2015

Design Thinking as a Framework for Fostering Creativity in Management and Information Systems Teaching Programs

Igor Hawryszkiewycz
University of Technology Sydney, igorh@it.uts.edu.au

Sojen Pradhan
University of Technology Sydney, sojendra.pradhan@uts.edu.au

Renu Agarwal
University of Technology Sydney, renu.agarwal@uts.edu.au

DESIGN THINKING AS A FRAMEWORK FOR FOSTERING CREATIVITY IN MANAGEMENT AND INFORMATION SYSTEMS TEACHING PROGRAMS

Igor Hawryszkiewycz, School of Systems, Management and Leadership, University of Technology Sydney, Australia, igorh@it.uts.edu.au

Sojen Pradhan, School of Systems, Management and Leadership, University of Technology Sydney, Australia, Sojendra.Pradhan@uts.edu.au

Renu Agarwal, Management Discipline Group, School of Management, UTS Business, University of Technology Sydney, Australia, Renu.Agarwal@uts.edu.au

Abstract

Modern businesses are recognising the power of innovation through design thinking to sustain innovation and growth in today's competitive markets. Design is now becoming a holistic process and there is emerging need for future business leaders to understand the underlying processes of design thinking in an urge to innovate. This paper introduces a framework in design thinking to encourage information systems (IS) and management students to foster their creativity and innovation capabilities, and also improve their metacognitive skills. The framework is used to develop and implement teaching methods that increasingly focus on agility and innovation. An exploration of steps of implementing this framework in teaching introductory to high level university subjects is discussed. One of the key goals of the framework was to ensure that students learn early in their studies that design thinking is not only about identifying new ideas, but how the ideas can be externalised and differentiated to get commercial acceptances. Idea management tools are introduced in some subjects to help students follow through their brainstormed ideas, building blocks management and on-going evaluations by peers. This process has helped to spawn new solutions based on what is discussed within their group. Through the use of these tools the experiential journey of learning in collaborative environment has allowed students to interact with their peers, encourage and motivate students to participate and learn better in an effective and efficient manner.

Keywords: *Teaching and Learning, Innovation, Creativity, Design Thinking, Metacognitive skills*

1 INTRODUCTION

Design thinking is becoming the predominant paradigm in the design of business systems. It is a social approach used to encourage depth analysis of a problem to collaboratively propose alternate and innovative solutions. It is commonly defined as "approaching management problems as designers approach design problems" (Dunne and Martin 2006, p.512). The result is an increasing emphasis in the curriculum at universities to adopt more open approach either by design thinking or other methods (Melles et al. 2012). Some common approaches used by many students, such as searching for standard solutions or the one correct answer must be de-emphasised and new methods that encourage a continuous search for new ideas throughout any activity. It is not about only choosing the best of alternate solutions but being able to continually evaluate and learn from alternatives to continually improve solutions. It calls for new ideas, critical evaluation and even continuing the creative process in decision making by learning from rejected alternative choices to improve the selected choice (Davis, 2012). The focus is, thus, increasingly on a co-evolutionary adaptive process that encourages creativity throughout any subject matter.

Wicked systems introduce new challenges because of a much wider problem space and greater problems complexity, open for interpretation, characterised by competing or conflicting opinions for solutions, and unlikely to ever be completely solved. Henceforth, "Designers think of themselves as problem finders more so than problem solvers because their solutions start with a deep understanding of the problem requiring a solution" (Bell 2010).

This paper provides a platform that fosters innovative, creative and entrepreneurial practices in practice-oriented learning environments. The paper adopts a cognitive framework for management and information systems subjects that foster creative thinking capabilities amongst students. Using design thinking serves two purposes; one is to inculcate creativity and innovative practices within a business context; the other is to teach an emerging research methodology to students, one that is increasingly practiced within industry. As such, an idea management tool is theorised and implemented, which provides students a collaborative and virtually accessible space to brainstorm, post user stories in various building blocks tailored for a given project, with an ability to review and evaluate alternate solutions posted and evaluated by peers remotely. This allows students to capture their thoughts ubiquitously and increases student engagement resulting in boosting competition within their groups, as well as help each other to achieve their common goals of finding the best solution on the given topic domain.

In this paper, we first describe how design thinking can be used to solve complex problems in a learning setting. The method is applied in teaching some subjects in the disciplines of management and information systems (IS) with students studying undergraduate and postgraduate studies in the university. The proposed framework has been operationalised by developing idea management collaborative tools such as *Innoworks* and *Innospace* which describes how the design thinking method has been adopted for the subjects in a classroom teaching environment. The steps are elaborated further with some results and impact assessments where *Innoworks* and *Innospace* have been introduced. Finally, conclusion is drawn with further recommendations in teaching courses to promote creativity and innovation in future subjects as well as improvements that can be made to the tools.

2 IMPORTANCE OF CREATIVITY, INNOVATION AND ENTREPRENEURIAL PRACTICE IN TEACHING

Creativity is harnessed through the conduct of deeper analysis which requires intuitive and creative decision making process in designing new products or services, and has been increasingly sought out technique by corporates (Davis 2010). Design thinking has been very effective in gathering business requirements from customers at different levels through creativity and technologies (Nguyen & Shanks 2009). It has been reported that the impact of design thinking spreads across both horizontally and vertically from higher level of management to customer services. Design thinking is a buzzword in the area of innovative and entrepreneurial business management (Stewart 2011) and hence warrants the need for integrating design thinking in teaching so that future generations will be able to

understand and leverage the skills and competencies required in contemporary times to work towards a successful business (Davis, 2010). Besides this obligation, it is now becoming increasingly important to teach creativity to students for a number of reasons, namely:

- Innovation is crucial for industry to remain competitive, and it is becoming imperative for students to develop qualities and competencies that prepare them to become creative in everything they do towards their future careers.
- Students enhance their performance if they are challenged to create new ideas in their area of interests within a broad topic, and
- With greater emphasis on self-directed learning, students are able to navigate through knowledge learning resources in discovering new solutions.

Much of the extant literature in the field of innovation has been concerned with the definition and delineation of different forms of innovation (Tidd et al. 2005). Dobni and Popadiuk &Choo (2006) described the importance of knowledge sharing and the creation of a collaborative environment. The subject describes that innovation is more than just unexpected breakthroughs (Birkinshaw 2011) but is a continuous and pervasive process (Wilson & Doz 2011) that must often be facilitated throughout the business (Martin 2011). Problems cannot be predefined but need to be continually changed as stakeholders learn as new ideas. These new ways of dealing with problems incorporates creative thinking in different levels of organisation (Davis 2010).

Creativity is a phenomenon, which is difficult to define but is one of the key competencies essential in contemporary business environments. Creative thinking is a part of cognitive skills which is emanated in learning, perceiving and creating. Cognitive skills are mental abilities used in our everyday activities such as remembering from the past, comparing, analysing, solving maths, measuring etc. But, on the other hand metacognitive skills are used to evaluate our own work to improvise own learning and knowledge (Flavell 1979 & Thiede et al. 2003). The term 'metacognition' was first evidenced in an example by Flavell (1976 p.232), wherein he cited "I am engaging in metacognition if I notice that I am having more trouble learning A and B or if it strikes me that I should double check C before accepting it as fact". Both cognitive and metacognitive skills are essential and important elements of active learning. During the process, students are able to acquire and construct knowledge using cognitive skills, but evaluating, planning and adjusting their own learning for better outcome is done through metacognitive skills (Flavell 1979). These high order competencies potentially are able to transform the knowledge into new forms in the form of new services or products (Armbrusher 1989). In the past, creativity has been explored in industrial and arts and design settings. Besides the fact that it was difficult to measure creativity, it has become a major criterion for recruitment when assessing work done by designers and students (Dorst & Cross 2001).

3 DESIGN THINKING IN TEACHING ENVIRONMENTS

In the context of management education, Agarwal et al (2013, p. 89) "critically consider[s] the role of management education in managerial and organizational innovation with a particular emphasis on the way in which business schools in the future might be better able to develop management competencies and attributes that encourage innovation in, and of, organization". Further Hall et al (2013, p.364) highlight that whilst many challenges are being faced by business schools in Australia, these schools "have clearly been innovating, reviewing curricula, trialling new teaching methods and approaches, and working and engaging differently with students, alumni delivery partners and businesses".

According to Teresa M. Amabile (1997) creativity is the first step in innovation and work environments have a significant influence in the level of individual creative behaviour. As the world is getting advanced with utilisation of leading technologies, more complex systems are being generated, however understanding the complex systems need a divergent approach by disintegrating mystery into simple parts as shown in Figures 1 and 2 below. Brainstorming ideas help in this process of making sense of complexity and unbundling complex systems by framing them in different ways. Framing plays an important role here in organizing thinking. We have used a variety of frameworks. With a close and in-depth analysis of different perspectives, an innovative solution emerges.

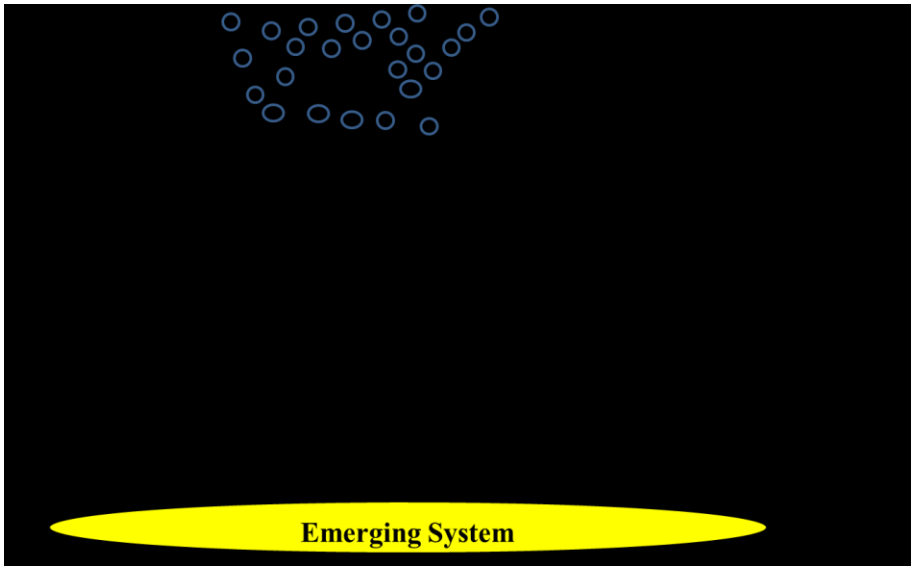

Figure 1. Design Thinking Process - Idea generation and capturing

One of the main advantages of using design thinking in teaching is that it creates an environment for ideation and experimentation. It encourages in depth analysis of given problems by letting students think as designers think to solve those problems. It allows students to analyse a given topic domain from their own and others' perspectives by disintegrating into several sub-topics. This continuous evolutionary process activates student's metacognitive skills in learning and allows them to strategise the process of thinking by linking to their individual intelligence competences (Livingston 2003). Cognitive processes can be facilitated with framing as for example the tool kit by Osterwalder and Pigneur (2010) within the business realm.

The basic principles of design thinking are illustrated in Figure 2. Both divergent and convergent thinking underpin design thinking framework which is instrumental in exploring possible ideas and solutions. Divergent thinking offers many possible unique and different ideas within a given topic domain whilst convergent thinking helps to narrow down the topic or domain in coming up with a solution. Both techniques are iteratively and continuously used to determine multiple perspectives of the topic, as well as provisions for evaluation of solutions from different aspects. When compared to system thinking, restricted to putting existing building blocks of a system together, design thinking focuses more on taking things apart (divergent) and then putting them together (convergent) in an innovative way (Dunne & Martin 2006).

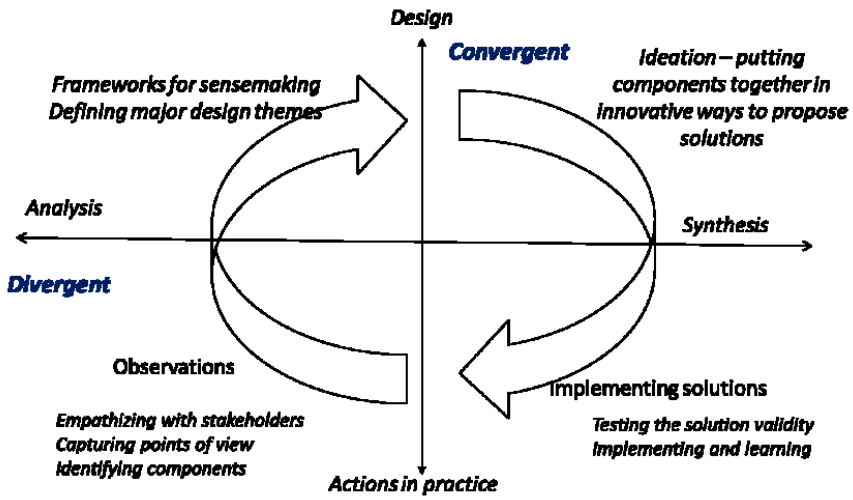

Figure 2. Basic principles of design thinking

4 THEORETICAL FRAMEWORK FOR TEACHING

Constructing knowledge and proposing solutions to business problems using metacognitive skills in a learning environment, requires an integrated seamless process operating in a collaborative environment (Goldman et al 2014). This teaching framework is operationalised using a heuristic approach as follows:

4.1 Organizing Teaching for Design Thinking

We herein propose a framework for teaching management and information system subjects using design thinking which incorporates heuristic approach as shown in Figure 3 below. Generating ideas and stories in any given context or domain in a group and then arranging them from different perspectives, assist in framing one or more solutions. The solutions are then evaluated by every group member to bring out the best possible scenarios. This reiterative process using heuristics is described by organizing the various components as follows.

- Organizational space – takes place in a design space where students store and filter information they have posted in one place which can be sorted, after they form a working group. In the design space, brainstorming of ideas and building blocks are arranged to be able to link with each other for further clarification within certain cognitive frames. The feedback feature is deployed in any idea postings whereby other group members comment and provide constructive feedback. Building blocks are arranged to sort out the ideas into clusters upon which students are able to propose solutions with in-depth understanding of this formative stage.

(It is to be noted that the relationships in the figure below can be 1-1, 1-many, or many to many, represented by 1-1, 1-N or N-M respectively.)

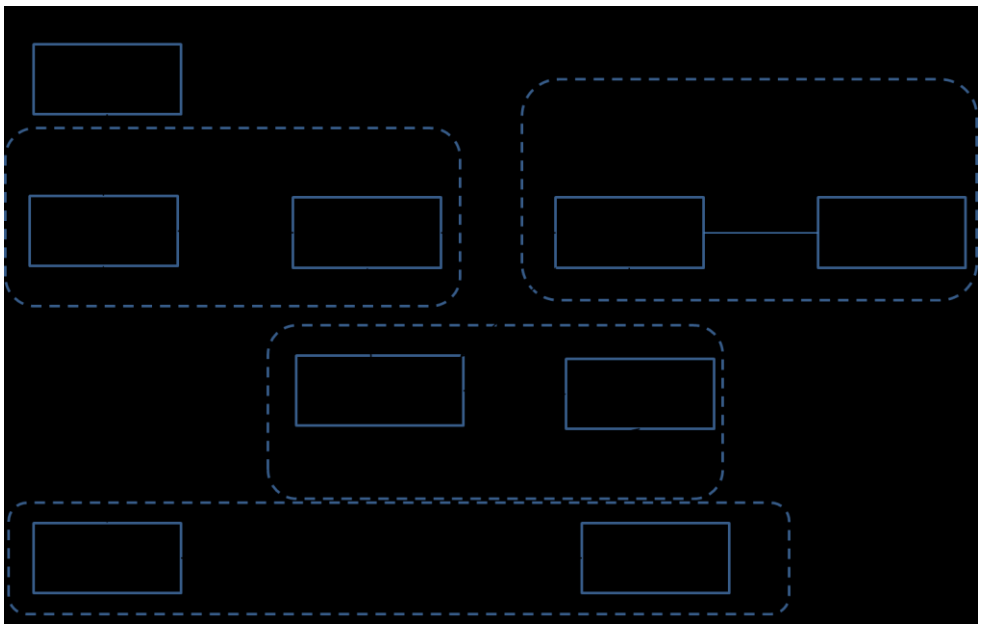

Figure 3. Framework for teaching design thinking in subjects using Cognitive Skills

- Empathizing and observation – is a major component of this framework where students are able to imagine and create scenarios in the area they are working on. Students collaboratively work together to write stories based on their knowledge in the specific area. They are encouraged to do research on something they are interested and to make more sense making of the stories they craft. This is the stage where students can think outside the box and create stories for finding better solutions.
- Ideation – is another core component of this framework which is facilitated within the design space. Ideas are captured and filtered through to building blocks with a clear indication of where they belong and need to be housed. Proposing solutions are devised from stories and ideas posted earlier.

- Experimentation – is the last stage of this framework wherein this method allows students to evaluate the solutions proposed by all group members. The evaluation rubric comprises of different factors and criteria that can be customized suitably to the aims of the project in question and be looked at from various angles. This stage allows students to evaluate not only on one solution, but examine alternative solutions to sort out the best outcome for further development in the project.

Seamless process flows and integrated set of activities implemented via the design space gives students a feel of using social media application in a classroom setting. This framework will be useful to manage projects, create new products, or find novel solutions in any business environment. With the growing popularity of social media, newer generation of students are accustomed to new technology, hence learning from similar technologies that they use in daily life for interactions with peers, will encourage and motivate students to participate and learn better in an effective manner.

4.2 The Learning Process - Steps students practice

Within the framework, idea management tool is implemented to assist students in the process of creative thinking and immerse in a given topic. We have developed two idea management tools and used in different stages of IS and management courses. The software is mainly to support students work in collaboration with their group members. The tool mainly allows students to:

- Form groups within the class.
- Post ideas once formed group in a common canvas page, referred as design space. Each student is required to post more than one ideas.
- Group the ideas together into cluster based on classification the group makes.
- Focus in one cluster of ideas usually related to one application domain.
- Research in this area and post stories on to the building blocks provided.
- Add building blocks if needed.
- Add solution based on the information on building blocks
- Evaluate solutions and create alternative solutions.
- Continuously improve the solution through collaboration within the group.

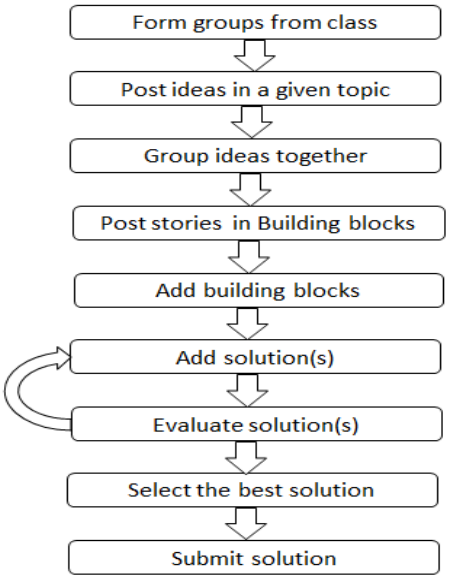

Figure 4. The Cognitive Process - Steps adopted by students

5 RESEARCH METHODOLOGY

It is clear that iPhone combined the three technologies: iPod, phone and internet communication. In a similar vein, we were inspired by the traditional way of brainstorming techniques in a meeting room using low technology tools such as butcher papers, notice boards, coloured post-it notes, and markers. We have created software tools which cater for three different stages of learning courses and bundles features of brainstorming technology (virtual sticky pads), SMS, chat, embedded with Google docs, and interactive movements of posts with access via mobile and smart devices. Two different aspects for using this tool: firstly, introducing framework to the subjects in IS and management, and secondly, encouraging students for using social media equivalent applications in a classroom setting for their efficient and effective engagements in the project.

5.1 Introducing the framework to subject curriculum

University students study across a diverse set of subjects which form part of their program. Not only that these days degrees are multi-disciplinary and generally span across two functional domains e.g. commerce and law, engineering and IT, etc. With this in mind we felt that the tool be introduced to various subjects spanning across various programs including multi-disciplinary programs. With this backdrop, we define three stages where this tool will be deployed and tested, which are: Introductory subjects for undergraduate students, Domain specific subjects, and Subjects that address complex inter-disciplinary topics.

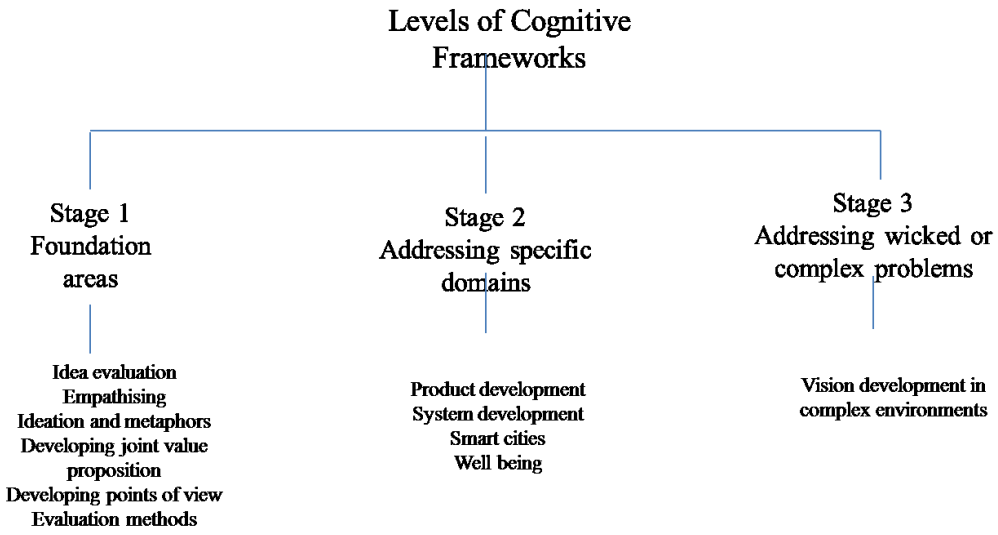

Figure 5. Applying the cognitive framework to create a curriculum framework

In our research for this paper, we have restricted the trialing of tools to stage 1 and 2 only.

5.2 Developing idea management tools – *Innoworks* and *Innospace*

The approach adopted deploys the features of a social networking software tool that support many of the skills needed in design thinking using metacognitive skills. Initially, an idea management tool namely *Innowork*s was developed from a technical perspective, one which provided students with the experience of initiating creative ideas and developing them to the stage of requiring commercial evaluation. As creativity is a difficult concept to learn and teach, a suitable environment is required to foster creativity in students to promote innovation (Amabile 1997). With this in mind, much broader collaborative tool, *Innospace* that provides virtual working space, has been designed to cater for specific domain and multi-disciplinary environments found in wicked systems. *Innopace* extends the learning attributes and tool characteristics attained from *Innoworks*. *Innospace* supports the development of extended attributes and skillsets via social activities and collaborative tools as per the theoretical framework defined earlier.

6 MAJOR COMPONENTS OF THE FRAMEWORK

The framework has integrated three dimensions, design thinking by Dunne and Martin (2006), the Stanford innovation process (d.school.stanford.edu) and business building blocks by Osterwalder and Pigneur (2010). Design thinking demands students' motivation, engagement and participation, and requires an appropriate environment to solve typical business problems, as such a learning environment that encourages innovative outcomes. The management of creativity and innovation is critical, thus demands structured management of the components of the framework mentioned earlier, which are now analysed next with seamless integration across stages.

6.1 Organisation

A design space is created by educators (teachers and tutors) for students to capture their thoughts, write ideas and stories from different perspectives for a given topic during the semester. Students access the design space canvas as a group where they start jotting down ideas and creating their work. This virtual space allows generating ideas and writing stories on building blocks, a concept promoted by Osterwalder and Pigneur (2010) wherein they formulated 9 building blocks business model canvas on paper. Using this canvas every group member has an opportunity to look at ideas posted in these building blocks from their own perspective. The use of building blocks fosters collaboration among the group members and allows them to find a solution collaboratively. Through this process, students are able to research and understand the context well and discuss through some stories to understand lower level processes of the system. It is important to note that the tool designed herein is not restrained to the 9 building blocks but rather can be customised to cater for any project, have different sets of building blocks and as many as you require.

6.2 Empathising and observation

One of the major steps of design thinking is empathising at user's level to understand the context well. Allowing students to post stories in building blocks from their experience and imagination, opens up many opportunities for discussion and collaboration. Feedbacks to the stories are carefully given and discussed among the group members. When they are not interacting face to face, students are still able to work on the ideas and stories virtually in this platform. These posts help students to propose a solution.

This step encourages critical thinking and is done through the posting of stories and discussion around the stories. All communication is in short sentences organized in a systematic manner on the canvas. Most of the inputs from students are precise and short, perhaps based on their extensive practise of using social networking sites, such as Facebook and Twitter. Stories are limited to 140 characters as were all other comments to encourage precise communication.

6.3 From Ideation to Innovation

Brainstorming is a substantial part of design thinking and it has been deployed well in this framework. Students are encouraged to generate ideas within the wider context and provide feedback to each other's ideas. These ideas help to populate building blocks with stories from their own experiences or understandings. In the introductory subject, we deployed *Innoworks*, which allows individual students propose ideas and stories in specific building blocks. This is made available to other students in their group, who then evaluate each other's ideas with the objective to select one idea for detailed design.

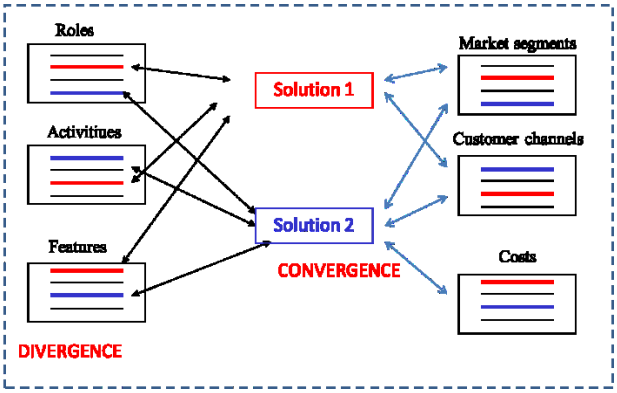

Figure 6. Combining cognitive frames

Figure 6 illustrates how cognitive frames can be combined to put creative ideas into practice. Few stories are chosen from the building blocks to propose solutions. Metaphors and perspectives are used to identify potential solutions and show how the solutions will work by creating prototypes. The solutions then lead to stories on how to implement the solutions in practice using Business Building Blocks proposed by Osterwalder (2010).

6.4 Experimentation

Experimentation is another critical step in the process of design thinking. Metacognitive skills are used to evaluate their own and other's solutions to formulate the best solution. The final solution is usually presented in the class with prototypes. The evaluation criteria for the introductory subject using *Innoworks* was based on evaluation used by Kano model, the Harvard R-W-W matrix (Day, 2008). However, in *Innospace*, the criteria are totally flexible and customisable depending on the topics given by the course coordinator in each semester. Moreover, students are encouraged to provide feedback while evaluating, so that alternative solutions can be designed. This process is on-going, one that allows self-assessing and self-correcting to get the best outcome. The evaluation is based on metrics dependent on the type of innovation in different disciplines. For example, the metrics in the case of designing a collaborative service are based on process design, the social relationships supported, the knowledge created and the type of tasks required.

7 DEPLOYMENT OF INNOWORKS AND INNOSPACE

In our introductory first year subject for undergraduate students, the first assignment included using the *Innoworks* to capture their ideas and develop further steps (user stories and features with roles). The subject provides a social context that empowers students to follow up on their own ideas in their context while adhering to processes designed to ensure business value and proposal. This subject introduces ways in which teams function in modern organisations and how these teams organise activities for innovation. It emphasises collaboration and the various services required to maintain teamwork or joint work when working remotely. The goal is to improve the ways people work together, develop trust, design team structures and establish information and communication technologies (ICTs) to support virtual teams. Emphasis is given to have clear understanding as well as critical analysis as their solution/prototype is going to be commercially examined, by on-going evaluations from the group. *Innoworks* has a cognitive framework composed of 4 building blocks called 'Activities', 'Features', 'Stories' and 'Roles' and hence limited in its use. The focus was to develop artefacts from creating stories in these building blocks. Through *Innoworks*, students can commence with their ideas being private, they can then share them with a group or make them public for evaluation purposes.

The domain specific and interdisciplinary subjects are used in postgraduate studies and we used our new tool *Innospace*. Major enhancement on this tool is that it allows flexibility to both students and educators to create a customized cognitive framework composed of customized building blocks and make use of the evaluation and feedback process through the use of evaluation criteria's. In this tool, our approach is different in a way that the building blocks do not necessarily have to be fixed, but can be tailored to meet the need of the problem domain. Certainly, when the process is introduced to specific domain, such as supply chain management, social innovation, not 9 building blocks from generic business model canvas are required, but rather a different set of building blocks are needed For example, for social innovation topic, building blocks such as community vision, social enterprises, social economy, public policies, innovators, social impacts etc. can be created by instructors for teams to use for their specific problem.

8 IMPACTS OF INNOWORKS AND INNOSPACE

From the framework and idea management tools, the following attributes for innovation and activities are acknowledged.

- **Collaboration and communication skill** - when students are working in a group and sharing the information they are posting, they need to explain to their group members and comment to each other in a constructive manner. This environment forces students to collaborate and communicate better building on each other's strengths. Students without *Innospace* will not be able to interact in a common workspace in real time off campus. Physically meeting on campus is not always easy for students.

- **Analytical and evaluation skill** - students need to analyse and evaluate their own work and other's work as they are undergoing a thinking process. They also need to comment on other group members' work regularly. The tools allow students to share their ideas real-time, gives them the ability to improve ideas and above all making them effective in coming up with their solutions and productive in terms of time utilisations - fast, quick and agile.
- **Need analysis** - while students are working in one integrated platform and sharing information amongst each other, generating ideas and writing stories on building blocks that serve as the cognitive framework, they need to be thinking on how their inputs will contribute to the scope of their assignment/task on hand. Since this tool forces students to work in a group and requires students to explain to each other the ramifications of certain decisions they would make. This real-time connectivity once again helps students maintain their assignment expectations whilst allowing them to make decisions with agility. This process indeed bolsters their analytical capabilities, as well as gives them insight to what they see as a solution in depth.
- **Presentation skills** - students need to communicate and present their idea(s) to their peers in a professional manner. With the ability to draw models and drawings through the solution page, students are able to evaluate and provide feedback to the proposed solution amongst themselves. Students can identify weaknesses and strengths of various solutions and share amongst themselves. In the absence of this, they are generally caught up with one solution and are more likely forced to present it in front of their peers, without having to understand the consequences nor the ramifications.
- **Creative skills** - students are asked to come up with ideas in a certain problem domain. They are able to research before they post their ideas and are able to post innovative ways/methods to solve their problem. While working in a group, when one member is posting and contributing, other members are encouraged to participate. This peer pressure and the social environment fosters is important to inculcate creativity.

Students expressed their feelings and gratitude about the idea management tool they used for the course. In the introductory course, most students found it very useful for discussion and contributed to interact with each other. Students contributed many ideas far beyond what expected. In fact, on an average, student posted 3 or 4 ideas each as against the 2 that was expected at that time. The empowerment of students to work on their own ideas while guided in the process, proved it successful. Figure 7 is an analysis of student's evaluation of the tool.

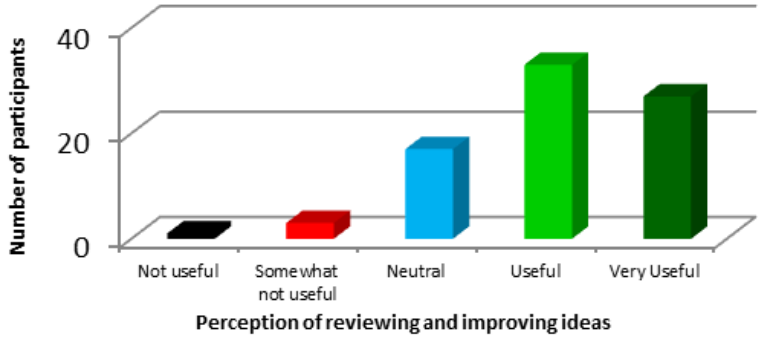

Figure 7. Student evaluation of system

In the postgraduate level course, we have used *Innospace*. 91 students participated in a quick survey. Students indicated that brainstorming through the tool and using building blocks, such as joint value propositions helped them come up with better solutions for their assignment - with an average score of 7.2 out of 9 on the likert scale.

The idea management tools have helped students to concentrate on their assignments for both undergraduate and postgraduate levels. On some occasions in the undergraduate level, the students found difficulty in working with ideas, and were unsure about the innovativeness of the ideas. As teachers, our emphasis was on how students adopted the process rather than the outcome per se. However, in solving complex interdisciplinary topics, students were able to research resources as well as develop relationships in different industry sectors. For example, in an attempt to address the

intractable housing problem in Australia, students were encouraged to contact relevant departments and companies and gain insights to facts and government policies in an attempt to find the solution to the problem in a systemic and holistic manner.

9 CONCLUSION AND FUTURE SCOPE

Undoubtedly, modern businesses are recognising the power of innovation through design thinking to sustain in today's competitive markets. Consequently, the skills and competencies that are required of the graduating students seeking for jobs entail the need for soft skills. This paper described ways to elevate the awareness of the creative and innovation processes within students through operationalisation of a theoretical framework using design thinking in a teaching environment. No doubt, the paper focuses on the higher order capabilities fostered amongst students of undergraduate and postgraduate students as a result of the pilot study conducted and demonstrated how students evaluated their ideas in the context of a specific subject. Subsequently, the methods adopted through the development of the idea management tool, namely *Innoworks* and *Innospace*, armed students with competencies such as the ability to collaborate and analyse needs, analytical skills, creative skills, and presentation skills. Our inference is that the same tool can be easily adopted and applied in other disciplinary subjects by simply defining and building relevant building blocks and evaluation criteria's for the relevant subject topic.

Today's learning environment demands students' motivation, engagement and participation. The tools provide a virtually accessible space for students to brainstorm ideas across various building blocks, tailored for a given subject, with an ability to evaluate each other's work remotely. Through collaborative learning, the quality of learning is improved and the students developed skills that were instrumental in solving wicked/intractable problems. The experience of solving problem in real-time gives students work-ready skills. Further development of the tool will include features and enhancements in the following specific areas such as:

- seamless inter-activity processes ensuring uninterrupted flow across idea pads, building blocks and solution stages, thus making the tool more user-friendly,
- documenting structured guidelines for students' ease to assist them with critical skills of team work, design thinking, cognitive and communication skills,
- customising building blocks to focus on specific area of organisation to get deeper understanding of the operations and outcomes,
- ability to expand the design space through further design of building blocks,
- fostering students' learning by amending the evaluation process at different levels (idea posts, building blocks and solutions stages) through drag and drop feature. This would encourage regular student's participation and frequent feedback virtually, thus allowing a better understanding of the domain, ability to think and reflect about the problem at a deeper level, foster ability to co-create their solutions, as well as enabling them to collaboratively enhance their competencies, and
- providing access to students through mobile phones to capture their thoughts for the project in a ubiquitous manner both virtually and in real-time from anywhere.

Overall, the framework develops and implements innovative teaching practices through the design and deployment of *Innoworks* and *Innospace* across various subjects. One of the key goals of the framework was to ensure that students learn early in their studies that design thinking is not only about identifying new ideas but how the ideas can be externalised and differentiated to get commercial acceptance. The experiential journey of learning in this collaborative environment has not only enhanced student's motivation and ability to engage and participate in group tasks virtually and in real-time, but has armed them with the capabilities required for changing and volatile times.

10 ACKNOWLEDGEMENTS

The work undertaken here was supported and funded by Vice Chancellor's Learning and Teaching as well as UTS Business Learning and Teaching grant.

References

Agarwal, R., Hall, R. & Green, R. (2012). Management Education for Innovation. The Handbook of Organizational and Managerial Innovation Pitsis, T. & Dhelin, E. (ed.). pp. 189-216.

Amabile, T. M. (1997). Motivating creativity in organizations: On doing what you love and loving what you do. California Management Review; Berkeley; Fall 1997.

Armbruster, B. B. (1989). Metacognition in creativity. Handbook of creativity, Part 2, Springer US, pp. 177-182.

Bell, S. (2010) Design Thinking and Higher Education. Inside High Ed. http://www.insidehighered.com/views/2010/03/02/bell accessed 03 January 2015.

Birkinshaw, J., Bouquet, C. and Barsoux, J-L. (2011). The 5 Myths of Innovation MIT Sloan Management Review, Winter 2011, Vol. 52(2). pp. 43-50.

Davis, B.M. (2010). Creativity and Innovation in Business 2010 Teaching the Application of Design Thinking in Business. Procedia Social and Behavioural Sciences 2. pp. 6532-6538.

Day, G.S (2008): Is it real? Can we win? Is it worth doing? Harvard business review, pp. 100-120.

Dobni, C.B. (2006). The Innovation Blueprint" Business Horizons, 2006, pp. 329-339.

Dorst, K. and Cross N. (2001). Creativity in the design process. Co-evolution of problem situation. Design Studies 22. Pp. 425-437.

Dunne, D. and Martin, R. (2006) Design Thinking and How It Will Change Management Education: An Interview and Discussion, Academy of Management Learning and Education, 5 (4): 512-523.

Flavell.J. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist. Vol. 34. No. 10, pp. 906-91.

Flavell, J. H. (1976). Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), The nature of intelligence (pp. 231–236). Hillsdale, NJ: Lawrence Erlbaum Associates.

Goldman, S., Kabayandondo, Z., Royalty, A., Carroll, M. P. and Roth, B. (2014). Student teams in search of design thinking. Design Thinking Research.

Hall, R., Agarwal, R. & Green, R. (2013). Future of Management Education – Education + Training; special issue on "The Future of the Business Schools", Vol. 55, No. 4/5, 2013, pp. 348-369

Livingston, J. A. (2003). Metacognition: An overview. Us department of education.

Martin, R.L. (2011). The Innovation Catalysts. Harvard Business Review, June 2011, pp.82-88.

Melles, G., Howard, Z., Thompson-Whiteside, S. (2012). Teaching Design Thinking: Expanding Horizons in Design Education. Procedia- Social and Behavioral Sciences 31, pp. 162-166.

Nguyen, L. and Shanks, G. (2009). A framework for understanding creativity in requirements engineering. Information and Software Technology, 51, pp. 655-662.

Osterwalder, A. and Pigneur, Y. (2010). Business Model Generation. John Wiley and Sons, Inc.

Popadiuk, S. and Choo, C.W. (2006). Innovation and knowledge creation: How are these concepts related? International Journal of Information Management. Vol.26 (4). Pp 302-312.

Stewart, S.C. (2011). Interpreting design thinking. Editorial. Design Studies. University of Technology Sydney. 32. Pp.515-520.

Thiede, K. W., Anderson, M. C., & Therriault, D. (2003). Accuracy of metacognitive monitoring affects learning of texts. Journal of Educational Psychology, 95, 66–73.

Tidd, J., J.R. Bessant and K. Pavitt (2005), Managing Innovation: Integrating Technological, Market and Organizational Change, Chichester: John Wiley.

Wilson, K., Doz, Y.L. (2011): "Agile Innovation: A footprint Balancing Distance and Immersion" California Management Review, Vol. 53(2). Pp. 6-26.