a complex adaptive system. Learners should be provided with an affordance network that provides opportunities to develop the effectivities needed to function effectively and succeed in the ecosystem of their chosen field.

## 2.4.2 Distributed Cognition

The concept of distributed cognition provides us with a basis for identifying these effectivities. It is important to understand the emerging dynamics of interaction within the complex networked world of a profession. The theory of distributed cognition has an important role to play in understanding interactions between people, technologies and environments, what we really do in them and how we coordinate our activity in them, as its focus is on whole environments.

“The distributed nature of cognition was discussed by Hutchins (1993) who studied how navigating a vessel is accomplished through a cooperative effort among its crewman, interacting with one another and the tools available on the ship. The shared experiences on the ship among the crewmen enable them to communicate with each other. Each crewman has specific responsibilities in terms of navigating the ship (e.g., quartermasters share among themselves the task of the plotter, bearing tracker, the bearing time-recorder), and manipulates appropriate tools for the task. The result of this cooperation is the community knowledge around how to navigate the ship. It is the group knowledge, as well as the tools on the ship, that enable the proper navigation of the naval vessel.”  
(Barab & Plucker, 2002, p.170)

Distributed cognition looks for cognitive processes, wherever they may occur, on the basis of the functional relationships of elements that participate together in a process. While traditional views look for cognitive events in the manipulation of symbols inside individual minds, distributed cognition looks for a broader class of cognitive events. For example, an examination of memory processes in an airline cockpit shows that memory involves a rich interaction between internal process, the manipulation of objects, and the traffic in representations among the pilots.

At least three kinds of distribution of cognitive process have been identified:

- Cognitive processes may be distributed across the members of a social group
- Cognitive processes may involve coordination between internal and external (material or environmental) structure
- Processes may be distributed through time in such a way that the products of earlier events can transform the nature of later events

(Hollan, Hutchins & Kirsch, 2000)

Culture, social organisation, the structure added by the context of an activity, and the tools used to complete that activity, are all forms of cognitive architecture.

“... in the distributed cognition perspective, culture shapes the cognitive processes of systems that transcend the boundaries of individuals [Hutchins 1995a]. At the heart of this linkage of cognition with culture lies the notion that the environment people are embedded in is, among other things, a reservoir of resources for learning, problem solving, and reasoning. Culture is a process that accumulates partial solutions to frequently encountered problems.

Without this residue of previous activity, we would all have to find solutions from scratch. We could not build on the success of others. Accordingly, culture provides us with intellectual tools that enable us to accomplish things that we could not do without them” (Hollan, Hutchins & Kirsch, 2000, p.178).

Knowing and meaning, both cognitive activities, are constructed from both internal and external resources, so that the meanings of actions are grounded in the context of activity. It is not enough to know how the mind processes information, it is essential to also know how that information is arranged in the material and social

world. Individuals interact with and within the structure in environments that are ecosystems, complex adaptive systems.

To design effective curriculum ecosystems it is important to know what that structure is for a particular discipline or profession, the processes individuals and groups engage in and the resources and tools they use to render their actions and experiences meaningful. It is also important to have an understanding of information flow, cognitive properties embedded in systems, social organisations, cultural processes, and how individuals learn and develop the related effectivities.

### **2.4.3 Perspectives on Learning**

#### *Fundamentals of Teaching and Learning*

The fundamentals of effective teaching and learning have been known for decades. According to Dewey (1938) experience is at the core of learning, and every experience affects, for better or worse, the attitudes that help decide the quality of further experiences. He argues that educators should be aware of what surroundings are conducive to having experiences that lead to effective learning and growth and that they should know how to utilise the surroundings, physical and social, that exist so as to extract from them all that they have to contribute to building up experiences that are worthwhile.

He argues that individuals live in a series of situations and that as an individual passes from one situation to another, their world, and their environment, expands or contracts. What is learned in the way of knowledge and skills in one situation becomes an instrument of understanding and dealing effectively with the situations that follow.

Dewey saw that learning was a direct result of life experiences and the social and environmental contexts within which they occur. He advocated providing an “educative” experience that focuses on the transactions and interactions within situations that provide that experience. This approach is reflected in ecological psychology and distributed cognition.

Learning Theories as described by Mayes & de Freitas (2004) are relevant to this study and can be categorised under the following perspectives.

### *Cognitive*

This perspective is embodied in the assumptions of constructivism (Jonassen 1999) where understanding is seen as being gained through an active process of creating hypotheses and building new forms of understanding through activity. Conceptual development occurs through intellectual activity rather than by the absorption of information. Brown et al (1989) argued that it is important to consider concepts as tools, to be understood through use, rather than as self-contained entities to be delivered through instruction. This consideration is the essence of the constructivist approach where the learners’ search for meaning through activity is central.

The cognitive perspective emphasises conceptual development, stressing the importance of achieving understanding of the broad unifying principles of a domain. This view also encourages the framing of learning outcomes in meta-cognitive terms, with the educational aim of achieving learning how to learn, and encouraging the development of autonomous learners.

### *Situative*

Learners will always be subjected to influences from the social and cultural setting in which the learning occurs. This view of learning focuses on the way knowledge is distributed socially. When knowledge is seen as situated in the practices of communities then the outcomes of learning involve the abilities of individuals to participate in those practices successfully.

The situative perspective encourages the definition of learning objectives in terms of the development of disciplinary practices of discourse and representation. It also focuses on learning outcomes that are dependent upon the establishment of collaborative learning outcomes, and on learning relationships with peers. This perspective also encourages the formulation of learning outcomes in terms of authentic practices of formulating and solving realistic problems.

#### **2.4.4 Experiential Space**

Elements of these perspectives (Dewey, 1938; Mayes & de Freitas, 2004) can be woven together to inform learning designs for educational experiences that reflect the real world challenges students will eventually face in the complex adaptive systems of their chosen fields in the knowledge economy of the 21<sup>st</sup> century. The key driver in the design needs to be the cognitive architecture embedded in systems, social organisations, and the cultural processes of the target profession. Whether the learning activity takes place in a physical or virtual space should not be the driving factor in the learning design, each space with its particular affordances is but another tool supporting each learner's journey.



An architect talks about space as something that is experienced. An analogous description might be just as a physical space is defined by containment (walls, ceiling, floor) and the (experiential) quality of that space influenced by textures, colours, shapes and volumes, in the end, what a person feels about the space is subjective, depending on their own perceptions and values and attitudes.

Learning is an experience and therefore rather than describing a learning space in terms of a location with physical or virtual dimensions, it is possible to start with the learning experience then support that experience with a range of appropriate tools which includes physical and/or virtual environments (Cheers, Chen & Postle, 2011). Designing for an educational experience can enable learners to use a broad range of tools to support their learning in ways that suit them, in spaces of their choice. These spaces and tools can be virtual, physical or a combination of both.

Any planned learning space can accommodate individual journeys (experiences), within design parameters, which support pre-defined curriculum outcomes. Designing for educational experience is designing for engagement and interaction in a community of learning (Barab & Duffy, 2000; Wenger 1999), interaction based on trust, openness and dialogue between learners & learners, learners & tutors and interaction with the environment, and cognitive tools (Jonassen & Reeves, 1996).

A community of learning within an experiential space, is the result of the collective behaviour of a group with shared objectives. In formal educational settings, this involves sharing a common process, values, experiences and intellectual exchange. Communities are living entities. They need the flow of energy and activities to keep them alive. They are made up of individuals who have the choice whether to participate in the collective activities or not, and choose to do so.

An experiential space may be defined by containment in four dimensions, three of the dimensions are the tutor and students, the learning resources, and the tools. The fourth dimension is that of time. These are the elements that are manipulated when such a space is designed. The experiential space is then the experiential activity (or learning journey) that the student(s) occupy, interacting with other fellow learners and tutors and moving along the fourth dimension of time (Cheers, Chen & Postle, 2011). Such an experiential space can be described as a Complex Adaptive System.

#### **2.4.5 Cognitive Apprenticeship**

Taylor (1994) argues that the psychology of teaching and learning should attempt to understand the development of cognitive structures and processes that characterise the proficient performance of cognitive skills by experts in particular disciplines. And that educational design should focus on the structure and organisation of the knowledge underlying expert cognitive skill performance. It should have the aim of shifting a learner from novice to expert through the creation of a series of learning activities that enable them to construct key elements of the organisation and content of the knowledge base of the expert in their own cognitive structure.

Taylor (1994) identifies a number of dimensions of domain specific, objective knowledge, which he calls 'item-specific knowledge', 'relational knowledge' and 'strategic knowledge' as well as two dimensions representing subjective knowledge, 'affective knowledge' and 'empirical knowledge'. He described the difference between novice and expert knowledge base as:

“The knowledge bases of the novices are likely to lack the coherence and connectivity of that of the expert, and may need to be represented as somewhat fragmented item-specific knowledge rather than organized frameworks of relational and strategic knowledge. Similarly, the affective and empirical dimensions of the knowledge bases of novices are unlikely to match the comprehensive richness of that of the expert” (Taylor, 1994, p.9).

Empirical knowledge is defined as a record of experiences. Taylor (1994) argues that for a novice to develop the comprehensive richness of an expert, a situated learning approach to instruction, which includes learning activities based on complex issues in authentic contexts, with associated provision of scaffolding to enable novices to operate meaningfully in such realistic environments, should be used.

Collins, Brown and Newman (1989) define such a process as Cognitive Apprenticeship. They build on the model of apprenticeships where skills are learnt in the context of their application to realistic problems, within a culture focused on and defined by expert practice. Apprentices learn skills and knowledge in their social and functional context and in the process develop not only the cognitive but also the metacognitive skills required for expertise.

They argue that applying apprenticeship models to largely cognitive skills requires the externalisation of processes that are usually carried out internally. Cognitive apprenticeship has dual focus on expert processes and situated learning. A culture of expert practice helps situate and support learning by providing learners with readily available models of expertise-in-use. This provision should include focused interactions among learners and experts for the purpose of solving problems and carrying out tasks (Collins et al, 1989).

To achieve this outcome experts must be able to identify and represent to students the cognitive processes they engage in as they solve problems. Alternating between expert and novice efforts in a shared problem-solving context sensitises students to the details of expert performance as the basis for incremental adjustments in their own performance. Cognitive apprenticeship involves the development and externalisation of a producer-critic dialogue that students can gradually internalise. This development and externalisation are accomplished through discussion, group problem solving and critical reflection.

Critical reflective practice is the process that underlies the ability of learners to compare their own performance to the performance of an expert. Such comparisons are seen as aiding learners in diagnosing difficulties and incrementally adjusting their performances until they achieve expertise.

Collins, Brown and Newman (1989) argue that teaching methods should be designed to give students the opportunity to observe, engage in, and invent or discover expert strategies in context. Such an approach enables students to see how these strategies fit together with their factual and conceptual knowledge and how they cue off and make use of a variety of resources in the social and physical environment. This is the essence of what they mean by situated learning and the reason why the cognitive apprenticeship method, with its modeling-coaching-fading paradigm, is successful.

The interplay between observation, scaffolding, and increasingly independent practice is seen as aiding learners both in developing self-monitoring and correction skills and in integrating the skills and conceptual knowledge needed to advance toward expertise.

## 2.4.6 Authentic Learning

Authors, researchers and theorists working in the field of ‘Authentic Learning’ have further supported the work of Taylor, and Collins, Brown and Newman.

Authentic Learning is based on the idea that usable knowledge and skills are best gained in learning settings that reflect the complexity of the environment where the final performance is expected to take place.

Authentic Learning designs feature the following characteristics shown in Table 1.

No.	Characteristic of authentic activity	Supporting authors, researchers and theorists
1.	Have real-world relevance	(Lebow & Wager, 1994) (Cronin, 1993) (Oliver & Omari, 1999) (Brown et al., 1989) (Cognition and Technology Group at Vanderbilt, 1990a) (Jonassen, 1991) (Resnick, 1987) (Winn, 1993) (Young, 1993)
2.	Are ill-defined, requiring students to define the tasks and sub-tasks needed to complete the activity	(Sternberg, Wagner, & Okagaki, 1993) (Lebow & Wager, 1994) (Bransford, Vye, Kinzer, & Risko, 1990) (Young, 1993) (Brown et al., 1989) (Cognition and Technology Group at Vanderbilt, 1990a) (Winn, 1993)
3.	Comprise complex tasks to be investigated by students over a sustained period of time	(Lebow & Wager, 1994) (Bransford, Vye et al., 1990) (Cognition and Technology Group at Vanderbilt, 1990b) (Jonassen, 1991)
4.	Provide the opportunity for students to examine the task from different perspectives, using a variety of resources	(Sternberg et al., 1993) (Bransford, Vye et al., 1990) (Young, 1993) (Cognition and Technology Group at Vanderbilt, 1990b)
5.	Provide the opportunity to collaborate	(Lebow & Wager, 1994) (Young, 1993) (Gordon, 1998)
6.	Provide the opportunity to reflect and involve students’ beliefs and values	(Young, 1993) (Myers, 1993) (Gordon, 1998)
7.	Can be integrated and applied across different subject areas and lead beyond domain-specific outcomes	(Bransford, Sherwood et al., 1990) (Bransford, Vye et al., 1990) (Jonassen, 1991)
8.	Are seamlessly integrated with assessment	(Reeves & Okey, 1996) (Young, 1995) (Herrington & Herrington, 1998)
9.	Create polished products valuable in their own right rather than as preparation for something else	(Barab, Squire, & Dueber, 2000) (Gordon, 1998)

10.	Allow competing solutions and diversity of outcome	(Duchastel, 1997) (Bottge & Hasselbring, 1993) (Young & McNeese, 1993) (Bransford, Sherwood et al.,1990) (Bransford, Vye et al., 1990)
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**Table 1: Characteristics of authentic activity (Reeves et al, 2002)**

Authentic learning experiences focus on the development of knowledge in real-world contexts and application of that knowledge to the solving of real-world problems. Situation and cognition are seen as being interdependent and that knowledge is a tool to be used dynamically to solve complex, often ill-structured, real-world problems. (Herrington et al, 2010).

### **2.4.7 Critical Reflective Practice**

Critical reflective practice is central to all these educational practices; both reflection in action and on action are integral to learning and effective professional practice (Schon 1983; Cowan, 1998).

According to Larrivee (2000, p.294) “in Dewey’s (1933, 1938) writings, he asserted that the capacity to reflect is initiated only after recognition of a problem or dilemma and the acceptance of uncertainty. The dissonance created in understanding that a problem exists engages the reflective thinker to become an active inquirer ...”

Critical reflection encompasses both the capacity for critical inquiry and self reflection (Larrivee 2000). It is a process of reflecting on a problem or dilemma and possible solutions, of evaluating and refining those solutions, taking input from other learners and peers and accepting, rejecting, and refining that input.

Reflection is the key to metacognition where individuals strategically monitor the effectiveness of their approaches in the complex adaptive systems within which

they study, live and work. Whether one is a professional or a student, whenever learning takes place reflection is an integral part of the process.

Critical reflective practice is at the core of learning where perception and knowing is a property of an ecosystem and is co-determined through the individual–environment interaction. Guided by experts in the target professional culture while solving an authentic problem in a relevant social and environmental context.

## ***2.5 Scaffolding Learning within a Complex Adaptive System***

All these preceding concepts and educational practices are the foundations upon which learning designs for complex adaptive systems can be developed. When learning in a complex adaptive system where the physical and virtual are intertwined and interdependent, and the lines between the two become increasingly blurred, well aligned online learning and blended learning Information and Communications Technology (ICT) solutions are pivotal to supporting and scaffolding effective learning practices within a complex adaptive system.

### **2.5.1 Blended Learning and Learning Online**

The evolution of online learning or elearning practices, often categorised as distance learning, has been described as growing through five generations (Anderson, 2008).

1. The Correspondence Model based on print technologies
2. The Multi-Media Model based on print, video and audio recording technologies

3. The Tele-learning Model based on video and audio synchronous teleconferencing and broadcasting technologies
4. The Flexible Learning Model based on online delivery via the internet
5. The Intelligent Flexible Learning Model leveraging on interactivity available via the internet

Since this description was developed there has been exponential growth of Web 2.0 and social networking solutions contributing to a worldwide ecosystem that is rapidly evolving. This growth has had little real impact on underlying approaches to educational practice (Garrison et al 2003, Laurillard 2006). Even MOOCs (Massive Online Open Courses) that are now beginning to challenge Higher Education practices globally do so in manner of delivery only. They are largely lecture and quiz based.

While there are pockets of innovative development in educational practice across Higher Education institutions as reflected in the Australian Government's Office for Learning and Teaching "Good Practice Reports", they are however often the exception rather than the rule.

This situation is contrary to strong ongoing support in the literature over decades advocating authentic learning practices. Teles (1993) building on the work of Collins, Brown & Newman applied cognitive apprenticeship methods to online learning arguing that a carefully designed environment, which provides instances of collaboration, coaching, scaffolding, reflection, and exploration is essential to supporting online learning and cognitive apprenticeship.



Hung (2002) argues that the use of technology in supporting teaching and learning should focus on the social process of learning triggered by authentic problems and tasks.

Garrison and Vaughan (2008) argue that at the core of blended learning is the goal of engaging students in critical discourse and reflection through increasing interaction and meaningful problem solving.

### 2.5.2 Supporting Learning with Technology

When considering the use of educational technologies to support learning Kimball (2002) argues that it is a question of how educators can engage learners in more meaningful learning activities. It is argued that there needs to be a shift in educators thinking (see Table 2). Although Kimball’s work was developed in relation to distance education, there are important resonances with the contemporary technologies associated with blended and online education.

<u>Change thinking from</u>	<u>Change thinking to</u>
Face-to-face learning and teaching is the ideal environment for learning and other modes represent a compromise.	Diverse learning environments utilised in a pedagogically appropriate way can support high quality learning.
Learning only occurs when teachers interact with students at a fixed time and space.	Learning is ongoing and boundary-less and is most successful when learners take ownership of their own learning.
Managing online learning is about learning how to use the latest technology.	Managing & facilitating learning in any environment requires greater understanding of the learning process.

**Table 2: Thinking about Learning (Adapted from Kimball, 2002)**

These learning activities should be designed to engage the participants, empower them to contribute and feel that they have something to contribute, and

connect the individual and collective experiences (Cheers et al, 2009). That is, learning design should be learner centred.

Learner centred learning has been described as including:

1. Active rather than passive learning
2. An emphasis on deep learning and understanding
3. Increased responsibility and accountability on the part of the student
4. An increased sense of autonomy of the learner
5. An interdependence between teacher and learner
6. A reflexive approach to the teaching and learning process

(Lea et al 2003 as cited in O'Neill & McMahon 2005)

An understanding of learning processes and the nature of authentic educational experiences provides a solid foundation for learning designs. This foundation can enable the effective scaffolding of those processes through the design of curriculum ecosystems, and activities within those ecosystems to provide relevant learning experiences.

All learning design should be informed by the knowledge that perception and knowing is co-determined through the individual – environment interaction. Knowing and meaning, and therefore learning is part of the dynamic interplay between individual and environment, interactions between people, technologies and tools embedded in a culture. The structure added by the context of the activity, and the tools used to complete that activity are all forms of cognitive architecture that inform and define individuals, and their actions, and that need to be considered and integrated into any learning ecosystem design.

Activity Theory (Engestrom, 1987) provides a framework for studying human practices as development processes, with both individual and social aspects interlinked within an environmental context. This can provide a base upon which to develop a design framework and scaffold learning activities within a curriculum ecosystem.

### **2.5.3 Activity Theory**

An Activity Theory perspective focuses on the interaction of human activity and consciousness within its relevant environmental context and offers a framework for describing activity and providing a set of perspectives on practice that interlink individual and social levels (Engeström, 1987; Leont'ev, 1974; Nardi, 1996). Actions are seen as always being situated in a context and they are impossible to understand without that context.

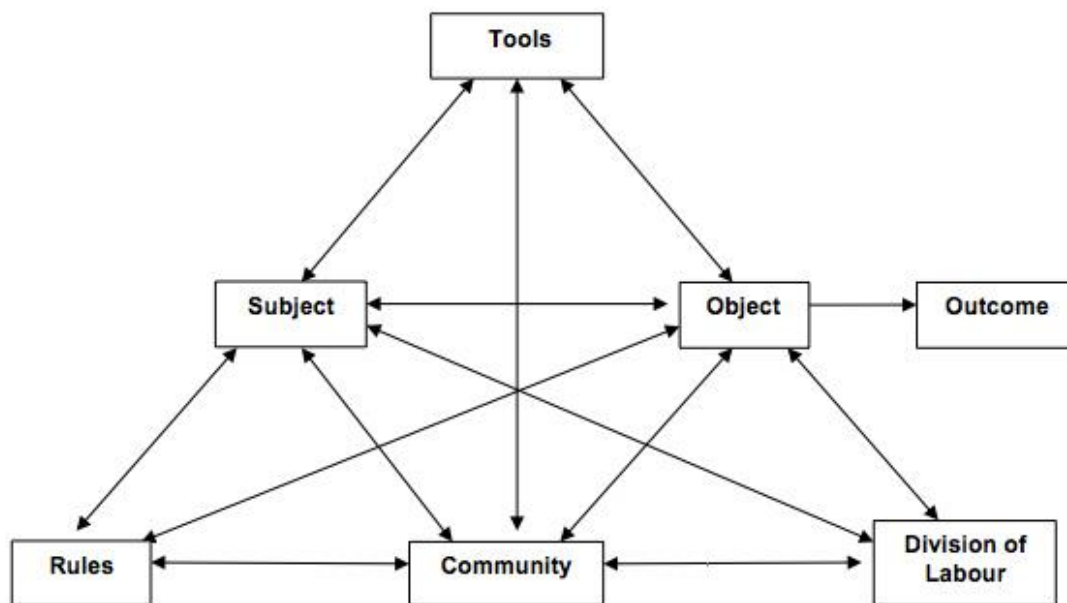
Activities are not static or rigid, they are under continuous change and development and this development is not linear. Dynamism and development at several levels are recognised as fundamental characteristics of activities.

According to Engeström, a human activity system is object-oriented, tool mediated and culturally mediated, and composed of “the individual practitioner, the colleagues and co-workers of the workplace community, the conceptual and practical tools and the shared objects as a unified dynamic whole” (Engeström, 1991).

Kuutti (1996) defines activity as a form of doing that is directed towards the fulfillment of an object (an objective) that, in turn, is linked to an anticipated outcome. An activity is undertaken by a human agent (subject) who is motivated toward the solution of a problem or purpose (object) mediated by tools (artefacts) in collaboration with others (community). The relationship between subject and object is seen as being mediated by "tools", the relationship between subject and

community is mediated by "rules" and the relationship between object and community is mediated by the "division of labour". A "tool" can be anything that is used in the transformation process, including both material tools and tools for thinking (cognitive tools); "rules" cover both explicit and implicit norms, conventions and social relations within a community; "division of labour" refers to the explicit and implicit organisation of a community as related to the transformation process of the object into the outcome (Figure 1). Each of the mediating terms is historically formed and open to further development. Tools (artifacts) may have been created and transformed during the development of the activity itself and carry with them a particular culture or historical remains from that development. (Kuutti 1996).

An activity system model, shown in Figure 1, can be used to map out the elements of a curriculum ecosystem for evaluation purposes.



**Figure 1: Activity system (Engestrom, 1987)**

The Subject refers to the individual or group of learners engaged in the learning activity and the Object refers to the focus of that activity. The agents are assisted in this process with physical, cognitive and symbolic, external and internal mediating instruments or Tools. The Community comprises multiple individuals and/or groups in a learning community who share the same Object. The Division of Labor refers to both the horizontal division of tasks between the members of the community and the vertical division of power and status. The Rules refer to the explicit and implicit regulations, norms and conventions that constrain actions and interactions within the activity system.

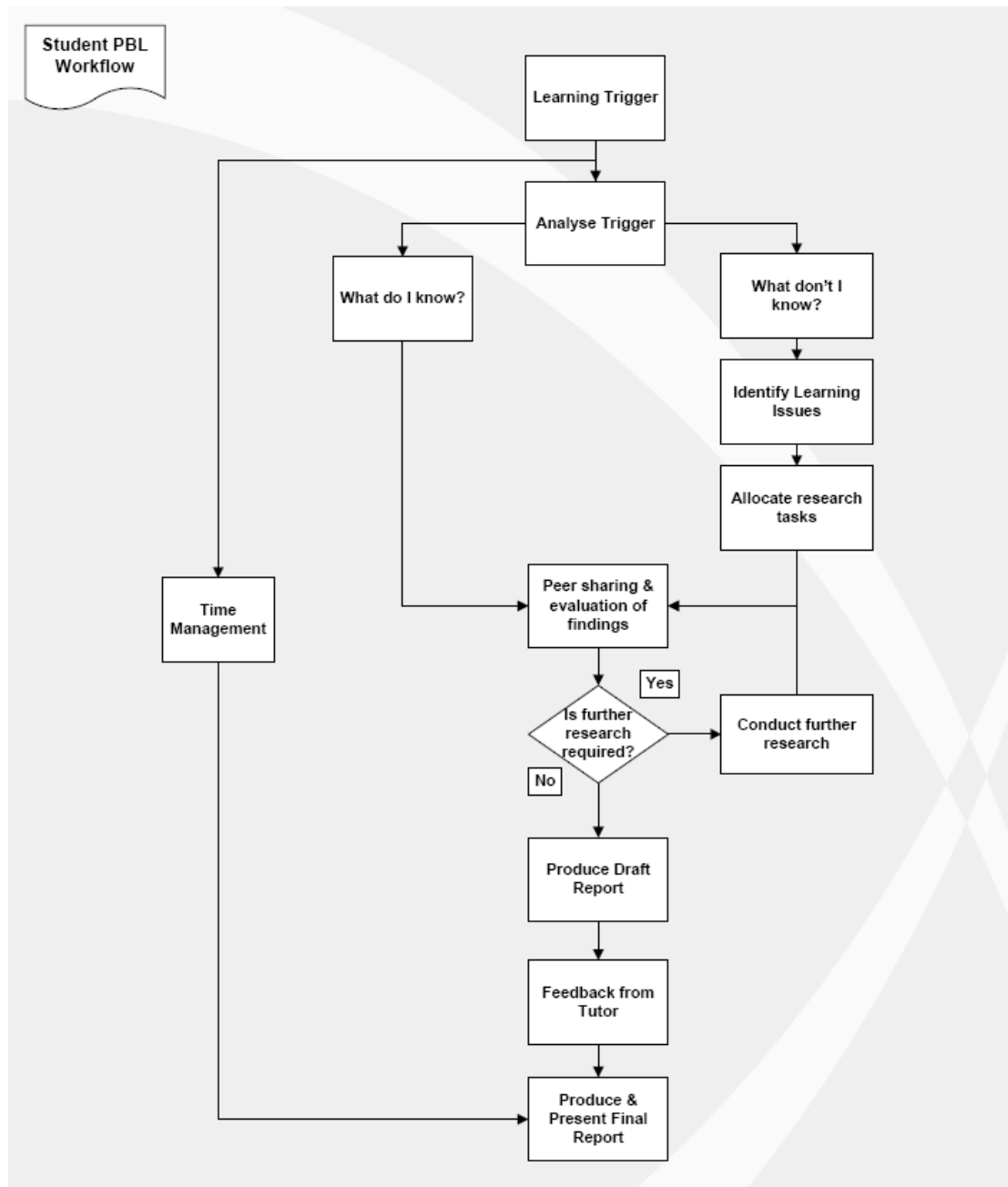
The activity system maps the major aspects of the ecosystem as the agent/s undertake a complex journey towards a learning outcome or goal. By analysing a profession's ecosystem as an activity system a framework for a curriculum ecosystem design that reflects that profession can be developed. Activity Theory can be used both to inform educational design decisions and as an evaluation tool.

Whether the activity takes place in a physical or virtual space should not be a driving factor in the learning design, each space with its particular affordances should be seen as part of an overall learning ecosystem and as another tool supporting each learner's journey through the activity system. The catalyst for learning should be a disruptive, engaging, real-world, ill-structured problem or dilemma that needs to be solved (Jonassen, 1997).

#### **2.5.4 Authentic Learning and Problem Based Learning (PBL)**

Problem Based Learning (PBL) is a well recognised form of authentic learning. It was originally developed and implemented in medical schools in the 1950s and 1960s. Since the 1970s it has found a place across a broad range of disciplines including architecture, law, engineering, nursing, biology and education

(Uden & Beaumont 2006, Savin-Baden 2003). PBL requires active learning where the learner plays an authentic role carrying out complex tasks in an authentic context. Learners are provided with the opportunity to grapple with realistic, ill-structured problems, which act as a catalyst for investigation and learning. In using a PBL approach the engagement is encouraged through the use of stimulating and challenging Learning Triggers; the empowerment of learners is inherent in the learner centred philosophy and processes where teachers are facilitators, mentors, coaches and co-learners rather than authority figures; and active learning generates meaningful experiences individually and collectively. In PBL the focus is on an iterative developmental process, shown in Figure 2, and not on the course content.



**Figure 2: PBL Process**

Characteristics of a Problem Based Learning approach include:

- Learner-centred
- Problem/Learning Trigger comes first
- Students identify their own learning needs

- The teacher/tutor facilitates student learning
- Focus is on process, not content
- Concurrent learning, application and assimilation
- Supports learning to learn
- Deep Learning vs Surface Learning
- Higher Order Thinking / Critical Thinking
- Integration of knowledge, skills and professional values

(Savery & Duffy 2001; Savin-Baden 2003; Uden & Beaumont 2006)

“Through intensive engagement in the collaborative solution of authentic problems, the learning outcomes accomplished by these learners will be of the highest order, including improved problem solving abilities, enhanced communications skills, continuing intellectual curiosity, and robust mental models of complex processes inherent in the performance contexts in which their new learning will be applied.” (Herrington, Reeves, & Oliver, 2010, p.10)

Hung (2002) argues that PBL is congruent with situated cognition and that learning and teaching, supported by technology, should focus on the social process of learning, centered on authentic problems and tasks. Jonassen (1997) identifies problems that can have multiple possible solutions, and require an iterative approach, supported by conversations between learners with a variety of perspectives, to develop a solution to ill-structured problems.



## *Learning Triggers*

In Problem Based Learning (PBL) such problems are described as Learning Triggers. Uden and Beaumont (2006) propose that the design of such Learning Triggers should address the following:

Student's experience	How does it relate to student's prior knowledge? Does it enable them to build on current understanding? Does the problem require knowledge integration?
Trans-disciplinary	Can trans-disciplinary or multi-disciplinary factors help students integrate learning effectively?
Authenticity	How relevant is it to the students and the 'real world'? How motivational would you regard it?
Complexity or ill-structured nature of problem.	Is there an appropriate level of complexity to require students to integrate their learning? Can students avoid analyzing the problem in detail? Are there appropriate cues that stimulate discussion and encourage students to search for explanations?
Learning Issues	What learning issues will students generate? How do these relate to the learning outcomes or objectives of the course?
Opportunity for reflection and self assessment.	Does it challenge student's existing approaches to learning? When will students have opportunity to reflect on the process?
Alternate solutions	Are there opportunities for critical evaluation and judgments of alternative 'solutions'?
Minimum information provided	Is the trigger brief enough to avoid information overload?
Presentation and content of problem statement	Does it identify context and task clearly and concisely?

**Table 3: Characteristics of a Learning Trigger (Uden & Beaumont, 2006)**

Problem Based Learning (PBL) is an educational approach that enables learners to engage in learning within a framework of relevant professional issues that require the use of professional judgment in learning, evaluation and application in an authentic context. This approach aligns with the literature cited throughout this review. PBL focuses on the development of metacognitive knowledge management skills seen as essential for education in a world characterised by rapid knowledge growth, change and increasing complexity and interconnectedness.

### **2.5.5 Disruptions, Disturbances and Contradictions**

Activity theory recognises inherent tensions between the various components of an activity system as being fundamental to producing change. These tensions are referred to as 'contradictions'. According to Kuutti (1996), "contradictions manifest themselves as problems, ruptures, breakdowns, clashes. Activity theory sees contradictions as sources of development; activities are virtually always in the process of working through contradictions".

Engeström (1987) refers to an activity system as "a virtual disturbance-and-innovation-producing machine" and emphasises the importance of contradictions driving these changes. This interplay of contradictions creates developmental transformations, which can in the context of educational activity be defined as learning outcomes.

This concept of contradictions or disturbances in an activity system is reflected in theories of learning where the breakdown of the expected, the disturbance of an individual's view of what should be, is seen as being the catalyst for active inquiry and learning. Piaget (1985) described this state as 'disequilibrium'

and saw it as a key component of cognitive development where a person's existing 'schemas' did not allow for the adequate understanding of an experience. He argues that disequilibrium initiates cognitive growth. Mezirow (1995) names disturbance or 'a disorientating dilemma' as a key step in transformative learning. Dewey (1938) asserted that inquiry was initiated only after recognition of a problem or dilemma and the acceptance of uncertainty.

Such a disturbance, disruption, dilemma or problem is seen as being a necessary trigger for learning. A learning trigger has also been described by

- Brookfield (1987) as an unforeseen event that results in feelings of inner discomfort and perplexity
- Garrison et al (2001) as "identifying or recognizing an issue, dilemma, or problem"

According to Cole and Engeström (1993) in activity systems, "equilibrium is an exception and tensions, disturbances and local innovations are the rule and the engine of change".

This understanding is also reflected in Complexity Science where a complex adaptive system in a state 'far-from-equilibrium' is seen as a necessary precursor to creativity and innovation. The use of a dilemma or ill-structured problem as a trigger or catalyst for learning is central to the Problem based Learning (PBL) approach to educational practice and to the design of a curriculum ecosystem for higher education.

## 2.5.6 Community of Inquiry

Learning design needs to reflect the social and cultural setting of professional practice in the target discipline and culture. Learners need to be guided through such a setting towards learning outcomes as they travel through a curriculum ecosystem.

Garrison and Vaughan's (2008) Community of Inquiry model (see Figure 3) provides us with an additional tool that enables the mapping of the elements necessary for a rich and meaningful educational experience where learners working collaboratively are guided towards achievement of curriculum learning outcomes. They argue that the ideal educational design is a collaborative constructivist process that has inquiry at its core. This process they define as a Community of Inquiry that consists of social presence, cognitive presence and teaching presence (see Table 4).

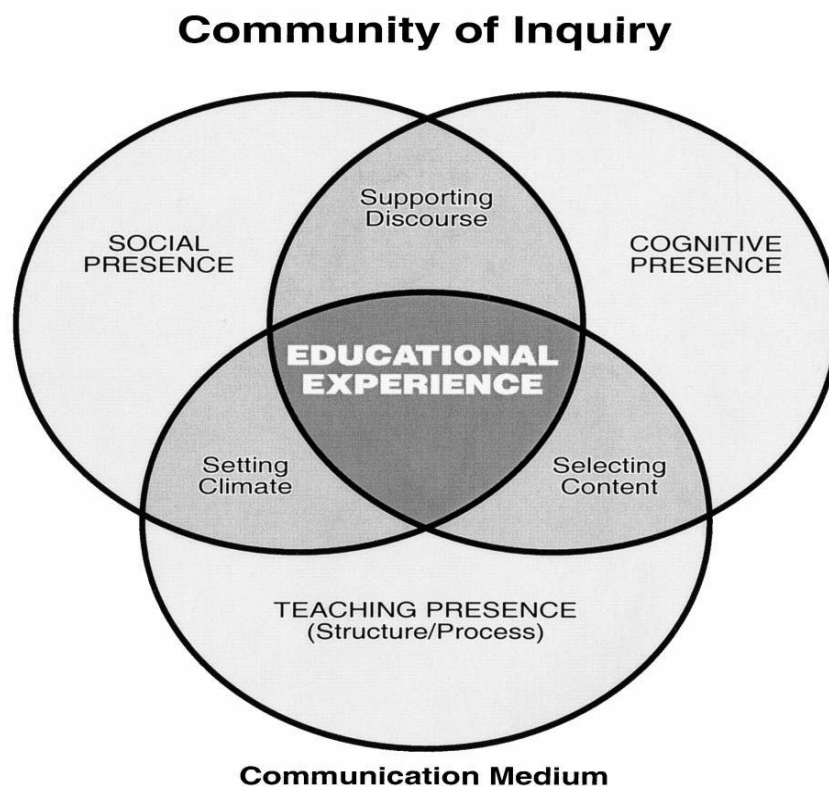
<b>Elements</b>	<b>Categories</b>	<b>Indicators (examples only)</b>
Social Presence	Open communication Group cohesion Affective/personal	Enabling risk-free expression Encouraging collaboration Expressing emotions, camaraderie
Cognitive Presence	Triggering event Exploration Integration Resolution	Having sense of puzzlement Exchanging information Connecting ideas Applying new ideas
Teaching Presence	Design & organisation Facilitation of discourse Direct instruction	Setting curriculum and methods Sharing personal meaning Focusing discussion

**Table 4: Community of Inquiry Categories and Indicators (Garrison & Vaughan, 2008)**

The emphasis is on inquiry processes that ensure core concepts are constructed and assimilated in a deep and meaningful manner. A Community of

Inquiry model, illustrated in Figure 3, is shaped by purposeful, open, and disciplined critical discourse and reflection.

“... the goal is to create a community of inquiry where students are fully engaged in collaboratively constructing meaningful and worthwhile knowledge. From both theoretical and empirical perspectives, there is little question as to the necessity and effectiveness of interaction and collaboration to achieve deep and meaningful learning outcomes (Garrison, Anderson, & Archer 2000; Lapointe & Gunawardena, 2004; Oliver & Omari, 1999; Schrire, 2004).” (Garrison & Vaughan, 2008, p. 31)



**Figure 3: Community of Inquiry model (Garrison & Vaughan, 2008)**

A Community of Inquiry when mapped as part of an activity system with an authentic problem as the catalyst for inquiry and learning allows the further refinement of designs for a curriculum ecosystem.

## **2.6 Curriculum ecosystems**

An essential aspect to the design of a curriculum ecosystem is the need to have an overarching curriculum design that recognises a learning ecosystem as an essential part of the learning and teaching process, and the need for authentic learning activities within a complex adaptive system.

### **2.6.1 Curriculum Development**

Tyler (1949) organised his rationale (for constructing a curriculum) around four fundamental questions, which he claimed must be answered in developing any curriculum:

- What educational purposes should the school seek to attain?
- What educational experiences can be provided that are likely to attain these purposes?
- How can these educational experiences be effectively organized?
- How can we determine whether these purposes are being attained?

(Walker & Soltis 2009)

Tyler's questions, and the work of Hilda Taba (1962), an influential colleague of his whose model was a further development of Tyler's, have guided curriculum designers for decades. Tyler's approach has been criticised by some as being too linear and based on assumptions about cause and effect (Ornstein & Hunkins 2013). However his questions are still very relevant when defining a learning ecosystem.

They can be seen as elements that need to be considered in a non-linear, dynamic, system that provide adaptive tension within the ecosystem.

While Tyler's questions can be considered when designing curricula they do not go far enough when designing a curriculum ecosystem and the necessary scaffolding for facilitation of interactions within and across an ecosystem. Doll (2009) offers an alternative to the Tyler rationale, which opens up questions around the criteria he labels as:

- *Richness*: a curriculum's depth of meaning ... The concept of developing richness through dialogue, interpretations, hypothesis generation and proving
- *Recursion*: the complex structures that support critical reflection ... to reflect on one's own knowledge ... this is also the way one produces a sense of self, through reflective interaction with the environment, with others, with a culture ... such "recursive reflection" lies at the heart of a transformative curriculum: it is the process which Dewey and Piaget advocate
- *Relations*: the intersecting of curriculum and cultures
- *Rigor*: a commitment to exploration ... purposely looking for different alternatives, relations, connections ... so the dialogue may be meaningful and transformative

All these criteria reflect the concepts and processes identified in this literature review. Curriculum design needs to provide a foundation that encourages much more than the transmission of pre-digested content. It needs to recognise that knowing and meaning, cognitive activity, is constructed from both internal and

external resources and that the meanings of actions are grounded in the context of activity. It needs to facilitate the processes individuals and groups engage in and recognise the resources and tools they use to render their actions and experiences meaningful. Curricula should reflect the cognitive architecture embedded in systems, processes, social organisations, and culture of the target professional practice.

### 2.6.2 Approaches to Curriculum Design

When designing curriculum, Mayes and de Freitas (2004) argue that the task of making curriculum design decisions can be made more straightforward by adopting the assumptions of a constructivist pedagogical approach, where the focus is always on what the learner is actually doing and placing the learning and teaching activities at the heart of the process (see Figure 4).

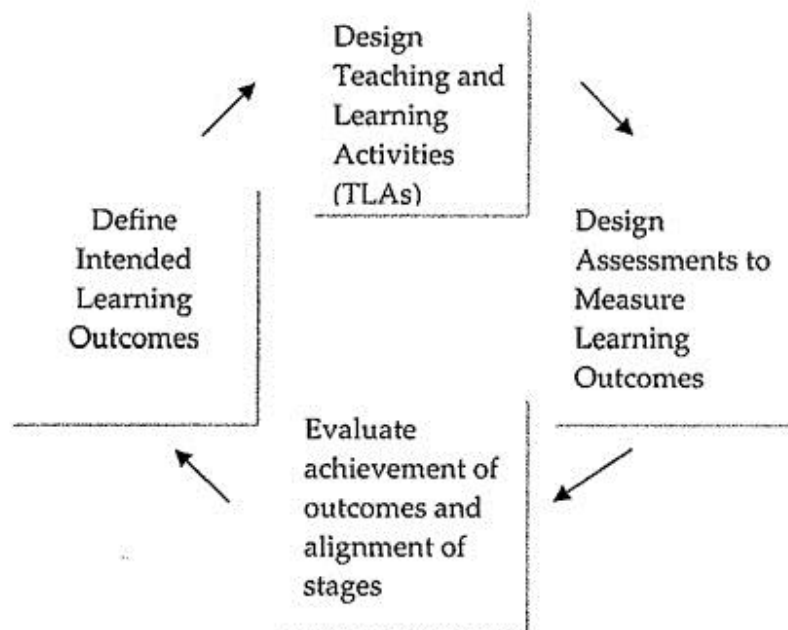


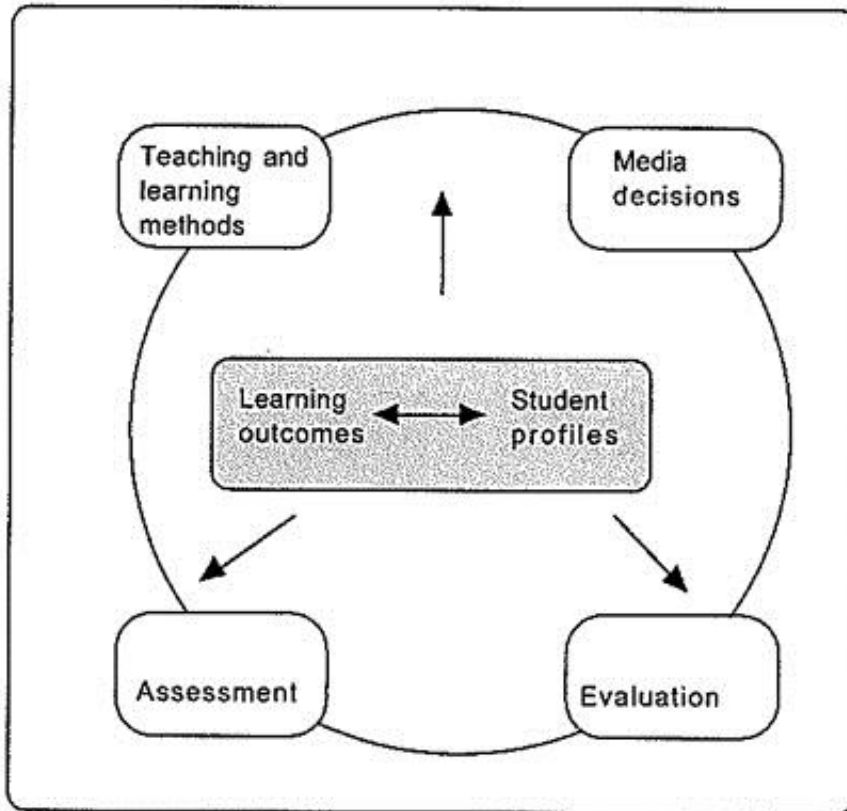
Figure 4: Curriculum Design Cycle (Mayes & de Frietas, 2004)



A curriculum ecosystem needs to be designed with affordances that support these activities. Bell and Lefoe (1998) see learning outcomes as driving the design, however they also include media decisions as an integrative element, as shown in Figure 5. With the use of audio and video recorded lectures, multimedia presentations and simulations, synchronous chats, asynchronous discussion forums, video and teleconferencing, and virtual classroom solutions becoming commonplace in educational practice the consideration of the type of media and its affordances should be an essential part of the design process. This approach reflects the views of Marshall McLuhan (McLuhan & Fiore, 1967) whereby the media that are used are seen as having a major impact on human activity:

“All media are extensions of some human faculty ... all media work us over completely. They are so pervasive in their personal, political, economic, aesthetic, psychological, moral, ethical, and social consequences that they leave no part of us untouched, unaffected, unaltered. The medium is the message. Any understanding of social and cultural change is impossible without a knowledge of the way media work as environments.”

This understanding also reflects the need to consider the choice and use of appropriate cognitive tools (Jonassen & Reeves 1996, Herrington et al 2010). The ecosystem and related curriculum needs to be designed with the concepts of affordance networks and effectivities, found in ecological psychology, in mind throughout the design process. The tools, media and modes of communication used to facilitate actions and interactions are an integral part of the overall curriculum ecosystem.



**Figure 5: Flexible Delivery Model (Bell & Lefoe, 1998)**

All of these elements re-enforce the need to design for experience through rich learning activities within an appropriate curriculum ecosystem with affordances that support those activities.

### **2.6.3 Educational Affordances**

Such a curriculum ecosystem should be designed with affordances that reflect professional practice and the related culture, and support active collaborative learning. Professional practice occurs in a socio-cultural system in which intelligent agents use various tools and multiple forms of interaction to engage in collaborative activity. These tools have certain affordances. Careful design and a thorough

understanding of the dynamics of these affordances when acting together are necessary.

A curriculum ecosystem with an integrated PBL approach and Community of Inquiry at the core should be designed with the following affordances:

- **Connectivity and social rapport:** Support networks of people, stimulate the development of a participatory culture and facilitate connections between participants.
- **Collaborative information discovery and sharing:** Research activities and data sharing enabled through a range of web enabled software applications.
- **Content creation:** Creation, assembly, organisation and sharing of content to meet learners own needs and those of others. Teams and individuals should be able to work together to generate new knowledge through an open editing and review structure.
- **Project management:** Effective management and delivery of individual and team projects within a set time frame should be facilitated through use of tools that support time management, task allocation, setting of milestones and communication between team members.

(Adapted from McLoughlin & Lee, 2007)

When designing a curriculum it is important to emphasise the alignment of the processes, tools and dynamics of the related curriculum ecosystem. Biggs and Tang (2007) describe good curriculum design as one that has 'constructive alignment', one where there is alignment between the intended learning outcomes, the teaching & learning activities and the assessment tasks. This alignment also necessarily applies

to a related curriculum ecosystem design. The alignment process needs to bring together the underlying assumptions about learning, the expected learning outcomes and adopted teaching & learning methods and the scaffolding provided by the tools and processes within the ecosystem for learners to achieve those learning outcomes.

## **2.7 Conceptual Framework**

The literature in this chapter can be drawn together under the following headings for the purpose of this study:

1. Dynamics of a Complex Adaptive System
2. Learning within a Complex Adaptive System
3. Scaffolding learning within a Complex Adaptive System

	<b>Concepts</b>	<b>Description</b>
<b>1. Dynamics of a Complex Adaptive System.</b>	1.1 Complex Adaptive System	A complexity paradigm views the world as complex and unpredictable, relationships are non-linear and dynamic. It is made up of complex adaptive systems (CAS) where intelligent agents anticipate the behaviour of others and the external environment, and modify their behaviour accordingly.
	1.2 Open System	Open systems function to keep just the right amount of imbalance, so that the systems might maintain a creative dynamism. An open system is a living, far-from-equilibrium system, where there is an orderly disorder, which has been described as the very source of creativity.
	1.3 Emergence	The process by which new patterns, features, qualities or products result from the non-linear interactions of agents within the system. Emergence is driven by the

		self-organising nature of a system far-from-equilibrium.
	1.4 Far-from-equilibrium	Systems in far-from-equilibrium states evolve and adapt to changing conditions and spontaneously self-organise with structures of increasing complexity.
	1.5 Self-organizing	The tendency of many systems to generate new structures and patterns over time on the basis of its own internal dynamics – order emerges from patterns of relationships among individual agents.
	1.6 Ecological Psychology	Knowing does not simply exist in the head, it emerges from learner-environment interactions that are dynamic and continuous, not static or linear. Perception and knowing is a property of an ecosystem.
	1.7 Affordance Networks	A combination of properties of an environment, a collection of facts, concepts, tools, methods, practices, and even people, that are distributed across time and space and are viewed as necessary for the satisfaction of a particular set of actions or goals.
	1.8 Effectivity Set	An effectivity is the dynamic actualisation of an affordance. An effectivity set consists of those behaviours that an individual can produce so as to realise the potential of an affordance network.
	1.9 Distributed Cognition	Distributed cognition focuses on the interactions between people, technologies and environments, what they really do in them and how they coordinate their activity in them. Distributed cognition looks for cognitive processes, wherever they may occur, on the basis of the functional relationships of elements that participate together in a process.
<b>2. Learning within a Complex Adaptive System</b>	2.1 Social constructivism	Emphasises experiences, collaboration, problem solving and the contextual aspect of learning. Knowledge is seen as being personally constructed, socially mediated and inherently situated.

	2.2 Situated Cognition	Knowledge is situated, a product of the activity, context and culture in which it is developed and used.
	2.3 Disruption / Disequilibrium	Trigger for inquiry and learning
	2.4 Critical Reflective Practice	Critical reflection encompasses both the capacity for critical inquiry and self reflection. It is a process of reflecting on a problem or dilemma and possible solutions, of evaluating and refining those solutions, taking input from other learners and peers and accepting, rejecting, refining that input. It is the key to metacognition where individuals strategically monitor the effectiveness of their approaches in the complex systems within which they study, live and work.
	2.5 Authentic Learning	Authentic learning experiences focus on the development of knowledge in real-world contexts and application of that knowledge to the solving of real-world problems. Situation and cognition are seen as interdependent. Authentic Learning is based on the idea that knowledge and skills are best gained in learning settings that reflect the complexity of the environment where the final performance is expected to take place.
	2.6 Cognitive Apprenticeship	Enabling the learning of the processes used by experts to handle complex problem solving tasks. Conceptual and factual knowledge are exemplified and situated in the contexts of their use. The shift from novice to expert facilitated through a series of learning activities that enable the development of the cognitive structures and processes of experts.
	2.7 Curriculum Development	Developed through defining the educational purposes, experiences, and evaluation of achievement, with a focus on richness, recursion, relations and rigor.
<b>3. Scaffolding Learning within a</b>	3.1 Activity Theory/ Activity System	Object oriented, collective, and culturally mediated human activity. An activity is undertaken by a person/s (subject) who is

<b>Complex Adaptive System</b>		motivated toward the solution of a problem or purpose (object) mediated by tools in collaboration with others (community).
	3.2 Cognitive Tools	Cognitive tools are used to support and enhance the cognitive abilities of learners. These tools enable and facilitate critical thinking and higher-order learning and can include databases, spreadsheets, wikis, blogs, expert systems, project management solutions, design software and modelling tools.
	3.3 Community Of Inquiry	A collaborative constructivist process that has inquiry at its core. A Community of Inquiry consists of social presence, cognitive presence and teaching presence.
	3.4 Problem Based Learning (PBL)	PBL requires active learning where the learner plays an authentic role carrying out complex tasks in an authentic context. Learners are provided with the opportunity to grapple with realistic, ill-structured problems, which act as a catalyst for investigation and learning.
	3.5 Curriculum Design	Design based on learning activities, outcomes, assessment and the media and modes used to provide the educational experiences. That is, the experiences and environment within which they occur.

**Table 5: Conceptual Framework**

## ***2.8 Guiding Principles***

Applying this conceptual framework when designing curricula and the integrated curriculum ecosystem, guiding principles are that they should:

1. Be an open system that facilitates emergence

2. Use ill-structured, authentic, disruptive, problems as catalysts for inquiry & learning
3. Be learner centred
4. Be tutor facilitated
5. Use a collaborative learning approach
6. Provide experiences that reflect the culture of the profession/discipline
7. Support the interactions, dynamics and flow of processes, and use the tools (cognitive, physical & virtual) that reflect that culture
8. Support self organisation
9. Support critical reflective practice

The resulting curriculum ecosystem should replicate the culture and tools of the chosen profession or discipline, and reflect the disruptive nature of changes and challenges within that discipline. These Guiding Principles are applied and evaluated through the iterative development of the Built Environment Degree Programs (BEDP) curriculum ecosystem.

Furthermore, these Guiding Principles, and the conceptual framework from which they derive, have been carefully aligned with the strategies employed to generate and analyse data in the study. For example, the data were collected during three iterations of the selected program over six years, thereby situating data generation directly and explicitly within the emergent and iterative character of a Complex Adaptive System. Similarly, this data generation was inclusive of multiple manifestations of the phenomena related to the study's selected foci. Moreover, as was noted above, the data analysis was conducted iteratively with, rather than separately from, the data generation, thereby enhancing the accuracy and



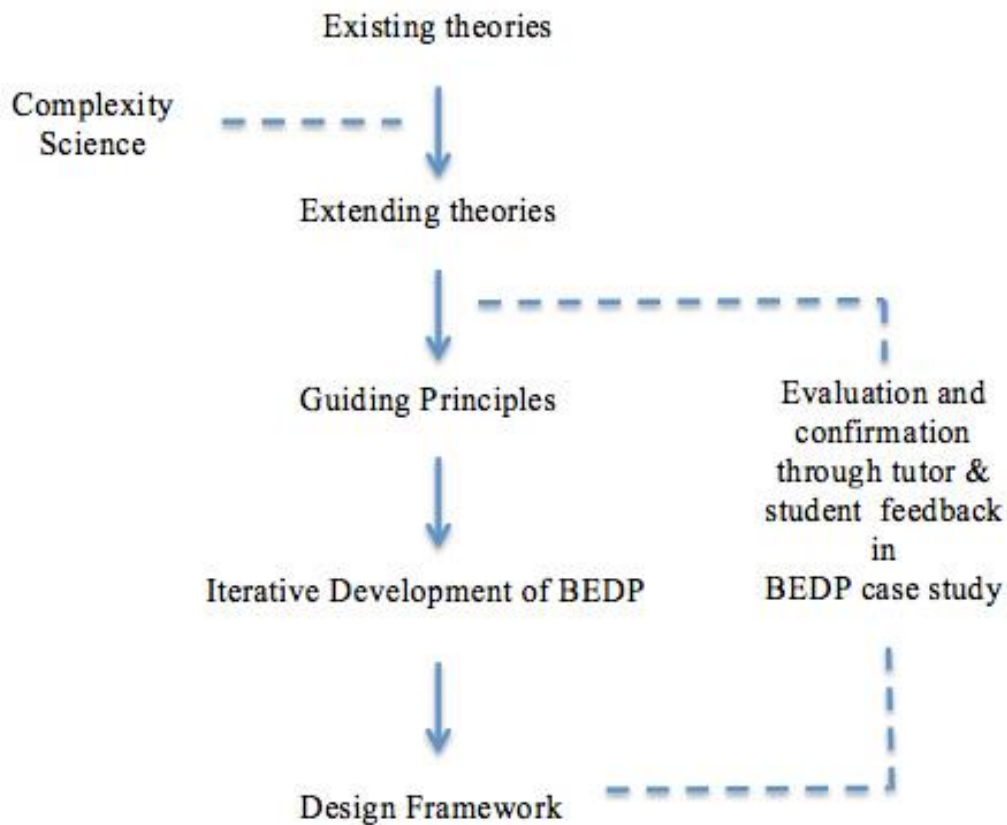
authenticity of both elements of the study's research design. Relatedly, the study's application of activity systems analysis to underpin the data analysis again emphasised dynamism, emergence and fluidity, which are features alike of the study's conceptual framework and of its Guiding Principles. All of this highlights the close alignment between the conceptual framework on the one hand and data generation and analysis on the other hand.

### **3. Research Design**

#### ***3.1 Overview***

The research design, outlined in Figure 6, has drawn on Grounded Theory and a Design Based Research / Educational Design Research approach with a Case Study narrative describing the iterative development of the Holmesglen Built Environment Degree program (BEDP) as a curriculum ecosystem.

The aim of the research was to evaluate and confirm the set of guiding principles drawn from the review of the literature and extended through a complexity science perspective, and to develop a design framework for higher education curriculum ecosystem design through a review of the iterations in the development, and implementation of the BEDP curriculum ecosystem.



**Figure 6: Design for the research**

The guiding principles drawn from the literature are that when designing a curriculum ecosystem it should:

1. Be an open system that facilitates emergence
2. Use ill-structured, authentic, disruptive, problems as catalysts for inquiry & learning
3. Be learner centred
4. Be tutor facilitated
5. Use a collaborative learning approach
6. Provide experiences that reflect the culture of the profession/discipline
7. Support the interactions, dynamics and flow of processes, and use the tools (cognitive, physical & virtual) that reflect that culture
8. Support self organisation

## 9. Support critical reflective practice

The research has drawn on Grounded Theory and Educational Design Research approaches using both qualitative and quantitative data, employing survey and interview techniques (Burns 1997, Krathwohl 1993), drawing data from course evaluation surveys, tutor interviews, tutor reports, and building on existing literature.

The research has also used an immersion approach (Bloomberg & Volpe, 2008) that draws on the researcher's extensive experience, insight, intuition and creativity in the implementation of interventions in each iteration.

### **3.1.1 Research Questions**

The study has been guided by the following research questions:

- What guiding principles for curriculum ecosystem design can be drawn from current literature?
- What affordances are central to such an ecosystem?
- What design framework can be defined through the iterative redevelopment, informed by these guiding principles, of a Built Environment Degree Program as a curriculum ecosystem?

### **3.2 Grounded Theory**

The objective of grounded theory is to generate theory, or modify or extend existing theory, from data gathered through systematic research. These data can include existing literature, interviews, surveys and prior experience of the researcher. It is used to identify relevant concepts, and inform the development of categories and

the exploration of connections between them, and develop predictive understanding, explanations and applications (Glaser & Strauss 1967, Bloomberg & Volpe 2008).

In the context of this study a grounded theory approach is implemented in the following way:

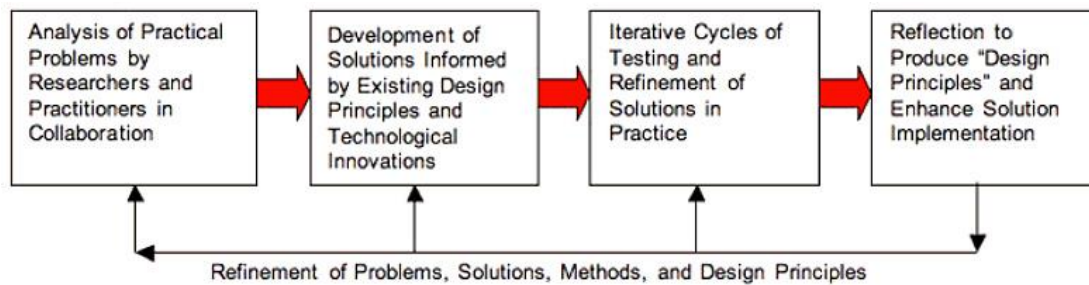
- Review of the literature to identify relevant concepts.
- Drawing together of those concepts in the form of a conceptual framework and a set of guiding principles.
- Review of data gathered from the iterative development of BEDP to identify patterns, and evaluate and confirm the guiding principles.
- Develop theory from a complexity perspective in the form of a design framework for curriculum ecosystem design.

### ***3.3 Educational Design Research***

An Educational Design Research, also known as Design Based Research (Reeves et al 2011) or a Design Experiment approach has been used to explore the iterative development of BEDP as a curriculum ecosystem. Educational design research has the aim of developing innovative approaches to solving teaching and learning problems and improving educational practice while at the same time constructing a body of design principles that can guide future developments.

A Design Experiment has been described as a test-bed for innovation. The intent is to investigate the possibilities for educational improvement by bringing about new forms of learning in order to study them. It is based on an iterative design process with “cycles of invention and revision as a way of exploring a learning ecology - a complex, interacting system involving multiple elements” (Cobb et al, 2003).

As Figure 7 illustrates Design Based Research or Educational Design Research was developed as a way to conduct formative research in real world contexts, in collaboration with practitioners, to test and refine educational designs (Reeves 2006).



**Figure 7: Design Based Research Process (Reeves, 2006)**

This approach is used to develop, through an iterative process, effective models of educational practice. An intervention in the form of a teaching & learning strategy, or educational technology solution is implemented with the aim of solving a complex educational problem. While working with teacher/practitioners, researchers, informed by relevant literature and/or research, develop intervention prototypes and through an iterative development process refine the prototypes until solution/s to the problem is/are achieved. Then through reflection on their research related design principles can be articulated. Characteristics of this type of research as summarised by Van den Akker et al (2006) are:

- *Interventionist*: the research aims at designing an intervention in a real world setting
- *Iterative*: the research incorporates cycles of analysis, design and development, evaluation, and revision

- *Involvement of practitioners*: active participation of practitioners in the various stages and activities of the research
- *Process oriented*: the focus is on understanding and improving interventions
- *Utility oriented*: the merit of a design is measured, in part by its practicality for users in real contexts; and
- *Theory oriented*: the design is (at least partly) based on a conceptual framework and upon theoretical propositions, whilst the systematic evaluation of consecutive prototypes of the intervention contributes to theory (and/or design principles) building.

Educational design research, with its close collaboration of practitioners and researchers in the testing and refinement of prototype solutions, provides a direct link between research and practice, has greatly enhanced chances of having a meaningful impact on Higher Education (Reeves, McKenney & Herrington, 2011). This approach of progressive refinement through iterative design processes has been used throughout the development and implementation of the Holmesglen Built Environment Degree Program (BEDP) as a curriculum ecosystem. The BEDP with its requirement for seamless integration of on-line and off-line learning, has provided an opportunity for a design experiment to explore how a curriculum ecosystem and educational experiences can be designed leveraging on the strengths of a digital ecosystem.

The focus of this study is on three iterations in the evolution of BEDP as a curriculum ecosystem:

**Iteration 1:** Provision of scaffolding / cognitive architecture to support Problem Based Learning (PBL) processes. Student Learning Process Maps to support

student workflow and time management, and a Subject Writer's three stage development process embedded in their contract to support a learning process focus rather than a content development focus throughout curriculum development.

**Iteration 2:** Implementation of the Basecamp project management solution to support collaborative group work processes.

**Iteration 3:** Implementation of Moodle and revised subject structure to support communication and interaction between tutor and learners, learner and learners.

The study's application of grounded theory was through its alignment with and contribution to the study's design based research approach. Activity systems analysis was used as a method of analysis of the data collected.

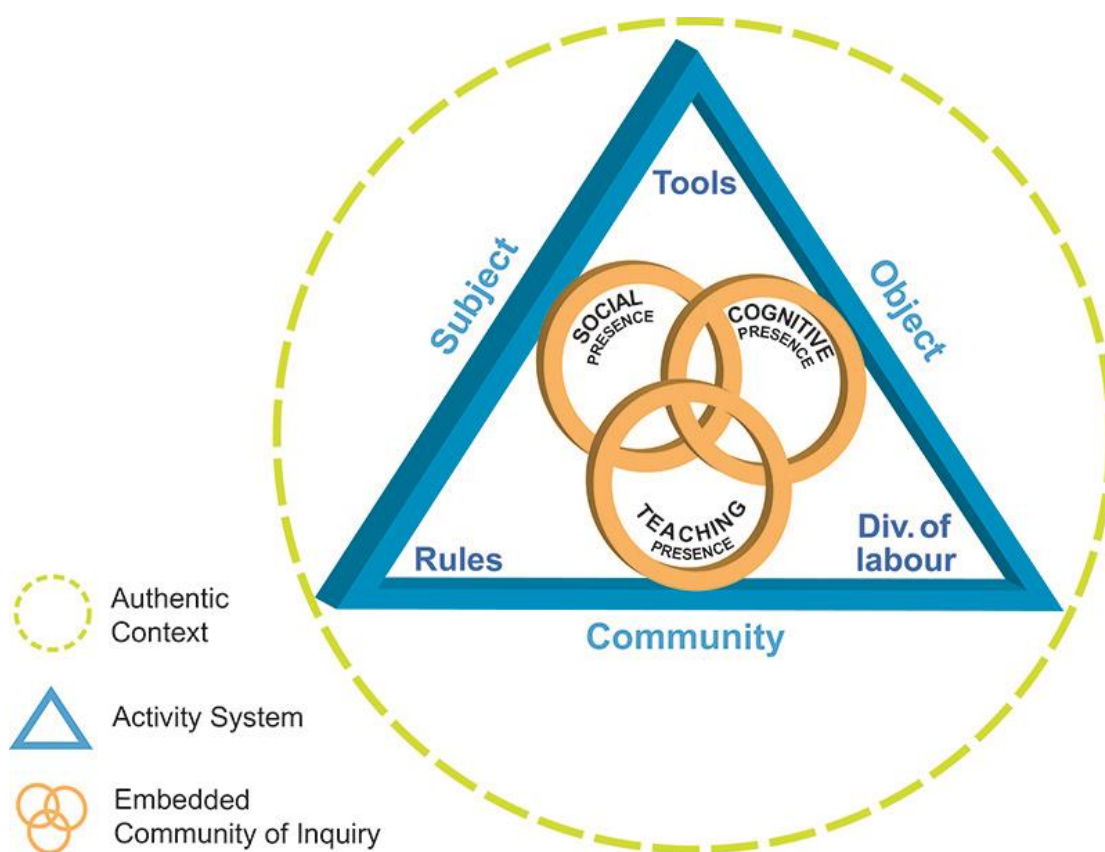
### ***3.4 Activity Theory and the BEDP Curriculum Ecosystem***

Activity Theory has been used as a method to analyse activity within the BEDP curriculum ecosystem. This strategy takes the form of Activity System models. The BEDP curriculum ecosystem can be seen as an Activity System (Engestrom, 1987) with an embedded Community of Inquiry (Garrison & Vaughan, 2008) within an authentic context (Figure 8).

Activity Theory has been used to inform the key aspects of educational design, and provides a powerful framework for analyzing needs, tasks, and outcomes (Mayes & de Freitas, 2004; Jonassen & Rohrer-Murphy, 1999). Activity Theory and activity system models are used to provide a method for managing complex qualitative data sets. Activity systems analysis has been used as a descriptive tool in qualitative data analysis by researchers to:

- a) “Capture the processes involved in organizational change (Barab, Schatz, & Scheckler, 2004; Engestrom, 1993, 2000)
- b) Identify contradictions and tensions that shape developments in educational settings (Barab, Barnet, Yamagata-Lynch, Squire, & Keating, 2002; Roth & Tobin, 2002)
- c) Demonstrate historical developments in organizational learning (Yamagata-Lynch, 2003)”

(Yamagata-Lynch, 2007)



**Figure 8: BEDP activity system / Community of inquiry**



The Subject refers to the individual or group of intelligent agents engaged in the activity whose point of view is taken in the analysis of the activity. The Object refers to the focus of the activity. The intelligent agents (learners & tutors) are assisted in this process with physical, cognitive and symbolic, external and internal mediating instruments or Tools. These tools are seen as cultural artifacts that shape the way the agents interact with each other and the world around them (both physical and virtual). The Community comprises of multiple individuals and/or groups (Community of Inquiry) who share the same Object. The Division of Labor refers to the allocation of roles and responsibilities, the horizontal division of tasks between the members of the community and to the vertical division of power and status. The Rules refer to the explicit and implicit regulations, cultural norms and conventions that constrain actions and interactions within the activity system.

The Activity System maps the major aspects of the ecosystem as the intelligent agent or group of intelligent agents undertake(s) a complex journey towards an outcome or goal. Central to activity analysis is the concept of 'contradictions', and it is such contradictions or disturbances that cause activity systems to evolve.

The activity system models in the context of this study are drawn to explore how well the ecosystem has supported learning in each of the iterations, and to identify contradictions or disturbances within the system that can then lead to the intervention for the next iteration, and inform the development of the Design Framework.

The Design Framework produced will be represented graphically as a concept and process map, a 'rich picture' of a complex adaptive system and its key components and processes (Dick 2010).

### ***3.5 Case Study as a Complex Adaptive System***

The BEDP case study provides authentic examples of learning over a comprehensive degree program, and over a substantial period of time. The case study narrative provides a description of the further development of the BEDP as a curriculum ecosystem. Themes, patterns and issues are drawn from the data collected and the shaping influences present in the case study are explored. The case narrative is a filter through which the experience of those involved in development of the BEDP curriculum ecosystem is shaped and given meaning (Bloomberg & Volpe 2008).

A case study narrative approach is supported in recent work in the area of complexity science and educational research.

“As a result of the multiplicity of interactions and feedback within a case, and the non-linear causality within complex systems, one could argue that in a complex case study, the narrative rather than comparative approach to case study is likely to be more appropriate” (Hetherington, 2013).

Castellani, Schimpf and Hafferty (2013) argue that complex systems are cases and should be studied as such, and that the case should be the focus of the study, not the individual variables or attributes of which it is comprised. Cases are composites of interdependent, interconnected variables or attributes; the whole is more than the sum of its parts. Each variable is not an isolated factor; it is part of a larger set of factors that together define the case, often in non-linear ways.

Education and learning take place through the interactions of participants with each other and their environments in ways which cannot be controlled in an experiment with a restricted number of variables. It takes place within a Complex Adaptive System with its own ecology of multiple interacting and evolving elements that have to be viewed holistically. The unit of analysis should be an ecosystem. (Cohen et al 2011)

A complex case study is characterised by rich interactions between diverse elements within an open system influenced by positive and negative recursive feedback loops. BEDP is such a case study.

### ***3.6 Research Method***

The research was conducted in three Stages (see Figure 9).

1. Key concepts drawn from current literature and informed by a Complexity Science perspective are articulated as a set of Guiding Principles
2. These Guiding Principles are evaluated, confirmed and/or revised through the iterative development and implementation of BEDP as a curriculum ecosystem
3. A Design Framework is developed through analysis of data gathered, and review of the BEDP iterations and resulting curriculum ecosystem design

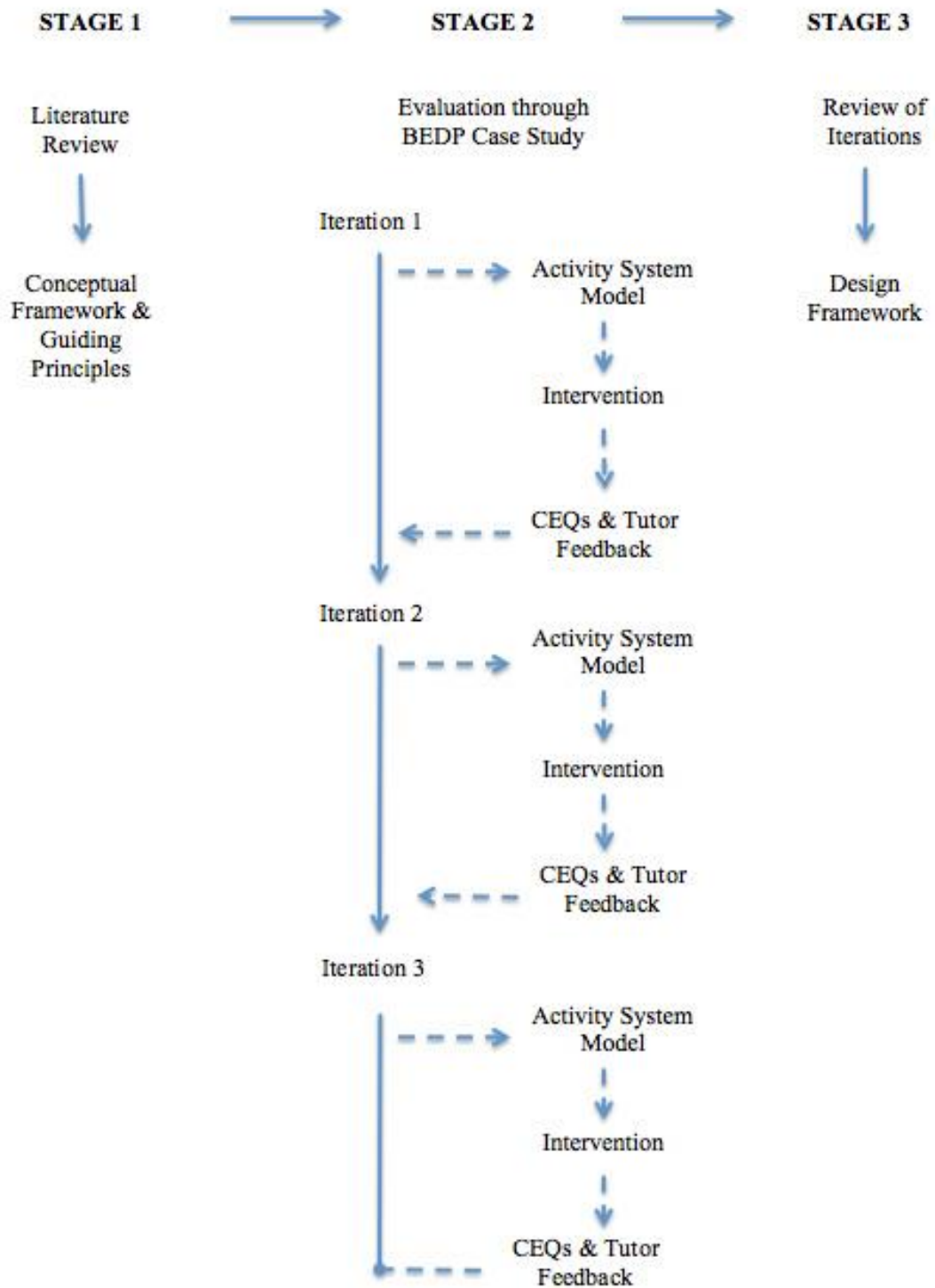
Data collected throughout the BEDP design iterations are in the form of:

- Student Course Evaluation Surveys (CEQs)
- Tutor Reports
- Tutor Interviews

These sources of data have been used to achieve triangulation of multiple perceptions of BEDP to clarify meaning and provide supporting evidence for conclusions drawn. The tutor interviews provide in-depth, context rich personal accounts, perceptions and perspectives of BEDP. The CEQ results provide quantitative data on the student perspective (Bloomberg & Volpe, 2008).

Themes drawn from results of the CEQs, tutor interviews and reports, and ongoing discussions with tutors, who are experts in the target professional culture of the building & construction industry, are used to inform development of Activity System models and the design and implementation of each of the BEDP iterations.

Tutor reports were submitted at the end of each trimester, for each of the subjects they taught, as part of the academic quality assurance continual improvement process. Tutors were aware of the overall design of the BEDP.



**Figure 9: Research Method**

The BEDP Course Evaluation Questionnaire (CEQ) is in Appendix 1. The purpose of the Student Course Evaluation Questionnaire (as shown in Figure 9) is to

elicit feedback from students at the conclusion of each delivery cycle of each subject as part of BEDP academic quality assurance processes. The consolidated results provide longitudinal performance data, which are monitored over time for each subject, and for all the courses. The CEQs were conducted at the end of every trimester and were part of the continual improvement process. The results are reviewed at the conclusion of every trimester by the academic leadership team, and Issues identified inform on-going academic development, tutor professional development, and any necessary changes to course materials or systems.

Each section in the Student Course Evaluation Questionnaire (CEQ) has a theme that will be mapped against corresponding Guiding Principles drawn from the literature. These sections are:

- The Subject
- Teaching Approach and Support
- The Tutor and Tutorials
- Perceived Outcomes
- Online Learning
- Learning Trigger Design
- General Issues

The Tutor Reports are required on completion of each trimester for each subject for which a Tutor has had responsibility. Full details are in Appendix 2. The report gathers information on:

- Strategies used to support learning
- Learning Trigger effectiveness
- Learning Material design
- Student performance

- General feedback

### ***3.7 Ethical Considerations***

The USQ Ethics Committee provided ethics approval. Approval Number H09REA100, available in Appendix 4. All interview participants were informed of the purpose of the study and a consent form was used. Participation in the interviews has been on a voluntary and anonymous basis.

Data have been gathered from the ongoing tutor reports and course evaluation student surveys conducted on completion of each trimester. Results from these reports and surveys are used to inform the ongoing refinement of the programs. Permission for use of these data has been obtained from Holmesglen Institute.

## 4. Case Study - Built Environment Degree Program

The Holmesglen Built Environment Degree Program (BEDP) offers Bachelor of Construction Management & Economics (BCME) and Bachelor of Building Surveying (BBS) degrees. The degrees are designed to prepare graduates to operate across the building and construction industry with a level of professionalism that is consistent with best international practice.

Students in BEDP over the period of this study had predominantly one or more of the following characteristics (approximate %): male (80%), 25 years or older (60%), studying part time (80%), studying off campus (50%). Over the period of the study there were between 120 and 150 students enrolled in the degree programs. There were only a small number of international students in the programs during this time.

Learner-centred principles with an emphasis on deep, experiential and active learning design underpin the engagement of students in BEDP (Biggs, 1999). The emphasis is not on lectures and the delivery of content. The emphasis is on the students developing learning strategies appropriate to themselves, and the facilitation and support of their learning through tutorials, collaborative learning opportunities, supporting learning materials and the use of appropriate cognitive tools (Jonassen & Reeves, 1996)

The challenge of educating building and construction professionals in a knowledge economy is the need to anticipate the dynamic nature of knowledge. Professionals need to have the skills to locate, evaluate, and apply information appropriately, and to create new knowledge in changing environments where jobs and job challenges of the future may possibly not yet exist.



This challenge has been met by BEDP through the move from a content focus to an experiential, inquiry focused, Problem Based Learning (PBL) approach. This approach bridges the divide between theory and practice through the use of an iterative process that is driven by industry practice-relevant problems, research activities, and critical reflective practice.

All students entering the degree programs face the challenge of moving from their previous experiences of traditional approaches to education to a PBL approach with industry problems and expectations of professional practice at its core. Student performance in BEDP has been seen to be driven more by individual motivation rather than background. Those with industry experience have found the PBL approach easier to adapt to however they often struggle with the academic requirements while school leavers are more comfortable with the academic requirements but struggle with the expectations of independent learning and professional conduct.

#### ***4.1 The BEDP Curriculum Ecosystem***

Authentic learning, complexity science, and ecological psychology concepts as reflected in the guiding principles drawn from the literature are used to inform the design and iterative development of the BEDP as a curriculum ecosystem. The BEDP has been designed to reflect professional practice, to provide authentic learning experiences and support the dynamics and flow of interactions, the exchange of ideas and negotiation of shared meaning, and the engagement with

others in a community of inquiry (Garrison & Vaughan, 2008), within and around a professionally relevant educational experience (Cheers et al., 2011).

The BEDP operates from the perspective that all knowledge is inextricably a product of the activity and situations in which it is produced (Brown et al., 1989). Knowing and meaning is constructed from both internal and external resources, the meanings of actions are grounded in the context of activity. Learners are guided towards an understanding of information flow, cognitive skills requirements, social organisations, and related cultural processes of the building and construction industry.

All tutors in the BEDP have extensive building and construction industry experience, and are experts within the target professional culture, as well as having appropriate academic qualifications. This situation supports the creation of professionally relevant educational experiences for learners that reflect the structure, processes and dynamics of a building and construction professional practice complex adaptive system.

The complexity paradigm (Mitchell 2009) that has been used to inform the design and development of the BEDP provides a view that sees the world as complex and unpredictable, one where relationships are non-linear and dynamic. A world made up of complex adaptive systems where intelligent agents (learners) anticipate the behaviour of others and the external environment, and modify their behaviour accordingly. This view reflects the processes and culture of the building and construction industry where change is a constant and ongoing problem solving the norm.

The BEDP has been designed and developed with a requirement for seamless integration between on-line and off-line learning to provide educational

experiences that leverage on the strengths of the world's evolving digital ecosystem. In the BEDP information and communication technologies are seen as being most valuable when they are used with educational approaches that emphasise problem solving, inquiry and critical thinking, rather than simple acquisition of factual knowledge, and when a learner is an active constructor of knowledge. (Jonassen 1999; Garrison & Anderson 2003)

Authentic learning (Herrington et al 2010) in the form of problem based learning (PBL) and an integrated online learning approach that is utilized across the BEDP provides students with opportunities to develop the skills and knowledge needed to operate effectively across a range of professional roles in the diverse and rapidly changing building and construction industry. Online interaction has become a core component of professional practice across all industries, including the building and construction industry. Email, virtual teams, video and teleconferencing and the technologies that support them are now central to the successful completion of construction projects locally and internationally. This approach is reflected in the evolving BEDP curriculum ecosystem.

The online interaction across the BEDP provides students with the opportunity to hone their communication skills and strengthen their ability in using information and communication technologies as part of their daily activities in preparation for their entry into professional life in the 21st century's knowledge economy. PBL is core to this strategy and requires active learning, where the learner plays an authentic role carrying out complex tasks. Students are provided with the opportunity to grapple with realistic, ill-structured problems, which act as a catalyst for investigation and learning. The challenge when developing the BEDP as a curriculum ecosystem has been to integrate problem based learning, on-line and off-

line interaction, cognitive tools and learning materials as a seamless connection of physical and virtual.

Problem-based learning (PBL) is used both as a curriculum philosophy as well as a delivery method. The curriculum is conceptualised around holistic themes that integrate learning across traditional subject boundaries so that students acquire appropriate knowledge, skills and values concurrently in a practice context. The focus is on the learning process, while the content is contextual. The overall intention is for students to develop strong lifelong learning and problem solving skills.

In using a PBL approach the engagement is encouraged through the use of stimulating and challenging Learning Triggers. Student empowerment is inherent in the learner centred philosophy and processes where Tutors are facilitators, mentors, coaches and co-learners rather than authority figures, and active learning generates meaningful experiences individually and collectively.

A learning problem or trigger initiates the learning process. This trigger usually presents a challenging situation that represents real life, work related situation that is beyond the student's ability to address without additional learning of new knowledge and skills. A combination of individual assignments and collaborative group work is used.

## ***4.2 BEDP Learning Design***

The BEDP learning design is underpinned by a number of elements:

### **4.2.1 Students are Empowered**

Learners are placed in the role of professionals solving challenging, real world, problems. Their learning is their responsibility and tutors are seen as a resource.

### 4.2.2. Learning Journey

Each trimester's activities are seen as Learning Journeys. Figure 10 illustrates this Learning Journey. Student learning is facilitated by the tutor as the students develop the knowledge they need to produce a solution to the learning trigger.

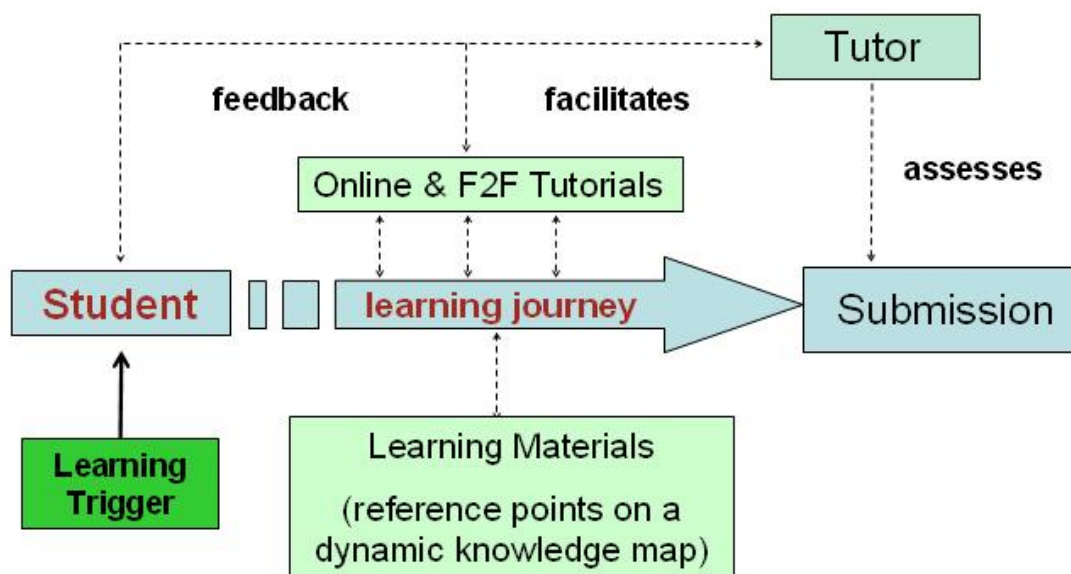


Figure 10: BEDP Learning Journey

### 4.2.3. Learning Triggers

At the core of the BEDP learning design is the Learning Trigger, which can be described as an issue, disorientating dilemma, or problem. Such a trigger is designed to be engaging, encompass all intended learning outcomes, and act as a catalyst for student inquiry.

Learning Triggers

- are ill-structured in nature (Jonassen, 2011)

- usually presented as a realistic scenario
- can change with new information
- are not solved easily or formulaically
- often have no one right answer
- cannot be solved without new learning

To provide stimulating relevant triggers current construction and building industry projects are used. These learning triggers are revised regularly.

An example of a third year subject learning trigger from *LSD363 – Large Scale Mixed Use Sustainable Development*, is one where learners, working in teams, were placed in the role of Consultants who have been tasked by the CEO of their company to conduct a Feasibility Study of the Barangaroo Darling Harbour redevelopment in Sydney NSW.

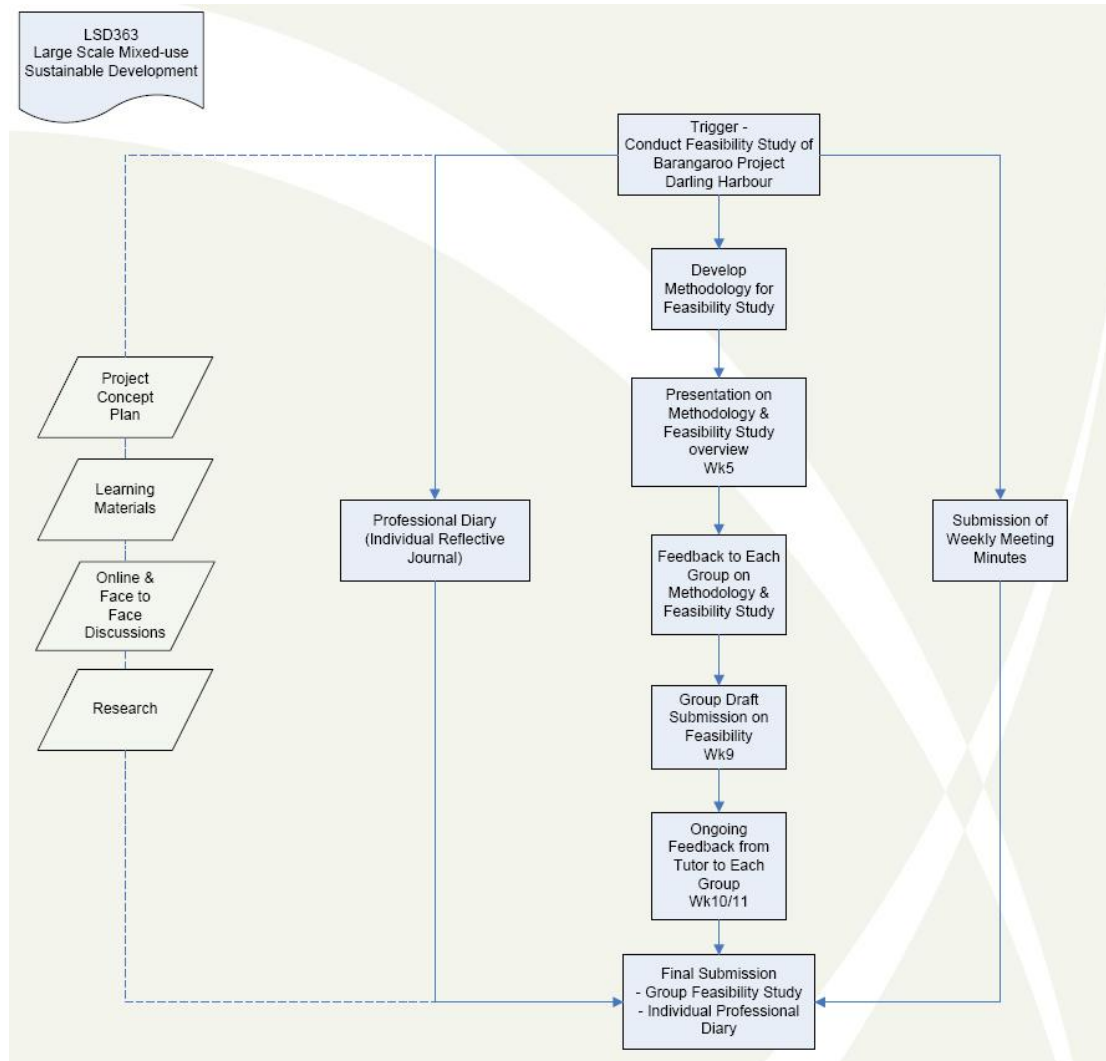
In this subject a range of complex and interrelated issues are examined including macroeconomics, environmental economics and large-scale economic investment, social and cultural diversity issues, cost benefit analysis and large-scale economic investments, sustainability, risk analysis and project management as they relate to large-scale mixed-use sustainable development.

#### **4.2.4. Student Learning Process Maps**

A Student Learning Process Map (SLPM) provides learners with an overview of the subject, guides them through their learning journey, and supports effective time management over the trimester.

The Student Learning Process Maps vary in structure from levels 1 - 3 across the degree programs. More structure and guidance is provided to first year students

to support them as they adapt to the PBL process than to third year students who are expected to be ready to enter the workplace as industry professionals. Figure 11 presents an SLPM for one such subject.



**Figure 11: LSD363 student learning process map**

#### **4.2.5. Discussion Forums**

Use of discussion forums is strongly encouraged with discussion threads created to reflect each aspect of the subject. They can range from mini case studies to highlight an important concept, to simple Question & Answer areas.

Discussions also take place in face to face sessions, however, the interaction between learners and learners, and tutors and learners, is not dependent on place and is ongoing across physical and virtual spaces.

#### **4.2.6. Basecamp**

The development of effective teamwork skills through group work is an integral part of the BEDP and highly valued in the building and construction industry. Time management, establishing and maintaining productive group processes, and the nurturing of effective interpersonal skills, are ongoing challenges for all those involved in such group work.

To address these issues, Basecamp, a web-based Project Management solution, was implemented, first as a pilot then across all BEDP (<http://www.basecamp.com>). Basecamp, shown in Figure 12, provides students with tools to manage their group work effectively and transparently. They can create To-Do lists, allocate Tasks, set Milestones, share Files and communicate with their group members to keep work on track.



The screenshot displays the Basecamp interface for the Holmesglen Built Environment Degree Program. At the top, there is a navigation bar with 'Dashboard', 'To-Dos', 'Milestones', and 'Time' tabs. The user 'Christopher Cheers' is logged in, with options for 'My info', 'Log-out', and 'HELP'. Below the navigation, there are links for 'All People', 'Search', 'Account (Upgrade/Billing)', 'Templates', and 'Settings'. The main content area is titled 'Latest activity across your projects' and features a 'Create a new project' button. The activity is organized into sections: 'Late & Upcoming Milestones' with a calendar for June 17-21, and four project activity feeds for HBDP 1 (MDP123-1), HBDP 3 (SHD353-1), HBDP 1 (MDP123-3), and HBDP 1 (MDP123-4). Each feed shows comments, messages, milestones, and file uploads. A sidebar on the right, titled 'Your projects', lists various project codes and names, including MDP123-1 through MDP123-5, SBS110-3 through SBS110-5, and BCM402 Buildability and Constructability. Below the sidebar, there are links for 'Plumbers Plumbing Certificate 3' and 'Your archived projects'.

Figure 12: Basecamp interface

#### 4.2.7. Additional Scaffolding for Interaction

A range of other strategies have also been implemented to scaffold student interaction.

These include:

- Learning Contracts
- Weekly Meeting Minutes
- Reflective Journals
- Self Assessment

- Peer Assessment

#### **4.2.8. Assessment**

All aspects of the learning journey are considered in assessment.

Assessment practices:

- align with curriculum objectives
- are based on real world contexts
- include open book exams
- encourage learners to engage in critical reflective practice
- provide learners with the opportunity to demonstrate what they know and what they can do
- encourage creativity and risk taking
- pursue holistic assessment, including:
  - Teamwork
  - Research skills
  - Problem solving performance

Drawing on concepts found in Complexity Science, Ecological Psychology, Distributed Cognition and Authentic Learning the Holmesglen Built Environment Degree Program (BEDP) has been designed to support learner's interactions rather than the dissemination of information, and to be a true reflection of professional practice in the real world. The BEDP through its iterations has been designed as a curriculum ecosystem (Barab & Roth 2006) that supports, and in fact enhances, the evolution and emergence of professionally relevant attitudes, skills and knowledge (Reeves et al 2002; Herrington et al 2010).

## **5. BEDP Iterations, Data, Analysis and Findings**

### **5.1 Overview**

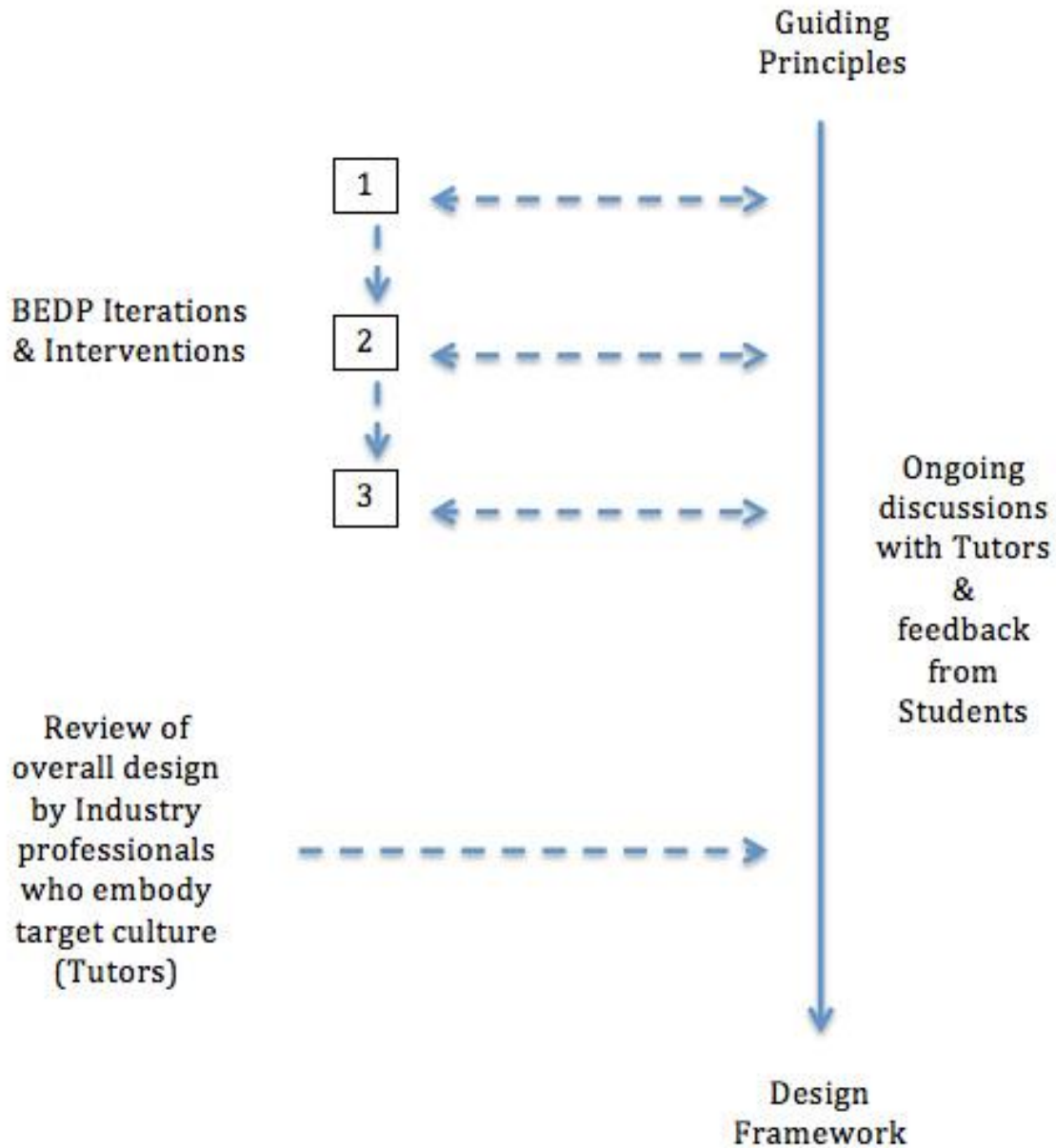
This chapter explores the BEDP iterations, design interventions implemented, and their impact, over six years in BEDP from 2007 to 2012. The results of the three BEDP iterations address the concepts drawn from the literature in regards to designing for learning as part of a complex adaptive system and scaffolding that learning process within a curriculum ecosystem.

The iterative development of BEDP as a curriculum ecosystem is also informed by ongoing discussions with tutors and feedback from students. The overall design of BEDP is reviewed by building and construction professionals who embody the target culture. These professionals are also tutors in BEDP.

A Design Framework for a Higher Education curriculum ecosystem is then drawn out of this process, as shown in Figure 13.

Research questions addressed are:

- What guiding principles for curriculum ecosystem design can be drawn from current literature?
- What affordances are central to such an ecosystem?
- What design framework can be defined through the iterative redevelopment, informed by these guiding principles, of a Built Environment Degree Program as a curriculum ecosystem?



**Figure 13: Research process**

In response to the first research question the following guiding principles have been drawn from the literature. When designing curricula and an integrated curriculum ecosystem they should:

1. Be an open system that facilitates emergence
2. Use ill-structured, authentic, disruptive, problems as catalysts for inquiry & learning

3. Be learner centred
4. Be tutor facilitated
5. Use a collaborative learning approach
6. Provide experiences that reflect the culture of the profession/discipline
7. Support the interactions, dynamics and flow of processes, and use the tools (cognitive, physical & virtual) that reflect that culture
8. Support self organisation
9. Support critical reflective practice

The iterative development and evaluation of BEDP is used to confirm these guiding principles. The BEDP iterations have been as follows:

**Iteration 1:** Provision of scaffolding / cognitive architecture to support PBL processes.

**Iteration 2:** Implementation of the Basecamp project management solution to support collaborative group work processes.

**Iteration 3:** Implementation of Moodle and revised subject structure to support communication and interaction.

This chapter has a section for each iteration, followed by a discussion across iterations at the end. The data collected related to these iterations, and the overall BEDP design, are drawn from the following sources:

- Student Course Evaluation Questionnaires (CEQs)
- Tutor Reports
- Tutor Interviews

## **5.2 Guiding Principles and Course Evaluation Questionnaires**

Student Course Evaluation Questionnaires (CEQs) are conducted on completion of each subject, each trimester as part of the BEDP academic quality assurance processes, to gather students' feedback and perceptions on the following using a five point Likert scale (see Appendix 1):

- The Subject
- Teaching Approach and Support
- The Tutor and Tutorials
- Perceived Outcomes
- Online Learning
- Learning Trigger Design
- General Issues

Themes running through the question items address:

- Subject Design & Relevance
- Teaching Approach & Support
- Tutor Facilitation
- Independent Learning
- Tools
- Problem/Trigger Design

The items used in the Student Course Evaluation Questionnaires align with the guiding principles as follows:

The relevant guiding principle/s are listed (in red) at the end of each item and summarised in Table 6

A. The Subject –

- a. I clearly understand the relevance of the subject to my chosen field of studies. **(8)**
- b. The requirements of the subject were made clear in the Subject Outline given to me at the beginning of the term. **(3, 4, 8)**
- c. The coverage of the subject is intellectually challenging. **(2)**
- d. The assessments undertaken in this subject so far are relevant to the set learning objectives. **(7)**
- e. The assignments and assessments in this subject have encouraged me to understand and reflect on what I have learnt. **(3, 9)**
- f. I have found this subject to be stimulating and interesting. **(3)**
- g. I am satisfied with my learning achievements in this subject. **(3)**
- h. Overall, I would rate the design and delivery of this subject as:

B. Teaching Approach and Support –

- a. The Problem-based Learning approach in this subject is well organised. **(2, 4)**
- b. The learning problem(s)/triggers(s) used in this subject are stimulating and challenging. **(2)**
- c. I am able to identify my own learning needs in this subject and satisfy them. **(1, 8)**
- d. The learning materials provided are well designed and relevant. **(7)**
- e. I am able to use the learning materials to guide and support my learning. **(8)**
- f. The tutorial sessions in this subject are useful in helping me learn. **(4)**

- g. The tutorial sessions in this subject enrich my learning experience. (3, 4)
- h. The learning environment encouraged innovation and critical thinking. (1, 9)

C. The Tutor and Tutorials -

- a. The tutor/s is effective in helping me learn. (4)
- b. The tutor/s has facilitated a stimulating learning environment. (4)
- c. The tutor/s has encouraged me to participate in active learning. (3, 4, 8)
- d. The tutor/s in this subject is professional in attitude. (4, 6)
- e. The tutor/s continually challenges me to stretch my mind. (4, 9)
- f. The tutor/s is responsive to students' needs. (4)
- g. I get useful feedback in tutorials that helps me learn. (4)
- h. The tutorials in this subject are well managed. (4)

D. Perceived Outcomes –

- a. I have developed useful knowledge, skills and professional values in this subject. (1, 6, 7)
- b. I am able to relate what I have learnt to wider contexts and applications beyond the subject boundaries. (1, 6, 7)
- c. I am able to evaluate the quality of my own learning in this subject. (8, 9)
- d. I have learnt in a holistic and relevant manner in this subject. (6, 7)
- e. I am confident in being able to learn independently in this area. (8)
- f. I am confident in identifying and analysing issues relevant to this subject. (9)



- g. I am able to apply relevant knowledge and skills in this subject. **(3, 7, 8)**
- h. I have satisfactorily achieved all the learning objectives in this subject.

**(1, 3, 8, 9)**

E. Online Learning –

- a. My tutor/s made sufficient use of BEnet. **(4)**
- b. My tutor/s effectively facilitated my learning on BEnet. **(4)**
- c. The BEnet discussions were useful in supporting my learning. **(5)**
- d. Basecamp gave me greater control over my work. **(8)**
- e. Basecamp improved communication between team members. **(5, 6, 7)**
- f. Basecamp enhanced information sharing. **(5)**
- g. Basecamp improved coordination among the project team members.

**(5)**

F. Learning Trigger Design –

- a. The Learning Trigger was challenging but achievable. **(2)**
  - b. The Learning Trigger encouraged me to critically reflect and analyse.
- (2, 9)**
- c. The Learning Trigger was relevant to the learning outcomes of the subject. **(1, 2)**
  - d. The Learning Trigger was interesting and motivated me. **(2, 3)**

G. General Issues –

- a. I get timely feedback on the work I do. **(4)**
- b. The workload in this subject is reasonable.
- c. The expectations of this subject are set at a reasonably high standard.

**(6, 7)**

CEQ	Guiding Principles								
	1	2	3	4	5	6	7	8	9
A – The Subject		✓	✓	✓			✓	✓	✓
B - Teaching Approach & Support	✓	✓	✓	✓			✓	✓	✓
C - Tutor & Tutorials			✓	✓		✓	✓	✓	✓
D – Perceived Outcomes	✓		✓			✓	✓	✓	✓
E – Online Learning (Tools)				✓	✓	✓	✓	✓	
F - Problem/Trigger Design	✓	✓	✓						✓
G – General Issues				✓		✓	✓		

**Table 6: Guiding Principles - CEQs**

As can be seen in Table 6 the Guiding Principles are addressed through the CEQs.

### **5.3 Iteration 1 – Scaffolding (2007 -2008)**

#### **5.3.1 Design Narrative**

In mid 2007 the BEDP was using an eLearning platform called ‘Flexicomm’. The functionality offered by the platform was minimal. It included a notice board, folders for course materials, a very basic discussion forum without nested threads, and assignment upload. There was no consistency to the organisation of materials or layout across subjects.

While the degree program used a PBL approach this was not reflected in the setup of the eLearning platform. The layout was chaotic and the platform was used mainly as a content repository with some limited discussion forum use. Flexicomm

was being used to supplement what was in effect a fully on campus delivered program.

At this time many subjects were still in the process of being written. Informal discussions with tutors and subject writers indicated that while they were aware that the chosen educational approach was to be PBL they tended to approach subject development from a content development perspective.

Student feedback through the Student Course Evaluation Questionnaires showed that while they found the course interesting and rewarding, students wanted more structure and guidance and greater use of the online Flexicomm eLearning platform by tutors.

### **5.3.2 Design Issues**

Design issues were identified drawn from on ongoing discussions with tutors, the students' feedback and the researcher's extensive experience in educational design. An activity system model was created to reflect these issues and identify contradictions in the activity system that needed to be addressed.

These design issues were:

- Lack of alignment of the setup of Flexicomm with PBL processes
- Subject design (writers) needed to reflect a PBL approach
- Additional structure, scaffolding and guidance was required for learners

### 5.3.3 Iteration 1 Activity System Model

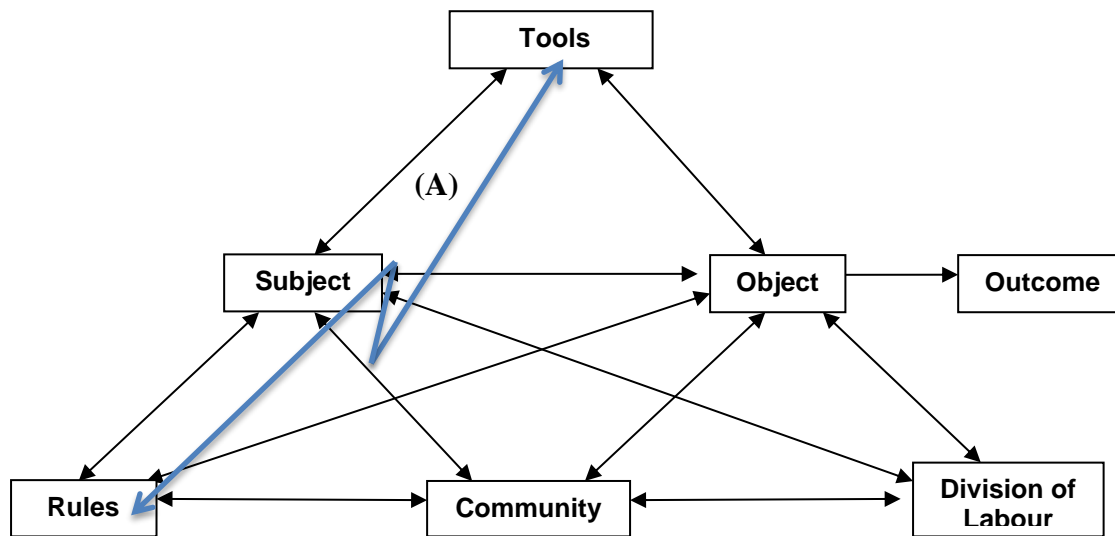


Figure 14: Activity System Model for Iteration 1

As Figure 14 illustrates, contradictions (A) – PBL process (Rules) and eLearning platform (Tools) setup, and subject design, were not aligned. This non-alignment placed additional unnecessary cognitive stress on learners.

### 5.3.4 Design Interventions

Subject layout on the Flexicomm eLearning platform was gradually revised to reflect PBL process across all subjects (see Figure 15).

A pilot for the new model was implemented in Trimester 2, 2007 with the subject LSD363 – Large Scale Mixed Use Sustainable Development and was subsequently used as a basis for redesign of all subjects on FlexiComm. This model

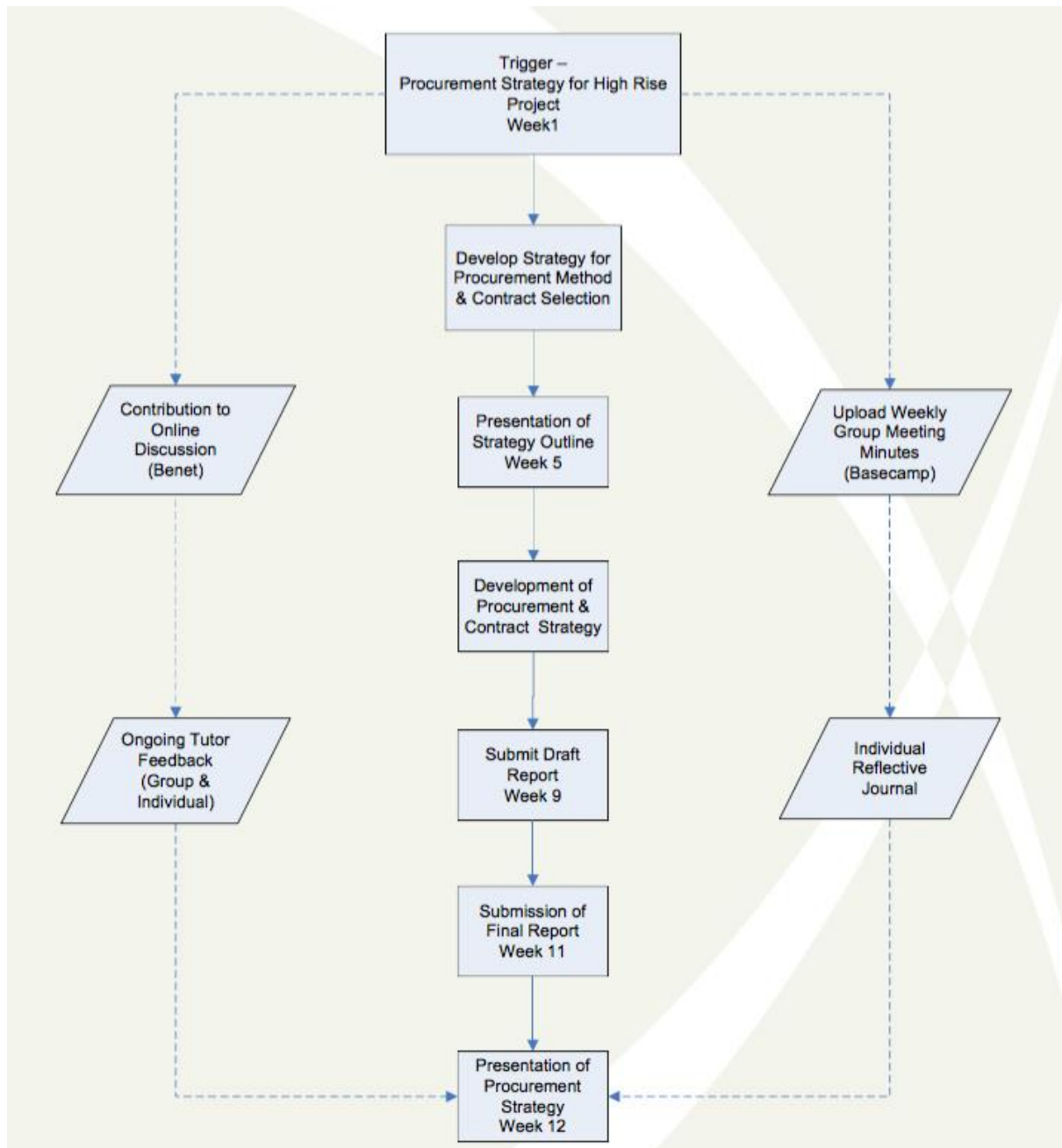
- Supported PBL process
- Increased communication with students through Discussion forums and Notices
- Provided easy access to Learning Trigger & Learning Materials

Learning Group	Resources	Notices	Discussion	Quiz	Assignments	Documents
<b>Current folder:</b> Large Scale Mixed-use Sustainable Development						
Search            Add file            Add link            Add folder            Import Third Party Content						
This folder contains <b>5 resources</b> . You are viewing resources 1 to 5.						
	<b>1. Introduction to LSD363</b> Folder (3 Items)				<b>Available until:</b> 17 Dec 2007, 09:30 AM	<a href="#">Modify</a> <a href="#">Delete</a>
Folder Contains: 1. Introduction to LSD363, 2. Subject Outline and, 3. Bibliography and References						
	<b>2. LSD Learning Trigger</b> Folder (3 Items)				<b>Available until:</b> 17 Dec 2007, 09:31 AM	<a href="#">Modify</a> <a href="#">Delete</a>
	<b>3. LSD Learning Materials</b> Folder (8 Items)				<b>Available until:</b> 17 Dec 2007, 09:29 AM	<a href="#">Modify</a> <a href="#">Delete</a>
	<b>4. Project Support Materials</b> Folder (6 Items)				<b>Available until:</b> 17 Dec 2007, 09:37 AM	<a href="#">Modify</a> <a href="#">Delete</a>
	<b>5. LSD Assessment Requirements &amp; Schedule</b> Folder (1 Items)				<b>Available until:</b> 17 Dec 2007, 10:34 AM	<a href="#">Modify</a> <a href="#">Delete</a>

**Figure 15: Flexicomm interface**

### *Student Learning Process Maps*

Student Learning Process Maps (SLPM) were also gradually developed for all subjects (see Figure 16). The SLPM shifted focus from the content to the Learning Trigger and activities leading to development and submission of a solution. Content was seen as supporting this process and not the central focus of the learning process.



**Figure 16: Student Learning Process Map (SLPM)**

### *Subject Development Process*

The SLPMs were also implemented as a central part of the writer's subject development process. Focus then shifted from content development to subject development driven by activities and tasks and the problem based learning process. This was integrated into the subject writers' contract as a three stage development

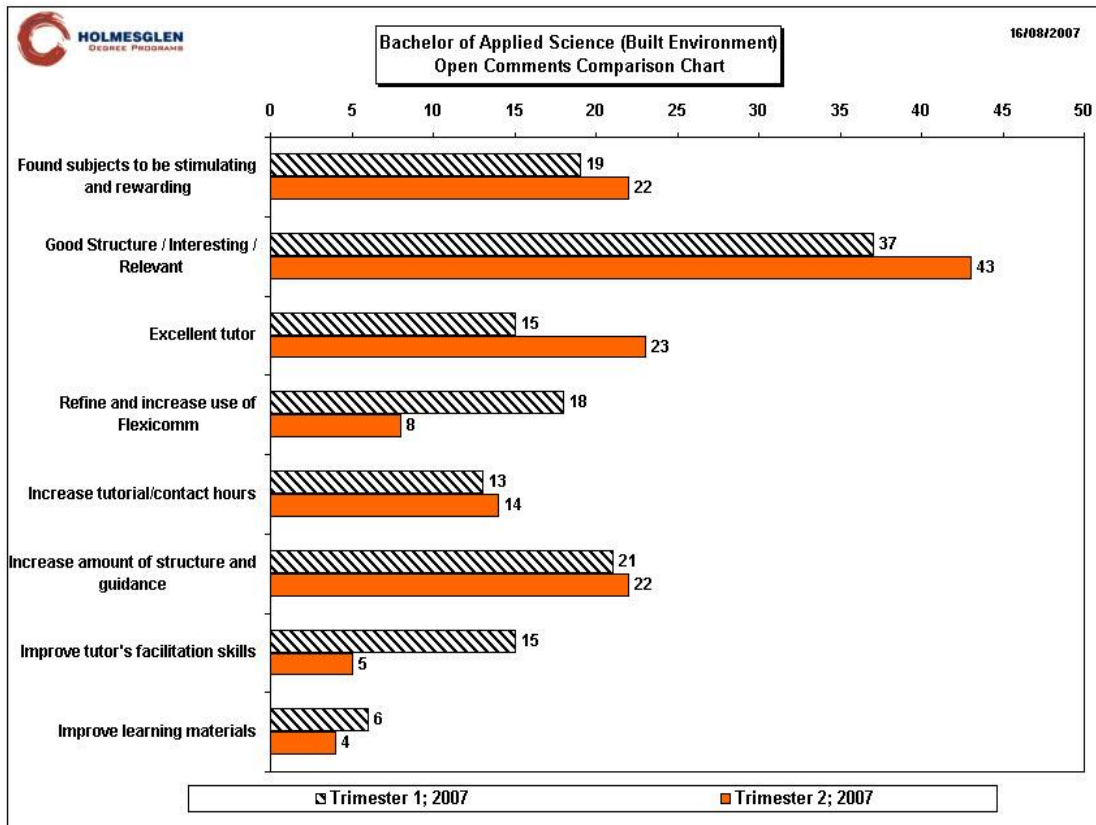
process with feedback from the course leader on completion of each stage and prior to payment to the subject writer for each stage. This process is shown in Table 7.

<b>Stage 1 Proposal (Delivery date).....</b>
<ul style="list-style-type: none"> <li>• Subject Workflow (SLPM identifying sequence, flow, topic folders &amp; links)</li> <li>• Outline of Triggers, Activities &amp; Assessment Items</li> <li>• Overview of delivery Strategy and Coverage (to be reconciled with Curriculum Map to ensure that all learning objectives are addressed)</li> </ul>
<b>Stage 2 Draft Submission (Delivery date).....</b>
<ul style="list-style-type: none"> <li>• Content outlines/descriptions</li> <li>• Learning Triggers</li> <li>• Readings for each of the topic folders</li> <li>• Developed Assessment Items</li> </ul>
<b>Stage 3 Final Submission (Delivery date).....</b>
<ul style="list-style-type: none"> <li>• Finalised version</li> </ul>

**Table 7: Subject Writer's Stages & Deliverables**

### **5.3.5 Data and Analysis**

After initial implementation of the changes, feedback from students began to show a gradual shift when comparing open comments for Trimester 1, 2007, with Trimester 2's open comments.

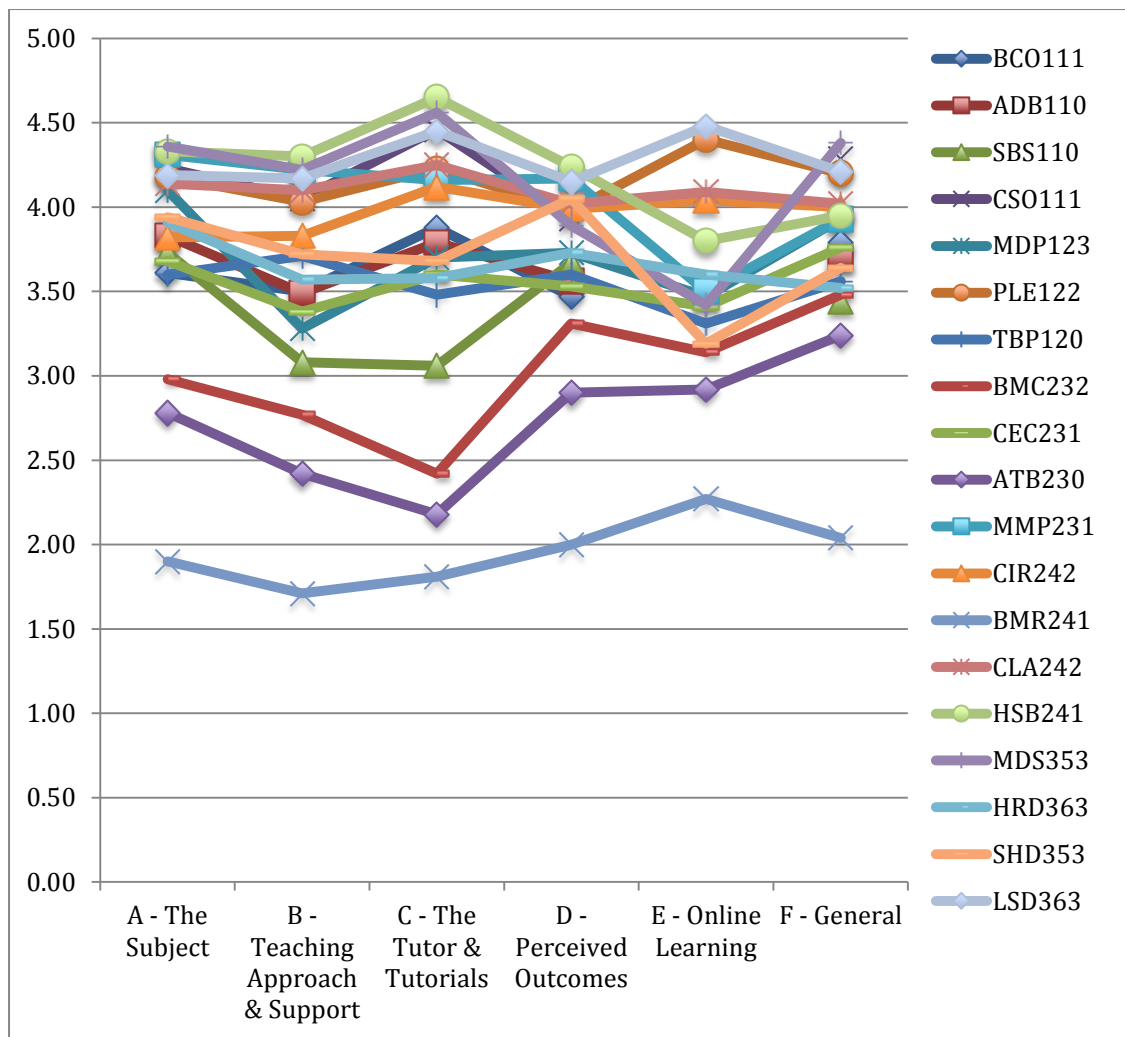


**Figure 17: CEQ open comments 2007**

Figure 17 shows there was an increase in the number of students commenting that the subjects had a good structure and that tutors were excellent. There was also a substantial decrease in the number of those asking for refinement and increased use of Flexicomm, and for improvement in tutors' facilitation skills.

A comparison between the CEQ results for 2007, graphed in Figure 18, and those for 2008, shown in Figure 19, showed that this shift continued as all subjects across the BEDP were gradually revised to reflect the new model. See Appendix 3 for full subject names and codes.





**Figure 18: CEQ results 2007**

The broad spread of responses on the 5 point Likert scale (y-axis) found in the 2007 CEQ results, in Figure 18, was replaced in the 2008 CEQ results by a tight band of results with most subjects between 3.5 and 5.00 in Figure 19.

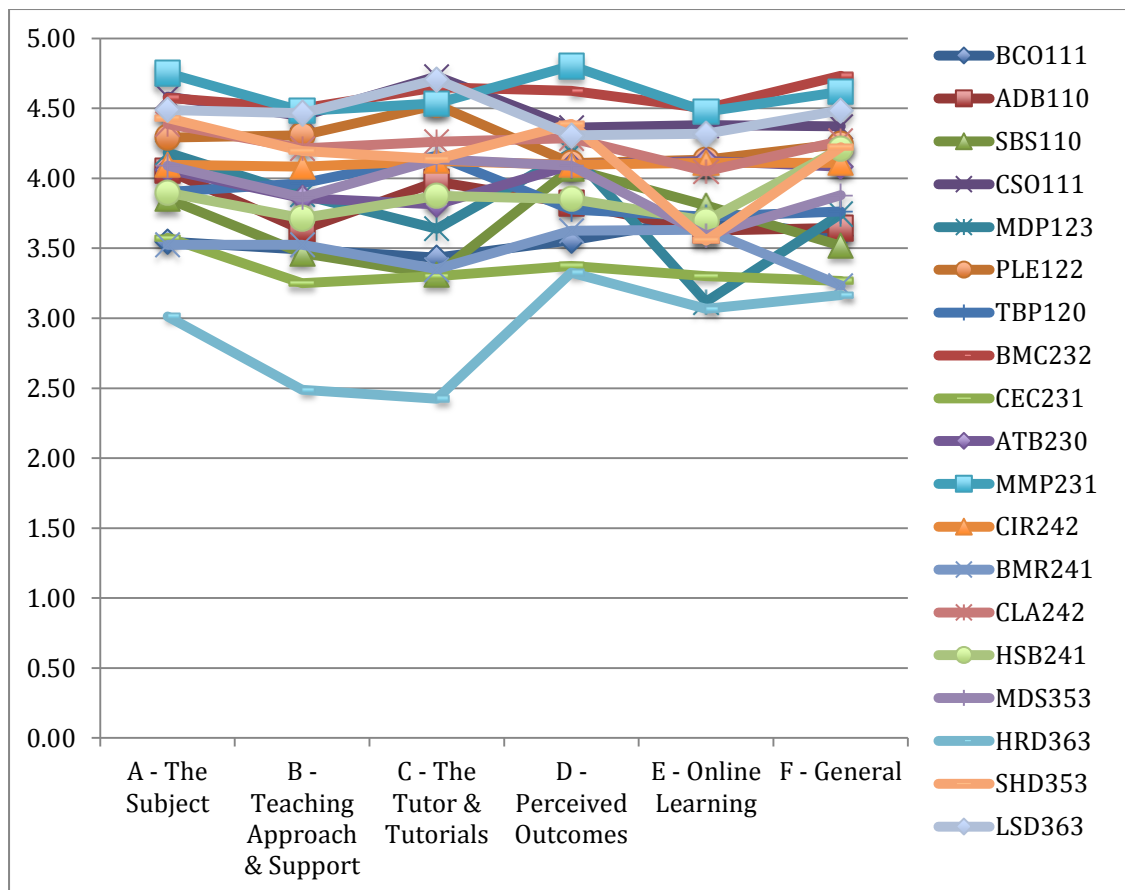


Figure 19: CEQ results 2008

### 5.3.6 Discussion

The guiding principles were reflected in the implementation of the following interventions in Iteration1:

- Restructure of Flexicomm interface
- Student Learning Process Maps
- Three Stage Subject Development Process

There are many aspects of a curriculum ecosystem design that need to be considered and aligned, as shown in the activity system model. When this alignment

is achieved the overall learning process and educational experience is scaffolded and enhanced.

## **5.4 Iteration 2 – Basecamp (2008 – 2009)**

### **5.4.1 Design Narrative**

The development of effective teamwork skills through collaborative group work is an integral part of the Built Environment Degree Programs (BEDP). Such skills are highly valued and expected in the building and construction industry. Time management, establishing and maintaining productive group processes, and the nurturing of effective interpersonal skills, are ongoing challenges for all those involved in such group work.

Students in BEDP began asking for an online space to work on their group assignments. However Flexicomm, the platform used at the time, with its very basic areas for learning materials and simple discussion board did not have the functionality to provide such a space.

### **5.4.2 Design Issues**

The following Design issues were identified following ongoing discussions with tutors and student feedback. An activity system model was created to reflect these issues and identify contradictions in the activity system that needed to be addressed.

- poor time management by group members

- tutors unsatisfactorily assessing the group and individual contributions due to lack of transparency of group dynamics
- identifying 'free – riders' within groups

### 5.4.3 Iteration 2 Activity System Model

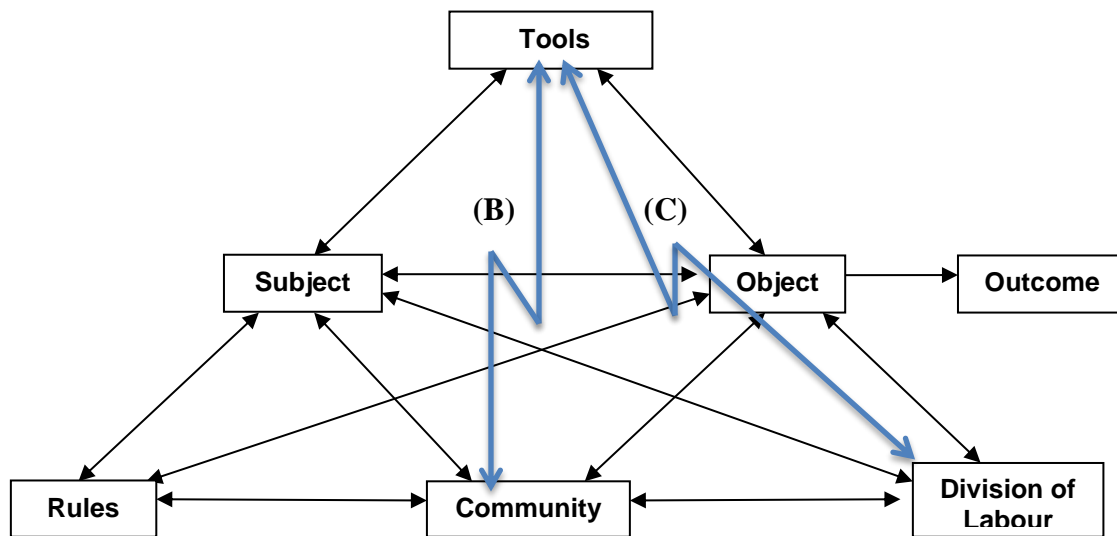


Figure 20: Activity System Model for Iteration 2

AS Figure 20 illustrates, contradictions (B) & (C) – Tools provided did not address the poor communication between group members, lack of transparency of task allocation and monitoring of progress, support self organisation, or enable the identification of those who engage and contribute to the group work and those who do not.

### 5.4.4 Design Interventions

To make the group processes more transparent, to support effective time management, and self organisation, a range of additional functions was required. To

address these issues Basecamp, a web-based project management solution, was piloted in four subjects across Trimesters 2 & 3 in 2008.

As was noted above, Basecamp provided the additional functions required with an intuitive interface. It is a user friendly web-based project management solution designed for industry. An example is shown in Figure 21.

Basecamp provides To-Do lists and Task Allocation, Milestones, File sharing and integrated Messaging. It was also possible with Basecamp to provide each group with a private project workspace with all this functionality.

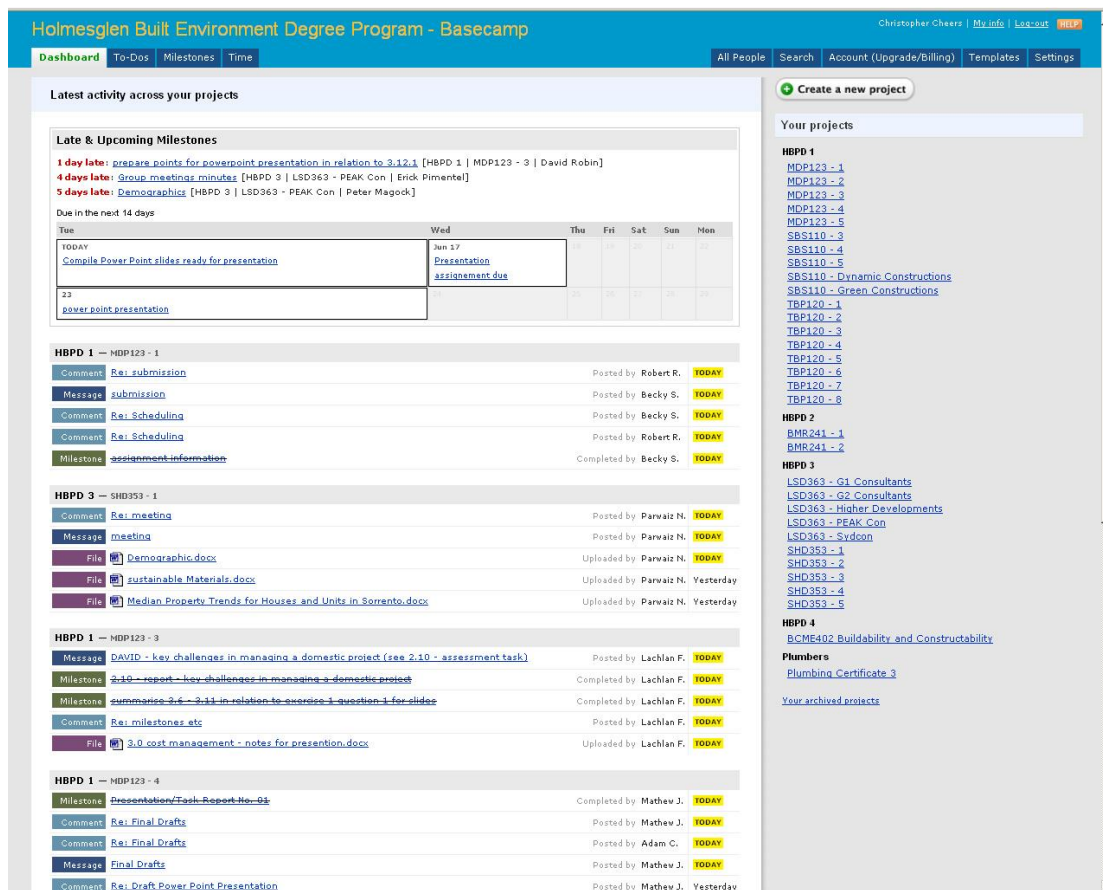


Figure 21: Basecamp interface

A pilot implementation of Basecamp was conducted across two Trimesters in 2008 for evaluation purposes.

- Trimester 2
  - ATB230 – Anatomy of a Tall Building
- Trimester 3
  - BMR241 – Building Maintenance and Refurbishment
  - CIR242 – Community and Industrial Relations
  - LSD363 – Large Scale Mixed-use Sustainable Development

It was intended that only two subjects would use Basecamp in Trimester 3 however the second year students asked for it to be used in both BMR241 and CIR242, which was done. Evaluation surveys were conducted on completion of the Trimesters.

#### **5.4.5 Data & Analysis**

Basecamp was used over the two trimesters with three Tutors and 51 Students.

Tutor feedback on Basecamp was very positive:

"From a tutor's point of view it is extremely beneficial as you can monitor the progress of the group and identify individual contributions."

Student comments included:

"Great tool to work with ... when working in groups you can see each other and communicate with them and upload files very easily"

"The best thing about Basecamp is the ability to check on the progress of an assignment '24-7'. This is great as it will fit in with everyone's schedule"

“High achievers do not have to hold back in their contributions, their efforts are now visible”

“Weaker team members can benefit from observing the work habits and processes of others”

“Slackers become very visible”

"I think it would help all my classes with group work."

Benefits of using Basecamp identified by students included:

- Transparency of who communicates/contributes
- Easy sharing of files between team members
- Integration with personal email
- Ease of use
- Individual student strengths are visible

Trimester 2 student survey results, on a Likert scale of 1-5, rated Basecamp:

- Impact on my performance 3.97
- Functionality 4.25
- Ease of Use 4.50

One point that was raised is reflected in a comparison of Trimester 3 survey results for LSD363, where all assessment submissions are group based, and CIR242, where assessments are individual submissions. It became evident and re-enforced that Basecamp is best suited for group work.

		Subject	LSD363	CIR242
<b>A) PERFORMANCE IMPACT: Basecamp ...</b>			<b>SCORES</b>	<b>SCORES</b>
<b>A1</b>	Enabled me to accomplish my tasks more effectively.		<b>4.33</b>	<b>3.55</b>
<b>A2</b>	Improved my work performance.		<b>4.08</b>	<b>3.64</b>
<b>A3</b>	Increased my productivity.		<b>4.25</b>	<b>3.64</b>
<b>A4</b>	Improved the quality of my work.		<b>3.75</b>	<b>3.45</b>
<b>A5</b>	Gave me greater control over my work.		<b>4.00</b>	<b>3.27</b>
<b>A6</b>	Improved communication between team members.		<b>4.58</b>	<b>3.91</b>
<b>A7</b>	Enhanced information sharing.		<b>4.75</b>	<b>3.82</b>
<b>A8</b>	Improved coordination among the project team members.		<b>4.33</b>	<b>3.55</b>
<b>Overall Average for A</b>			<b>4.26</b>	<b>3.60</b>
		Subject	LSD363	CIR242
<b>B) FUNCTIONALITY</b>			<b>SCORES</b>	<b>SCORES</b>
<b>B1</b>	Basecamp provided the functionality that I need.		<b>4.08</b>	<b>3.27</b>
<b>B2</b>	I found the Overview useful.		<b>3.92</b>	<b>3.55</b>
<b>B3</b>	I found Messages useful.		<b>3.92</b>	<b>3.64</b>
<b>B4</b>	I found the To-do Lists and Task allocation useful.		<b>4.25</b>	<b>3.55</b>
<b>B5</b>	I found the Milestones useful.		<b>4.08</b>	<b>3.55</b>
<b>B6</b>	I found the File upload useful.		<b>4.50</b>	<b>3.82</b>
<b>Overall Average for B</b>			<b>4.13</b>	<b>3.56</b>

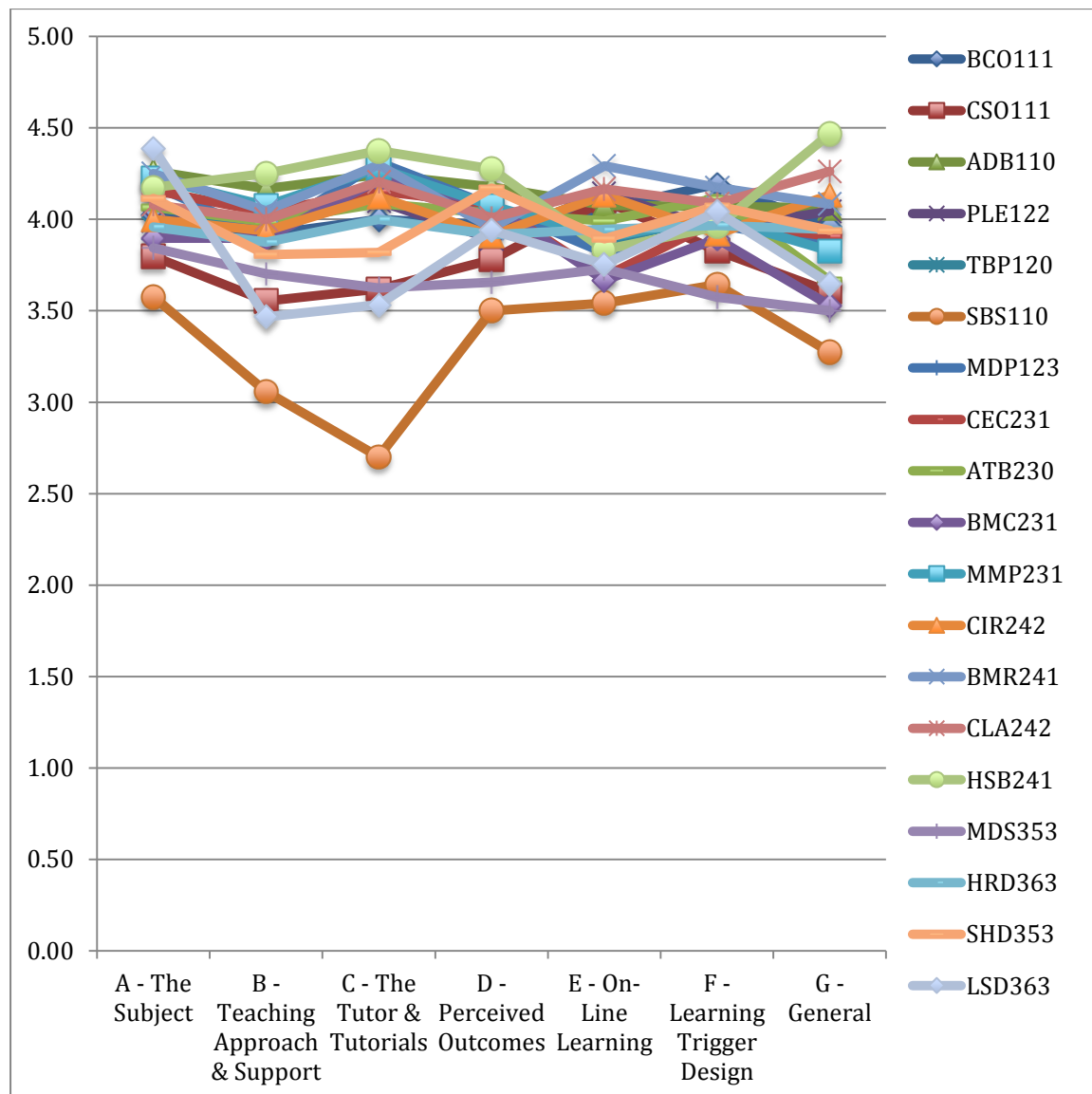
		Subject	LSD363	CIR242
<b>C) EASE OF USE: I found Basecamp to be ...</b>			<b>SCORES</b>	<b>SCORES</b>
<b>C1</b>	Easy to use.		<b>4.33</b>	<b>3.73</b>
<b>C2</b>	Easy to learn.		<b>4.42</b>	<b>3.91</b>
<b>C3</b>	User friendly.		<b>4.25</b>	<b>3.55</b>



<b>Overall Average for C</b>	<b>4.33</b>	<b>3.73</b>
<b>Subject</b>	<b>LSD363</b>	<b>CIR242</b>
<b>Overall Average for Basecamp</b>	<b>4.24</b>	<b>3.63</b>

**Table 8: Basecamp Student Evaluation Questionnaire Results for Trimester 3, 2008**

CEQ results for 2009, shown in Figure 22, when Basecamp was implemented for all group work showed a continuing strong positive response from students.



**Figure 22: CEQ results 2009**

The dip with the Subject SBS110 was due to an individual tutor's approach, which was subsequently addressed. The other aspects of the subject however were similar to the overall results.

#### **5.4.6 Discussion**

Basecamp proved to be a valuable asset in the range of tools used to support the BEDP. Its strength was perceived as being in the management of group work, and the scaffolding of related processes central to working in a team. Stronger and weaker team members were afforded opportunities to enhance their respective capacities, and the increased visibility of individual contributions made it more likely that students would contribute, given this heightened personalised accountability for such contributions. Basecamp's greater utility for group work than for individual submissions was a timely reminder that particular technologies are often more suited to some learning and teaching tasks than to others.

### ***5.5 Iteration 3 – Moodle (2009, 2010, 2011, 2012)***

#### **5.5.1 Design Narrative**

There were a progressively growing number of students who wanted to study from a distance. This situation meant that eLearning tools would no longer be just a supplement to face to face classroom based interaction. They were becoming the only means of communication and engagement in the learning process for an increasing number of students. As the BEDP continued to evolve through the

iterations into a curriculum ecosystem there was a need to anticipate the increasing demands and sophistication required of a central eLearning platform.

While Flexicomm was a user-friendly online learning platform its limited range of functions was undermining further development and support of the learning process. The discussion forums were very basic and tended to limit rather than encourage student engagement in discussion and interaction online.

### **5.5.2 Design Issues**

Design issues were identified drawing on ongoing discussions with tutors, student feedback and the researcher's extensive experience in educational design. An activity system model was created to reflect these issues and identify contradictions in the activity system that needed to be addressed. The issues were as follows:

- Limited communication support
- No central calendar function to support time management
- No quiz function to support self study
- No Messaging function
- Limited functionality for submission of assignments
- Limited functionality for providing feedback to student submissions
- Limited range of methods for organising materials & activities

### 5.5.3 Iteration 3 Activity System Model

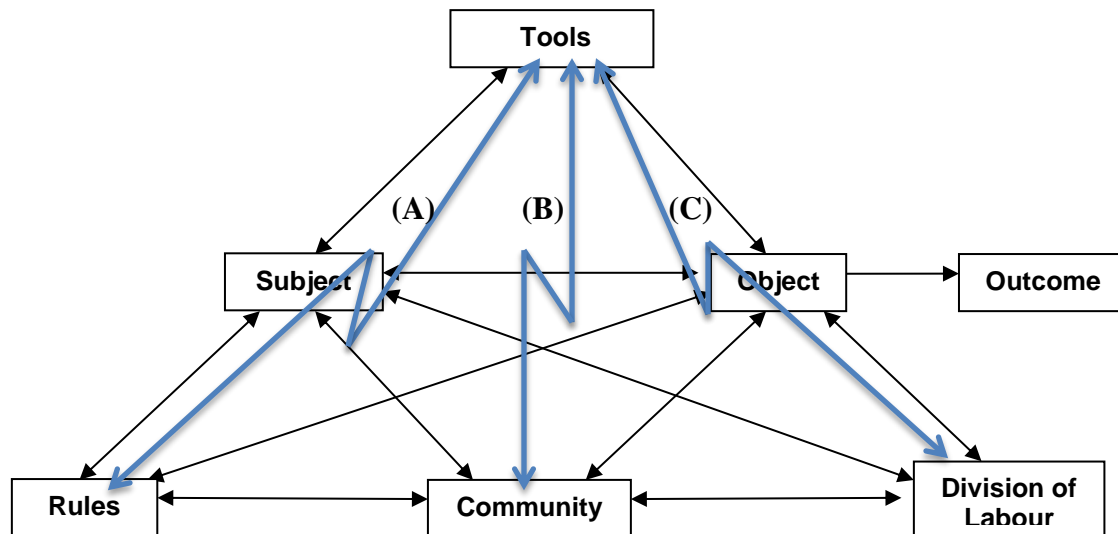


Figure 23: Activity System Model for Iteration 3

As illustrated in Figure 23, contradictions (A), (B), (C) – the Flexicomm elearning platform did not provide the necessary tools to effectively facilitate effectively fully online interaction across the evolving BEDP curriculum ecosystem.

### 5.5.4 Design Intervention

Moodle was identified as a possible solution. Moodle was developed to support a social constructivist approach to educational practice where knowledge is seen as being individually constructed and socially co-constructed by learners. It was therefore very well suited to supporting the problem based learning approach used across the Built Environment Degree Programs (BEDP).

Moodle was gradually implemented across the BEDP. Initially fourth year specialisation subjects were moved across to Moodle for Trimesters 2 and 3, 2009. On completion of each Trimester feedback was gathered from tutors, and student

course evaluations conducted. These showed a positive response. Then all the BEDP subjects were migrated across to Moodle from Flexicomm with full implementation in Trimester 1, 2010. The BEDP Moodle instance was branded as 'BEnet'.

Moodle provided the following:

- Discussion forums, messaging & notices
- Learning materials and resources
- Assignment submission & feedback
- Grade Book
- Integrated calendar
- Quizzes
- Linking to user's personal email
- User usage statistics

The BEnet interface was customised to reflect the problem based learning process and this design was used, with only minor variations, across all the BEDP subjects. This strategy minimised the need for training tutors and students as the interface was very intuitive and user friendly. An example can be seen in Figure 24.

The screenshot displays the BEnet interface for the course ABS481. At the top, the HolmesGlen logo and BEnet branding are visible, along with a user login status: 'You are logged in as Admin User: Student (Return to my normal role)'. The main content area is titled 'Outline' and contains a welcome message and a list of seven topics, each with associated readings and discussions. The right-hand side features a calendar for June 2009, a Learning Commons section for finding books and articles, a Latest News section with a recent post from Stephen Simonello, and an Upcoming Events section listing two triggers. A Recent Activity section is also present at the bottom right.

Figure 24: BEnet interface

### 5.5.5 Data & Analysis

In evaluating the BEnet pilot tutor feedback was very positive. One tutor commented that “The students found this program easy to use and contribute to on-line discussions and forums. BEnet allowed for flexibility within the learning environment and greatly enhanced the communication of students. BEnet, allowed the tutor to send messages directly to students to inform them of their progress or any special requirements for the subject.”

Student comments included this comment, “BEnet is connected to our emails and the email notifications are very useful for constant communication with tutor/students.” Another student said “The best thing about this subject was being able to complete majority of work via BEnet ... enables me to manage full time work & study.”

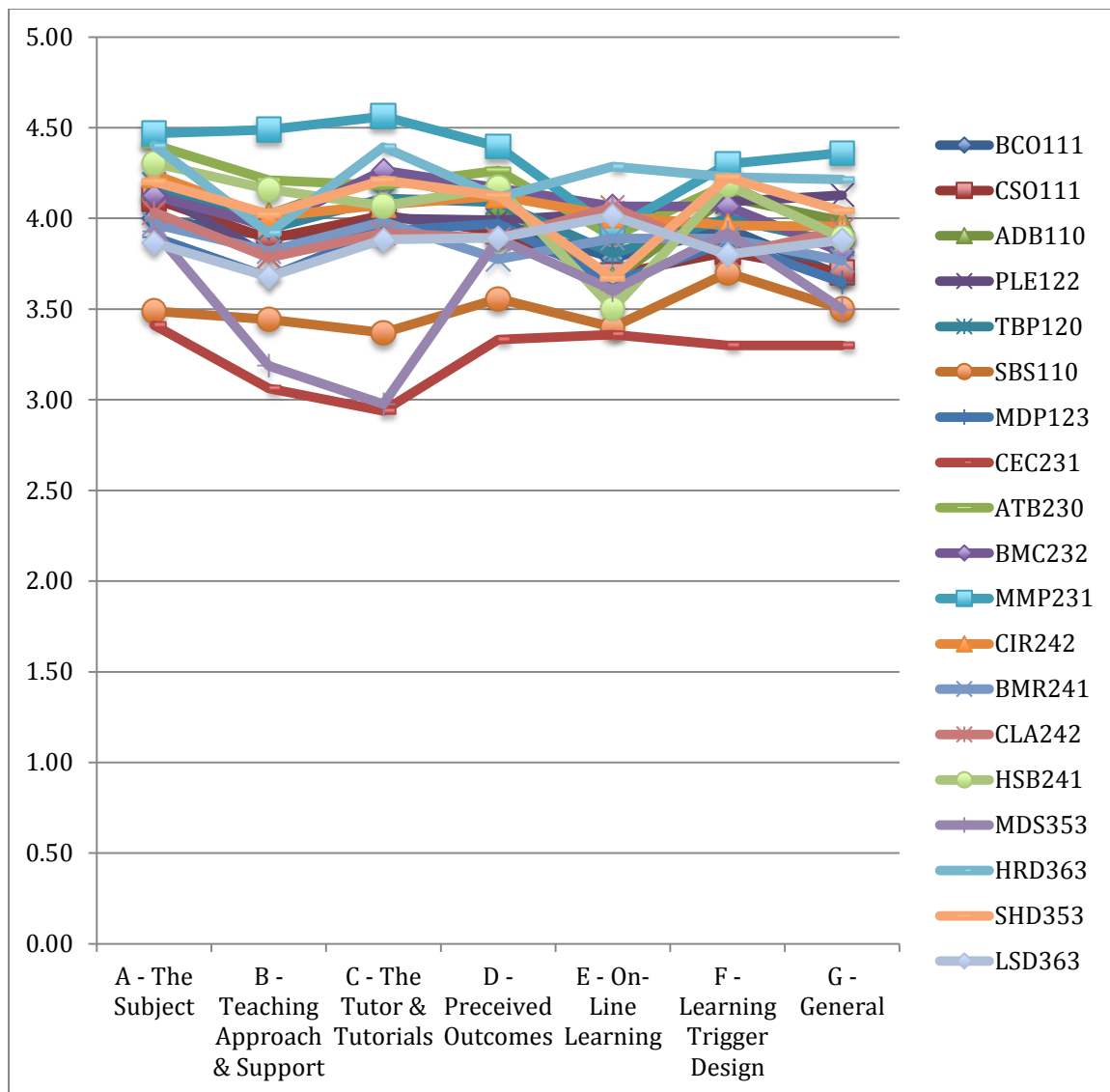
Trimester 2 student survey results for the BEnet - Online Learning section of the survey for the following subjects, on a Likert scale of 1-5, were:

- ABS480 - Advanced Building Surveying - 4.72
- BFM403 - Intelligent Services and Space Usage - 3.71

Trimester 3 student survey results were:

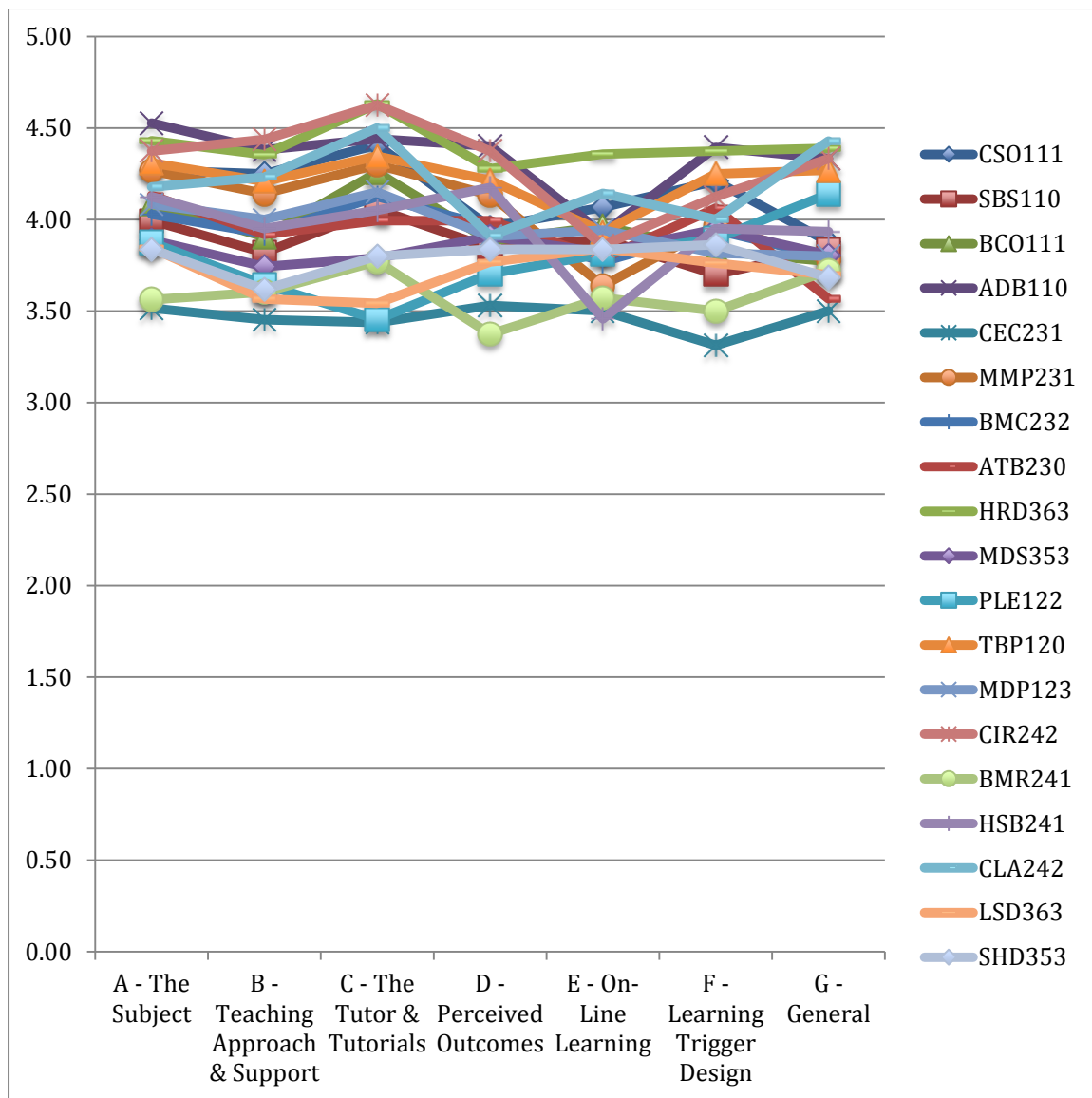
- RAM480 – Risk Assessment and Management - 4.88

The CEQ results for 2010, shown in Figure 25 and for 2011, shown in Figure 26 show a gradual shift to a tighter band of responses between 3.5 and 4.5 on the Likert 5 point scale. This shift reflected the implementation of Moodle.



**Figure 25: CEQ results 2010**





**Figure 26: CEQ results 2011**

As shown in Figure 27 this trend continued in 2012 except for one subject, ADB110, where there were issues with lack of support through BEnet by an individual tutor.

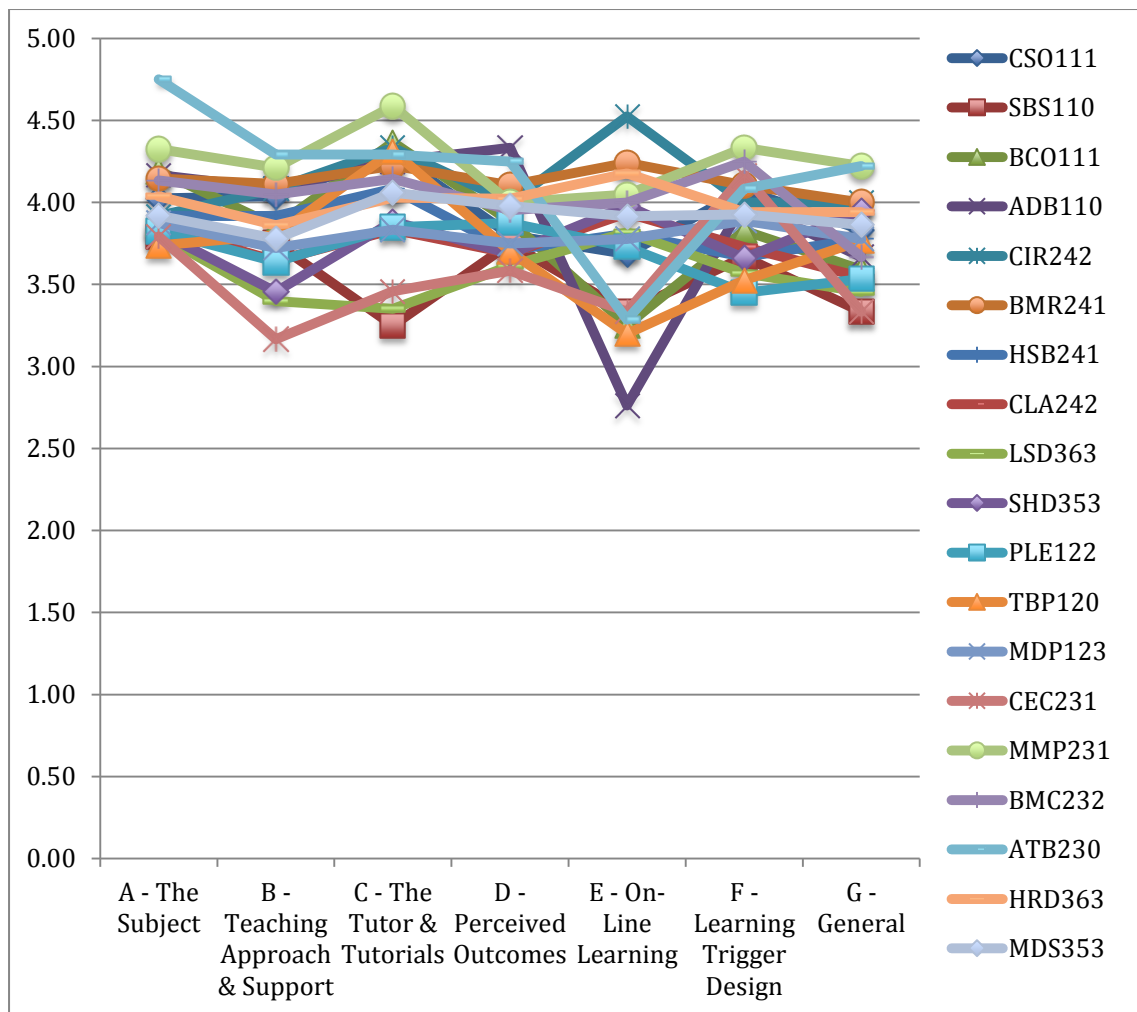


Figure 27: CEQ results 2012

### 5.5.6 Discussion

The implementation of Moodle met the needs of the evolving BEDP curriculum ecosystem in regards to Tools required to support learning. However, it took up to a year after its implementation for many tutors to gradually learn how to make the most of the Tools and to begin to effectively facilitate learning through the systems provided.

## ***5.6 Discussion across Three Iterations***

Gradually over the 3 iterations the learning processes across the BEDP were more effectively scaffolded. The first iteration addressed process, the second iteration addressed collaboration and the third iteration addressed interaction. Students could engage and succeed with their studies irrespective of which space they were working in, physical or virtual. The BEDP became a functioning curriculum ecosystem.

The strong shift in the student demographic to a larger proportion of students wanting to study and complete their degree fully online reflected the effectiveness of the BEDP design. As can be seen in the 'Student Registration by Mode' charts (Figure 28 – 31) there was a shift to where approximately 30% of students were enrolled as off campus students. This shift occurred more strongly with the implementation and refinement of the BEDP Moodle platform BEnet. Indications were that this shift was not necessarily due to geographic distance from the campus. Many students were working either part time or full time and wanted the flexibility provided through the BEDP design.

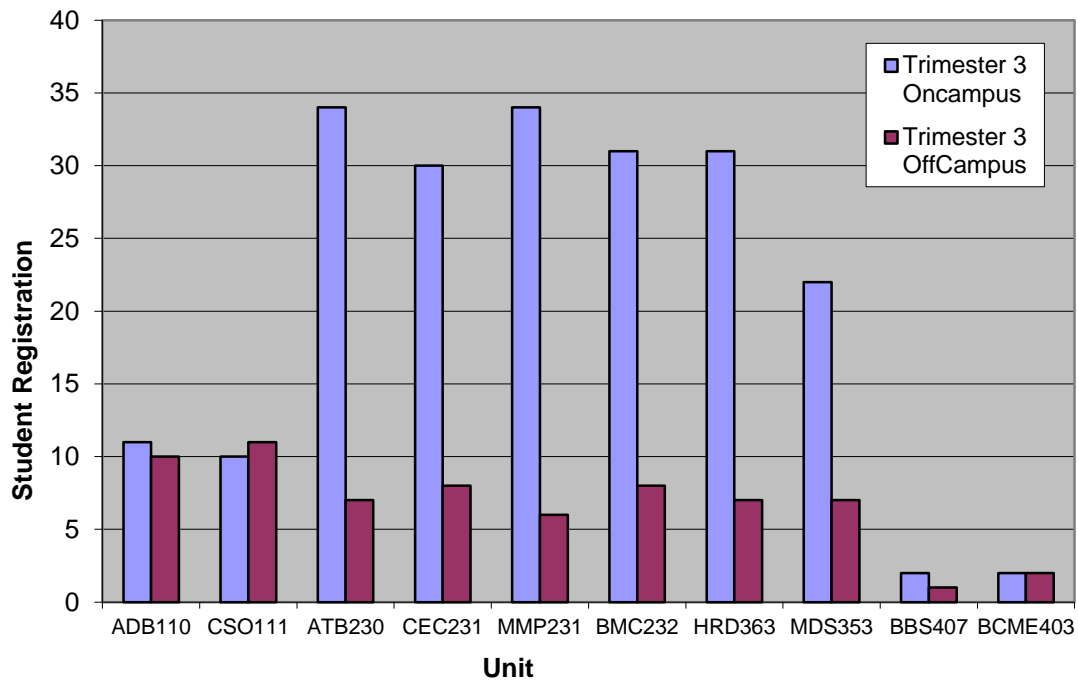


Figure 28: Registration by Mode Trimester 3 2011

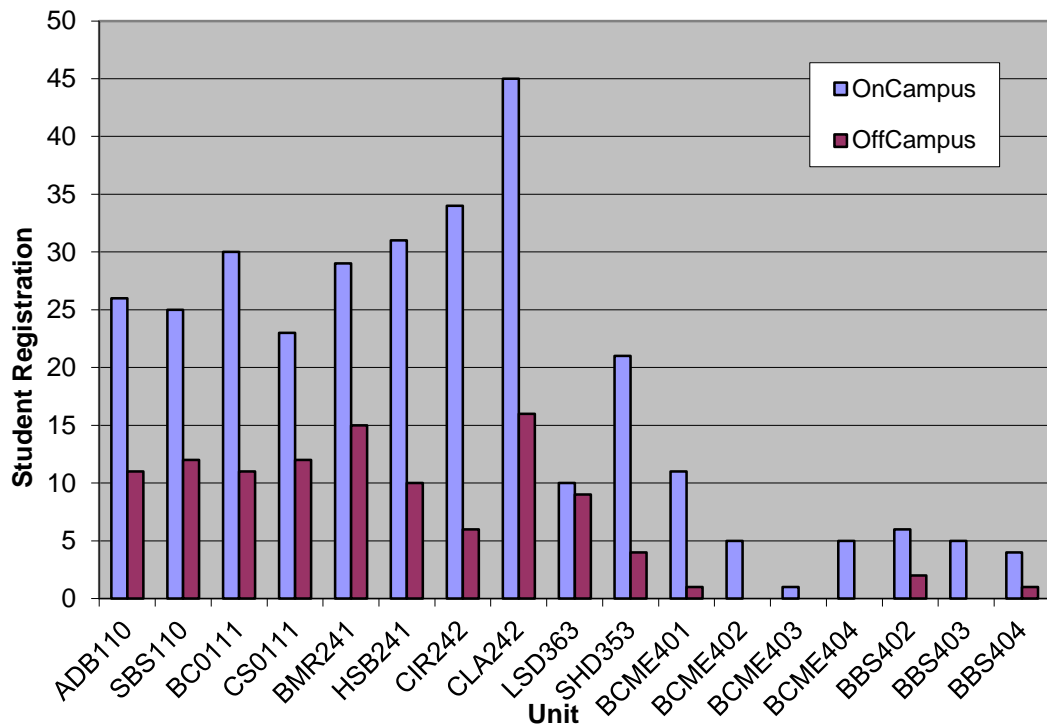


Figure 29: Registrations by Mode Trimester 1 2012

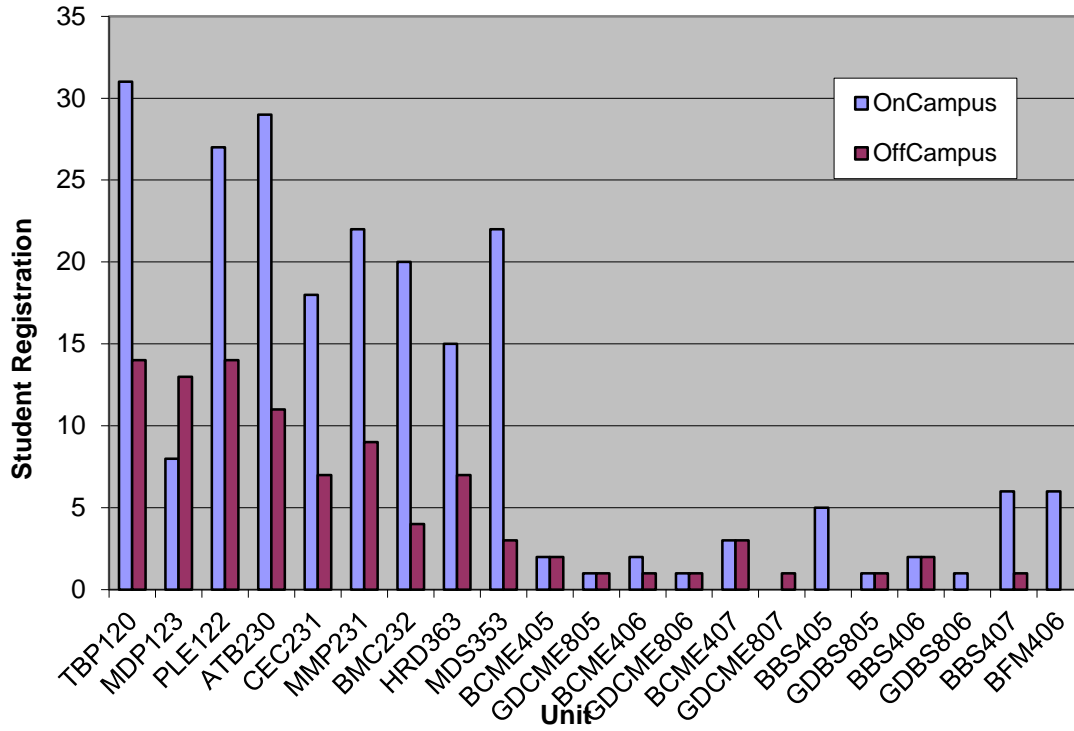


Figure 30: Registration by Mode Trimester 2 2012

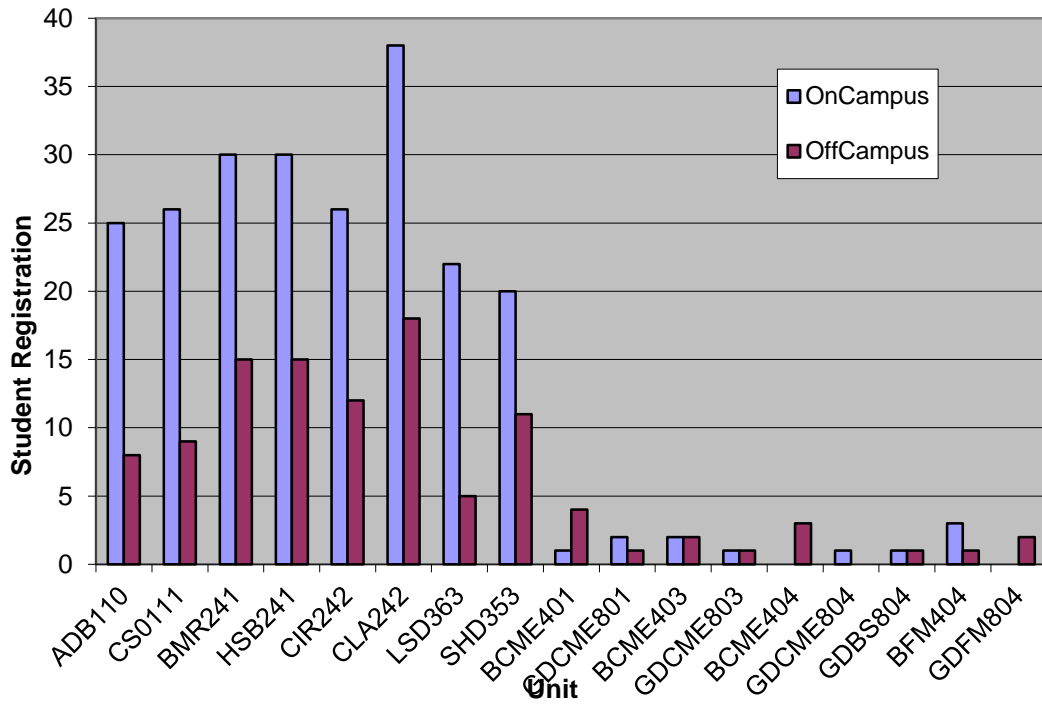


Figure 31: Registrations by Mode Trimester 3 2012

The BEDP had evolved from a classroom based program with some online activity to one where students moved freely between online and classroom sessions. The BEDP was functioning as a curriculum ecosystem.

Feedback from tutors began to tell of students coming to on campus classes only when they felt they needed to; the rest of the time they interacted through the range of tools provided in the BEDP curriculum ecosystem. As one tutor said “An interesting trend that emerged this trimester was the number of local students who enrolled as off-campus students. Of the students who were enrolled as off-campus students in this subject, only one lived interstate. Then interestingly, some of the off-campus students were amongst the most regular attendees at the face-to-face classes!”

As the BEDP curriculum ecosystem evolved there was a move to where place was no more than another tool for learners to use, as and when they needed.

## ***5.7 Tutor Interviews***

Interviews were conducted with seven Tutors in 2010, who were building and construction industry professionals embodying the target culture, to confirm alignment of the iterations and overall design of BEDP with industry requirements, and therefore the target professional culture.

The interviews focused on industry relevance of the design of BEDP, learning trigger design, Information and Communications technology integration within the BEDP, student learning processes and challenges they faced as tutors in the BEDP. The following themes drawn from the interview transcripts were identified, clearly supporting the guiding principles:

### Critical Reflective Practice

- very important and a must in PBL and professional practice
- critically reflect and analyse, if they are able to articulate and process what has happened it means they have understood
- it's really important professionally, it's how we grow and learn
- you need to be able to learn from your experience ... and apply that to the next situation and take it further ... and just keep developing yourself as an individual
- ... carry that knowledge to the next experience

### Industry Relevance / Reflects Culture

- effective communication skills leveraging on a range of methods/modes
- effective problem solving, independent learning and team working skills
- dealing with unforeseen situations (a key competency for construction project managers)

### Student Engagement / Independent Learning / Self Organisation

- effective facilitation - finding the best balance of tutor guidance and independent action by students
- the need for critical reflective practice
- development of necessary knowledge, skills and attitude for working effectively online
- student & tutor expectations - f2f vs online and PBL vs 'spoonfeeding'
- students need to be highly motivated and independent learners
- set up discussion forums with constructive questions that guide their process towards their deliverables

## Problem Design / Learning Triggers

- should disrupt student's world view
- when designing a trigger - identify learning objectives, define keywords, give students and tutor roles, and from there begin writing an encompassing story/scenario
- should be complex and multi-layered
- provide students with a role they can identify with / relate to – 'in a few years I could be doing this'
- should require research to solve
- should be carefully written with the use of appropriate keywords to guide towards the deliverable
- key headings that provide a sense of where they should be heading
- should be authentic, relevant and timely (preferably currently in the news)
- interesting and engaging
- can be a little overwhelming but exciting and challenging
- needs to be challenging but achievable, not too simple
- push them to explore their own capabilities and develop abilities beyond what they think they are capable of
- encompass subject learning outcomes, be developed from the learning outcomes
- problems should become more ill-structured from Year1 to Year 3
- have several possible solutions
- plan your facilitation at the same time as you design the trigger

## Contradictions / Disruptions



- push them out of their comfort zone but not so far that they get lost
- how much disruption is healthy
- how can tutor facilitation moderate this disruption
- how can tutor help students grow through this disruption
- tension in groups – destructive vs creative
- ‘uncertainty’ tolerance

The tutor interviews clearly supported the use and support of problem based learning and critical reflective practice as core to meeting the demands of professional practice in the construction and building industry.

The themes drawn from the Tutor interviews reflect and confirm the Guiding Principles and the iterative development of the BEDP as a curriculum ecosystem.

### ***5.8 Tutor Reports***

Tutor Reports for each subject are submitted on completion of each trimester.

The Tutor Reports gather tutor feedback and perceptions on:

- The delivery strategy used within the context of problem based learning addressing the identified learning objectives for the subject.
- The use of the learning materials integrated into the delivery strategy.
- Students’ learning performance.
- Any other issue relevant to the delivery of the subject.

Tutor Reports were all supportive of the BEDP design and recurring themes included:

- The learning trigger was a real world problem that motivated the students to think and promoted discussion, demonstrated application of the theoretical principles and was effective as an assessment tool.
- BEnet (Moodle) allowed for flexibility within the learning environment and greatly enhanced the communication of students.
- Students who submitted their drafts, completed online exercises and engaged in online discussion did not have any issue successfully completing required tasks or achieving a satisfactory result for their exam.

### **5.8.1 AUQA Audit**

Further recognition of the effectiveness of the program was provided through the Australian Universities Quality Agency AUQA 2011 audit of the Holmesglen Built Environment Degree Programs when it was commented that:

“Examples of good pedagogical practice are also evident in the Faculty of Building, Construction and Architectural Design in the Built Environment degree, where problem-based learning approaches are engaging students and industry in authentic learning. The use of Moodle sites in this program reflects a good problem-based learning design and is an effective pedagogy that supports student learning and uses industry connections very well.”

[http://www.teqsa.gov.au/sites/default/files/auditreport\\_holmesglen\\_2012.pdf](http://www.teqsa.gov.au/sites/default/files/auditreport_holmesglen_2012.pdf) , p12

## **5.9 Findings**

The three iterations in the evolution of the BEDP curriculum ecosystem, the interview responses from tutors with extensive industry experience, and the response of students through the CEQs have confirmed that the guiding principles, which are grounded in the literature, are effective in developing a curriculum ecosystem within the BEDP.

The overwhelmingly positive response from tutors and students has supported the fundamental soundness of the BEDP curriculum ecosystem design, its integrated problem based learning approach and the usefulness of the tools provided to support learning.

### **5.9.1 The Research Questions and Design Framework**

The Research Questions posed at the beginning of the study have been answered as follows:

***What guiding principles for curriculum ecosystem design can be drawn from current literature?***

When designing curricula and the integrated curriculum ecosystem they should:

1. Be an open system that facilitates emergence
2. Use ill-structured, authentic, disruptive, problems as catalysts for inquiry & learning
3. Be learner centred
4. Be tutor facilitated

5. Use a collaborative learning approach
6. Provide experiences that reflect the culture of the profession/discipline
7. Support the interactions, dynamics and flow of processes, and use the tools (cognitive, physical & virtual) that reflect that culture
8. Support self organisation
9. Support critical reflective practice

These Guiding Principles have been confirmed through the design, iterative development and implementation of BEDP as a curriculum ecosystem over six years.

### ***What affordances are central to such an ecosystem?***

The curriculum ecosystem should be designed with affordances that support:

- Connectivity and interaction within social networks that facilitate collaborative learning and problem solving
- Creation and sharing of new knowledge
- Effective management and delivery of individual and team projects within a set time frame

Affordances supporting cognitive architecture, reflecting the target culture, for problem solving, time management and communications, in the form of cognitive tools, information & communications technologies, and project management solutions are central to a curriculum ecosystem.

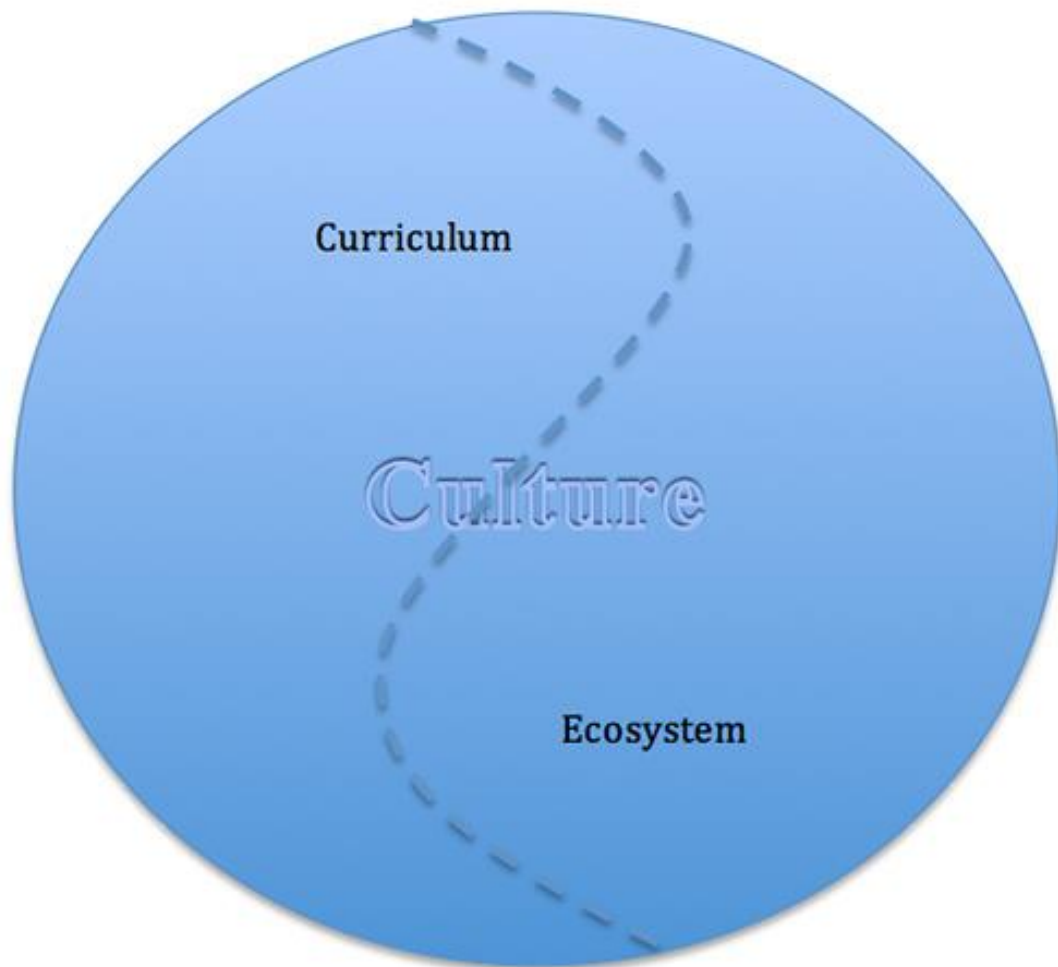
***What Design Framework can be defined through the iterative redevelopment, informed by these guiding principles, of a Built Environment Degree Program as a curriculum ecosystem?***

A design framework (see Figure 33) developed from these guiding principles, informed by feedback from tutors and guided by the conceptual framework drawn from the literature is as follows:

The design of a curriculum ecosystem should include and scaffold:

- Disruptive authentic learning triggers
- Critical reflective practice
- Iterative processes within an evolving complex adaptive system
- Community of Inquiry
- Processes and tools that reflect the target culture
- Curriculum design that reflects and supports all the above

A curriculum should be seen as dynamic, interactive, iterative, evolving, process driven and interdependent with the ecosystem and culture that it reflects (see Figure 32).



**Figure 32: Curriculum & culture**

## **6. Conclusions**

The BEDP Curriculum Ecosystem is an exemplar (Kuhn, 1970; Imershein, 1976) of a Higher Education Curriculum Ecosystem design. Education should be a transformative process. As previously discussed, deep learning is found at the edge of chaos, where there is disruption of individuals' worldviews, where creativity and innovation lives. The world is a web of dynamic complex adaptive systems and students need to be able to respond to constant change within those systems. Educators have to move to a dynamic, learner centred, curriculum design based on

a complexity paradigm, designed for experience and interaction within a complex adaptive system over time. (Doll 2005, 2012; Barab & Roth, 2006; Smitherman, 2005)

In a Higher Education context, learning is an individual experience within a learning community. Such a community no longer needs be bound by temporal or spatial limitations; the world's digital ecosystem has afforded freedom from such constraints. Learners can connect with other people, share ideas and work collaboratively anywhere and at any time. The challenge is to design educational experiences that leverage on the strengths of this ecosystem.

This study has shown how a Higher Education program can be designed for engagement and interaction within a complex adaptive system, supporting learning processes and outcomes that reflect the professional culture of a discipline, in an integrated manner across physical and virtual spaces. With the expanding and evolving integration of digital ecosystems into all aspects of individuals' lives the design of curricula has to evolve to embrace this reality. There should be a greater focus on learner experience, learning trigger design and the scaffolding of educational process across a curriculum ecosystem. Curricula have to be seen as dynamic, interactive, iterative, evolving, process driven and interdependent with the ecosystem and culture that they reflect.

As has been shown in the iterative development of the BEDP Curriculum Ecosystem, it is more meaningful in the digital world to talk about learning spaces as experiential rather than physical or virtual. Curriculum design has to focus on providing educational experiences that have been designed as a true reflection of professional practice in the real world and provide an environment, an ecosystem that supports, and in fact enhances, the evolution and emergence of professionally

relevant attitudes, skills and knowledge in learners facing a 21st century digital world.

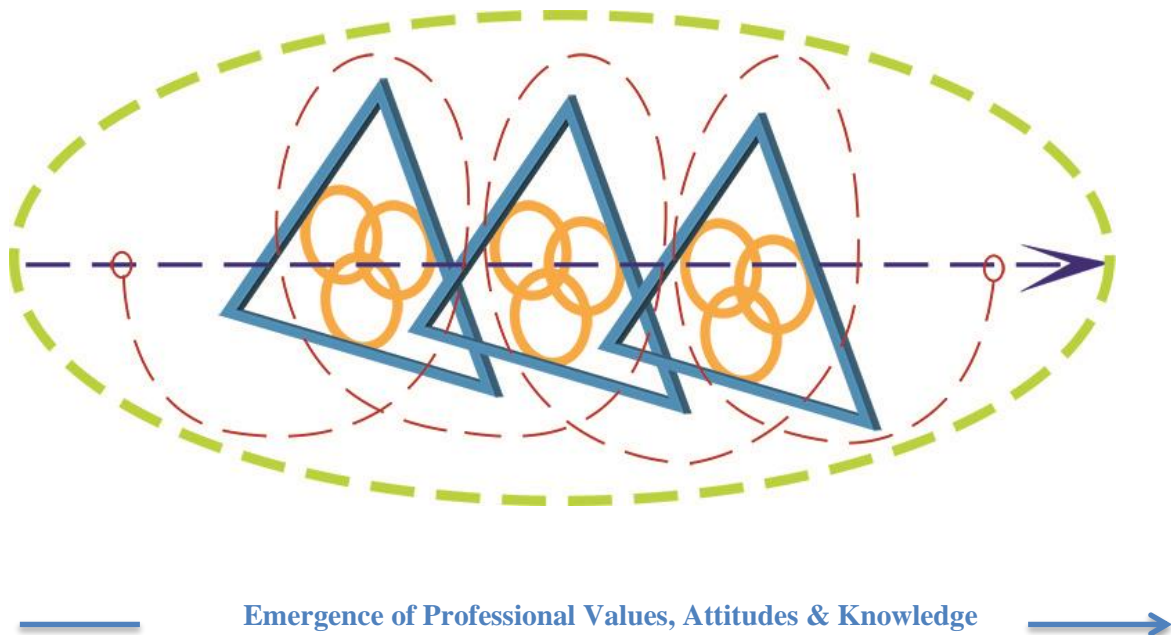
### ***6.1 Contribution to Higher Education Research***

Complexity science provides a new paradigm for curriculum design and complexity concepts provide meaningful descriptors of patterns that emerge in human systems. The development of the BEDP Curriculum Ecosystem exemplar, as described in this thesis, shows how the application of these complexity concepts can be used to build shared mental models to underpin the development of curricula and integrated curriculum ecosystems. Learners are an integral part of a web of complex adaptive systems and as educators have an obligation to prepare their students for the challenges of living and working within such systems.

This thesis extends educational theories through the application of a complexity science lens, describing educational practice as occurring within a curriculum ecosystem and viewing professional practice as an evolving complex adaptive system. This study explores the dynamics of a curriculum ecosystem over time and provides a model for exploring such ecosystems in other disciplines.

Learners traveling in and through such a curriculum ecosystem go through an iterative developmental learning process over time. They engage in a community of inquiry within an evolving complex adaptive system, with engagement based on an authentic context reflecting the target culture, using relevant learning materials, cognitive tools and cognitive architecture, Reflective practice involves feedback loops (critical reflection, feedback from tutors and peers, self organisation, self reflection) triggered by an authentic disruptive problem.





\* Snapshots of evolving Activity System with an embedded Community of Inquiry (PBL process, embedded information & communications technologies and social networking solutions, with supporting learning materials and authentic assessments)

**Figure 33: Curriculum Ecosystem Design Framework**

The design framework as encapsulated in Figure 33, and the BEDP Curriculum Ecosystem exemplar, where learning is initiated by a learning trigger in the form of an authentic disruptive problem, integrated with scaffolded critical reflective practice, self organisation, relevant cognitive tools, and ongoing feedback loops, contributes to an evolving paradigm that can have a meaningful impact on Higher Education (Reeves, McKenney & Herrington 2011).

This thesis shows that curricula can be designed to reflect the dynamics and flow of interactions, the exchange of ideas and negotiation of meaning, and the engagement with others supported in a community of inquiry, within and around a professionally relevant educational experience in a curriculum ecosystem, over time.

An analogy that can be used is that of birds. The current university Higher Education system tends to be like a bird feeder, a linear 'one way' system with students being fed content, when in fact the world for which educators are preparing their students is the opposite of this and reflected more in the movement of a flock birds, flowing, moving in seemingly random patterns, together with purpose. There is a fundamental disconnect.

Learning has to be recognised as a dynamic iterative process. One made up of what can be seen as energies flowing and ebbing, circling together in a complex adaptive evolving ecosystem over time. One that often throws things out of balance, away from equilibrium to a place far from equilibrium, to the edge of chaos, where creation and innovation is found, and back again.

## **6.2 Further Research**

The purpose of this study of the iterative development or evolution of the BEDP curriculum ecosystem is to provide an exemplar of a curriculum ecosystem and a design framework for such ecosystems. It should be seen as foundational research that will contribute to the evolving body of knowledge related to curriculum ecosystem design.

It will be through further research that additional effective exemplars are developed and implemented in other contexts.

Possible areas to focus on for further research could include:

- Application of the guiding principles and design framework to Higher Education programs in other disciplines
- Methods of scaffolding critical reflective practice

- Disruptive learning trigger design
- Impact of student demographic on student performance in a curriculum ecosystem

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# Appendix 1 - CEQ

## COURSE EVALUATION QUESTIONNAIRE

PROGRAM: .....

SUBJECT & CODE: .....

TUTOR: .....

YEAR: .....

TRIMESTER: ...3, 2012.....

### A) THE SUBJECT

<b>A1</b>	<b>I clearly understand the relevance of the subject to my chosen field of studies.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>A2</b>	<b>The requirements of the subject were made clear in the Subject Outline given to me at the beginning of the term.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>A3</b>	<b>The coverage of the subject is intellectually challenging</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>A4</b>	<b>The assessments undertaken in this subject so far are relevant to the set learning objectives</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>A5</b>	<b>The assignments and assessments in this subject have encouraged me to understand and reflect on what I have learnt.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>A6</b>	<b>I have found this subject to be stimulating and interesting.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>A7</b>	<b>I am satisfied with my learning achievements in this subject.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>A8</b>	<b>Overall, I would rate the design and delivery of this subject as:</b>			
Excellent	Very Good	Neutral	Poor	Very Poor
5	4	3	2	1

**B) TEACHING APPROACH AND SUPPORT**

<b>B1</b>	<b>The Problem-based Learning approach in this subject is well organised</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>B2</b>	<b>The learning problem(s)/triggers(s) used in this subject are stimulating and challenging.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>B3</b>	<b>I am able to identify my own learning needs in this subject and satisfy them.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>B4</b>	<b>The learning materials provided are well designed and relevant.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>B5</b>	<b>I am able to use the learning materials to guide and support my learning.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>B6</b>	<b>The tutorial sessions in this subject are useful in helping me learn.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>B7</b>	<b>The tutorial sessions in this subject enrich my learning experience.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>B8</b>	<b>The learning environment encouraged innovation and critical thinking.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

**C) THE TUTOR AND TUTORIALS**

<b>C1</b>	<b>The tutor/s is effective in helping me learn.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>C2</b>	<b>The tutor/s has facilitated a stimulating learning environment.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>C3</b>	<b>The tutor/s has encouraged me to participate in active learning.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>C4</b>	<b>The tutor/s in this subject is professional in attitude.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>C5</b>	<b>The tutor/s continually challenges me to stretch my mind.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>C6</b>	<b>The tutor/s is responsive to students' needs</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>C7</b>	<b>I get useful feedback in tutorials that helps me learn.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>C8</b>	<b>The tutorials in this subject are well managed.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

#### D) PERCEIVED OUTCOMES

<b>D1</b>	<b>I have developed useful knowledge, skills and professional values in this subject.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>D2</b>	<b>I am able to relate what I have learnt to wider contexts and applications beyond the subject boundaries</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>D3</b>	<b>I am able to evaluate the quality of my own learning in this subject.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>D4</b>	<b>I have learnt in a holistic and relevant manner in this subject.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>D5</b>	<b>I am confident in being able to learn independently in this area.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>D6</b>	<b>I am confident in identifying and analysing issues relevant to this subject.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>D7</b>	<b>I am able to apply relevant knowledge and skills in this subject.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>D8</b>	<b>I have satisfactorily achieved all the learning objectives in this subject.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

### E) ONLINE LEARNING – BEnet & Basecamp

<b>E1</b>	<b>My tutor/s made sufficient use of BEnet.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>E2</b>	<b>My tutor/s effectively facilitated my learning on BEnet.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>E3</b>	<b>The BEnet discussions were useful in supporting my learning.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>E4</b>	<b>Basecamp gave me greater control over my work.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>E5</b>	<b>Basecamp improved communication between team members.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>E6</b>	<b>Basecamp enhanced information sharing.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>E7</b>	<b>Basecamp improved coordination among the project team members.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

### F) LEARNING TRIGGER DESIGN

The Learning Trigger(s) ...

<b>F1</b>	<b>was challenging but achievable.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>F2</b>	<b>encouraged me to critically reflect and analyse.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>F3</b>	<b>was relevant to the learning outcomes of the subject.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>F4</b>	<b>was interesting and motivated me.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

**G) GENERAL**

<b>G1</b>	<b>I get timely feedback on the work I do.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>G2</b>	<b>The workload in this subject is reasonable.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

<b>G3</b>	<b>The expectations of this subject are set at a reasonably high standard.</b>			
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

**H) FURTHER COMMENTS**

I find a Learning Trigger interesting when .....

.....

.....

The best thing about this subject is .....

.....

.....

What I like to see improved is .....

.....

.....  
Any further comments? .....  
.....

## Appendix 2 – Tutor’s Report

### BUILT ENVIRONMENT DEGREE PROGRAMS HOLMESGLEN

#### TUTORS REPORT

**Name of Tutor:**

**Subject:**

**Trimester:**

<b>1. The delivery strategy used within the context of problem-based learning addressing the identified learning objectives for the subject:</b>
a. What strategies did you use to encourage active student-centred learning?
b. How effective was the Learning Trigger?
c. How were students supported and their learning needs facilitated?

d. Describe assessment strategies used to assess student learning performance.

e. Elaborate on any issues and/or recommendations for improvement. (eg. Learning Trigger)

**2. The use of the learning materials integrated into the delivery strategy:**

a. Provide feedback on the usefulness, relevance and adequacy of the materials in the learning package to the delivery strategy.

b. Describe & list additional resources provided by tutor and/or students.



c. Elaborate on any issues and/or recommendations for improvement

**3. Students learning performance:**

a. Describe level of Student engagement, motivation and strategies used in their learning.

b. Were Students able to achieve the subject learning objectives?

c. Elaborate on any issues and/or recommendations for improvement

**4. Any other issue relevant to the delivery of the subject:**

- a. Feedback and recommendations for improvement

**Please Attach the following as Appendices**

Copies of:

1. Learning problem(s) / Trigger(s) used during the delivery of the subject
2. Assessment items (including tests or examinations) and related assessment schemes
3. Summary of finalised assessment results breakdown.

N.B. Copies of any additional learning materials used in the subject will also be collected for on-going use and archiving purposes.

**Signature:** \_\_\_\_\_

**Date:** \_\_\_\_\_

## Appendix 3 – BEDP Codes and Technical Terms

- ADB110 Anatomy of a Domestic Building
- BCO111 Building Information and Communications Management
- CSO111 Construction Site Operations
- PLE122 Professional and Legal Environment
- SBS110 Sustainable Building Services
- TBP120 Total Building Performance
- MDP123 Managing a Domestic Project
- ATB230 Anatomy of a Tall Building
- BMC231 Business Management for the Construction Industry
- CEC231 Measurement and Estimating
- MMP231 Managing Multiple Projects
- BMR241 Building Maintenance and Refurbishment
- CIR242 Community and Industrial Relations
- CLA242 Construction Law
- HSB241 Health and Safety in Building
- HRD363 High Rise Development and Procurement Methods
- LSD363 Large Scale Mixed Use Sustainable Development
- MDS353 Medium Density Sub-division and Development
- SHD353 Sustainable Housing Development

### Glossary of Technical Terms

- Flexicomm – online learning management system
- Moodle - online learning management system
- Basecamp –

## Appendix 4 – Ethics Approval



University of Southern  
Queensland

(CRICOS Provider No. 00244B|QLD/02225M NSW)

Dear Chris

Thankyou for submitting your project below for human ethics clearance. The Chair of the USQ Fast Track Human Research Ethics Committee (GTHREC) recently reviewed your responses to the FTHREC's conditions placed upon the ethical approval for the above project. Your proposal meetings the requirements of the *National Statement on Ethical Conduct in Human Research* and full ethics approval has been granted.

Project Title	Triggers for Critical Reflection in a Higher Education Digital Ecosystem
Approval no	H09REA100
Period of Approval	08/10/2009 – 08/10/2010
FTHREC Decision	Approved

The standard conditions of this approval are that:

- a) You conduct the project strictly in accordance with the proposal submitted and granted ethics approval, including any amendments made to the proposal required by the FTHREC;
- b) You advise the HRECT (email: [ethics@usq.edu.au](mailto:ethics@usq.edu.au)) immediately if any complaints or expressions of concern raise, or any other issue in relation to the project which may warrant review of ethics approval of the project;
- c) You make submission to the HREC for approval of any amendments, or modification to the approved project before implementing such changes;
- d) In the event you require an extension of ethics approval for this project, please make written application in advance of the end-date of this approval;
- e) You provide the HREC with a written “Annual Progress Report” for every year of approval. The first progress report is due 12 months after the start date of this approval (by 08/10/2010);
- f) You provide the HREC with a written “Final Report” when the project is complete;
- g) If the project is discontinued, you advise the HREC in writing of the discontinuation.

For (d) to (f) proformas are available on the USQ ethics website:

<http://www.usw.edu.au/research/ethicsbio/human>

Please note that failure to comply with the conditions of approval and the *National Statement on Ethical Conduct in Human Research* may result in withdrawal of approval for the project. You may now commence your project. I wish you all the best for the conduct of the project.

Yours sincerely



Ashley Steele

Ethics Officer, Office of Research and Higher Degrees