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Chapter Twelve

Enriching Problem-based Learning through Design Thinking

Norman Jackson and Fred Buining

Introduction

This chapter explores the question:

> **How can we enrich problem-based learning (PBL) using the creative thinking techniques used by designers when they are trying to innovate?**

One of the most exciting qualities of the PBL learning environment is that it actively and explicitly encourages you and your students to draw from many different disciplines in the interests of solving a problem. The design discipline contains a range of concepts, techniques, and ideas that can be used, to good effect, to create engaging learning environments and activities. This chapter explores these possibilities and shows why and how the principles of Design Thinking are particularly suited to PBL processes.

Solving problems is a central process in work and by engaging students to learn through problem solving is preparing them for work. Most complex problems in work are solved by teams of people working together, so engaging students in group problem solving prepares them for the social problem solving that they will encounter in the work place. Really challenging problems require that people use their creative as well as their analytical abilities, thus, if we are to prepare students for the complexities of the world of work, teaching that enables students to develop and to use their imaginations is essential.

PBL provides an excellent learning environment for students to use both their imaginative and analytical abilities. To engage fully in the PBL process, students need to draw on their creative reserves and to think in inventive, and sometimes ingenious, ways, but they also need to be critical about their ideas and solutions. Part of your job, as a teacher, is to encourage and stimulate innovative, creative thinking, in order to help your students learn the dynamics of collaborative processes that are aimed at harnessing the collective creativity of the members of the group as they apply their energies to the tasks and problems that have been set. So, how can you help your students to think in innovative, creative ways? How do you create conditions that are more likely to lead to innovative solutions to problems? How do you create problems and challenges that require students to use their creative as well as their analytical abilities? This chapter outlines some of the techniques, tools and ideas for encouraging and facilitating creative thinking in your students and in yourself. It begins by providing a rationale for incorporating design thinking into PBL

processes and goes on to describe how we share these techniques in our Creative Academy which is aone day workshop for teachers and others involved in student development. At the end of the chapter, in the list of resources, we include a link to our Creative Academy wiki that provides film clips, PowerPoint slides, and background papers to illustrate the techniques that are described in this chapter.

Chapter Overview

This chapter will explore the following design based practice principles:

- Using Design Thinking in PBL and collaborative problem solving
- Developing and exploring problem statements
- Facilitating collaborative thinking and idea generation
- Evaluating innovative ideas and discovering inspiring solutions
- Involving higher education teachers in designing their own learning and teaching scenarios to incorporate the techniques and principles of Design Thinking into their own PBL practices.

Principles of Design Thinking

In the professional work environment, learning is a by-product of problem-focused working compared to the educational environment, where learning is the main product of work. When people solve problems in the work environment, they draw on generic and discipline/field-specific knowledge and skills which they adapt according

to their work situations; they often apply the benefits of other experiences of problem working that they have had in similar contexts – their experiential knowing (Cooke & Brown, 1999). Figure 12.1, adapted from Marsick and Watkins (1990; 1997) and Cseh, Watkins, and Marsick (2000), provides a conceptual framework for describing what happens when people learn through problem working situations at work.

When confronted with a work problem people engage in a range of different problem focused activities:

- They frame the problem and the situation.
- They use their judgment based on their knowledge and previous experience of similar problems.
- They diagnose the problem based on their previous experience of diagnosing similar problems.
- They identify or invent solutions using approaches that have worked for them in the past.

This process may be very rapid, e.g., a doctor consulting with a patient, or may require a significant period of time, e.g., a teacher designing a new course. This approach works well when working with a routine / familiar problem and works less well when a complex and unfamiliar challenge is encountered or a radical change in approach is desired. It is in the complex type of situation that the techniques of Design Thinking can be usefully applied to provide more potential solutions to the problem (see Figure 12.1).

Figure 12.1 Conceptualisation of learning as part of problem-based working in the workplace (Adapted from Marsick & Watkins (1990) and Cseh et al. (2000)).

[INSERT FIGURE 12.1 HERE]

Design Thinking (Brown 2008a; 2008b) is a creative process based on the generation of many ideas and the selection of really good ideas from the many generated. In order to engage in design thinking it is necessary to think generatively and to postpone judgments on the ideas that emerge. In design thinking problem framing and diagnosis, are replaced by a process of exploration that is facilitated through extensive questioning.

Through this thinking process designers or design teams come to understand the complexities that are often embedded in a problem and they may see more easily a multitude of problem(s) from different perspectives. This exploratory stage provides the basis for a generative stage in which numerous potential solutions to the explored problem(s) are identified before an evaluative stage occurs that leads to the selection of the best ideas.

Design thinking does not follow a linear or logically reasoned pathway; it is fundamentally different to the scientific, analytical, rational, linear, and convergent processes that tend to be encouraged in academic, higher education environments. Academics' cognitive styles are significantly more likely to be analytical as opposed to intuitive. Analytical thinking involves breaking problems into smaller parts in order

to study them. Rational thinking requires a detached, balanced, objective approach. Linear thinking evolves in a particular direction and convergent thinking involves starting with available choices and issues and working towards a single best solution.

Design thinking is a different sort of process which, at times, can feel chaotic and uncomfortable and may require people to suspend their disbelief and/or to “turn off” logic in order to participate in the process. Some teachers find that design thinking is difficult to do as formal educational environments tend to favour problem-solving modes that are linear and algorithmic. However, real world problems, particularly if they have a strong social dimension, tend to be less amenable to linear ways of thinking.

We need to learn to look at problems from many different perspectives. Designers have developed routines and techniques that can really help us to do this. In response to being confronted with the problem of innovation, designers have developed ways of thinking about the problem that enhances their ability to imagine a number of possibilities from which they can choose the best solutions. A consequence of the way that designers think about problems is that they are particularly good at creating novel solutions to their problems.

Design thinking involves a series of divergent and convergent steps (Brown 2008a; 2008b). During divergence, we are creating choices and during convergence we are making choices. Divergent thinking can feel frustrating, as it demands a high tolerance for ambiguity, uncertainty and, at least for a time, feel directionless; it

almost feels like you are going backwards and getting further away from the answer. In the early stages of a PBL experience, the students often struggle with a feeling that they are unproductive, “going nowhere” and are “all over the place” (see student insights outlined in Chapter Nine). Designers will tell you that divergence is often the place where really creative / innovative ideas are born.

Divergence needs to feel optimistic, exploratory and experimental, but often feels confusing to people who are more comfortable with a scientific approach to solving a problem. Design thinking relies on an inter-play between analysis (breaking problems apart) and synthesis (putting ideas together). The uncertainty of divergence and the integrative, head-hurting complexity of synthesis are the unique characteristics of design thinking; they are the very experiences that make this type of creative thinking both challenging and liberating at the same time. This creative thinking process resonates with Barrett’s (2005) description of PBL as “hard fun”; difficult, challenging, puzzling, even baffling, on the one hand, and empowering, exciting, fun and full of creative potential on the other. This concept of ‘hard fun ‘ is discussed further in Chapter Two

Designers have evolved visual ways to synthesise ideas and that is another one of the obstacles for those new to design thinking: a discomfort with visual thinking. A sketch of a new product is a piece of synthesis and so is a scenario that tells a story about an experience. Design thinkers create visual frameworks for synthesis that, in themselves, describe spaces for further creative thinking**.**

Creative Academy: A Process for Developing Design Thinking Skills

So, how can we help students develop and practice their inventive thinking skills in order to solve complex unfamiliar problems? And, how can we facilitate the process of learners pooling their creative ideas and inspiring each other in the process? Figure 12.2 shows the process that we have designed to help teachers develop facilitation skills that will enable students to think like a designer faced with the problem of having to invent a new design solution. In the professional development process teachers take the part of the learners and so experience the techniques for themselves. The context or challenge for problem solving in our Creative Academy was defined as – `designing courses or teaching /learning situations to improve students' creativity'. However, you can substitute any design challenge, for example, we could have used "designing problem-based learning situations where learners are required to invent an original solution". In the rest of this chapter, we take you through the process of design thinking to enable you to see how you might adapt it*WHAT IS IT? Our model? to your own PBL contexts.

Figure 12.2 The sequence of activities in our Creative Academy professional development process

[INSERT FIGURE 12.2 HERE]

Exercise 12.1 Reflections on Teaching for Creativity.

Before joining Creative Academy, we invite teachers to reflect on their own practices and experiences. To prepare yourself for Creative Academy think about an occasion when you trie to encourage your students to be creative. Write brief notes to yourself about this experience. You will draw on these experiences during the process

- What was the context?
- What did you do?
- What did students' do?
- What did you learn about facilitating students' creativity through the experience?

Exercise 12.2 Getting Started – an exercise to start students thinking about their views and perspectives on creativity (or any other topic).

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Have your students form a circle and introduce themselves and say what they hope to get out of the day. The whole group engages in a short 'warm-up' exercise. The one we used involved: 1) writingon a piece of paper three things you associate with being creative 2) screwing the paper into a ball and throwing it to another participant on the other side of the circle 3) reading what was on the paper 4) adding your own three points and repeating the exercise. After repeating the process three times students are invited to call out the words written on their sheet, after a dozen shout-outs, the facilitator might ask a question like "how many of you agree that these things are associated with being creative?"

This activity is a good way of showing students that there are many widely held beliefs about creativity.

The same or a similar exercise can be used to encourage people to start sharing their thinking and beliefs about other topics e.g. student capabilities topics, for example teamwork or discipline specific topics

Exercise 12.3 *Sharing understandings about creativity*

(or another topic)

We have found that it is fruitful to help learners to make their beliefs about creativity public. We use a voting system to reveal patterns of beliefs but you can use coloured cards if you do not have a voting system. The main purpose of the exercise is to develop trust within the group – as soon as students start to share their beliefs about creativity, they begin to get a stronger sense of themselves and of each other, and to explore some of the opinions and ideas that they have in common and those on which they disagree. This type of dialogue creates fertile ground for interaction and subsequent collaboration.

When we do this sharing exercise with faculty groups, we put propositions about creativity on a PowerPoint slide, and invite participants to vote on the proposition (typically a 5-point scale ranging from strongly agree to strongly disagree is used). If you do not have a voting system, you can give each participant three or five pieces of coloured card to represent the scale you use and invite them to raise the appropriate colour when they vote. We also invite whole group or paired discussions using the perspectives that emerge from the voting. Negotiation here involves participants taking the discussions in whatever direction they feel it needs to go in order to resolve their questions or to elaborate on their beliefs. The propositions we use and typical patterns of voting for a group of higher education teachers can be found on the Creative Academy Wiki.

The same or a similar exercise can be used to encourage people to start sharing their thinking about problem-based learning topics e.g. problem-solving or discipline specific topics

Design thinking techniques

Following the initial exploration of the idea of creativity, we move into the collaborative problem solving part of the process (Figure 12.2) which comprises a series of exercises that you could use with students at an early stage in a PBL module or programme in order to help them to share their notions of creativity (or any other subject) and to gain greater insights about how they might work best together.

Thinking Like a Designer

The process of this exercise takes about 75 to 90 minutes to complete. You will need a large wall or expanse of windows for this process and the wall or windows need to be systematically covered with sheets of flipchart paper. Alternatively, white wall paper can be used. Participants sit in a semi-circle facing the papered wall. The optimum size for a group is 10-12 but this process can be undertaken with smaller or larger groups. If the group is larger than 15, it should be split into two groups each

with its own facilitator. Participants will need half a pad of post-its and a felt-tip pen or biro to write on the post-its.

Figure 12.3 A process amp showing techniques used to stimulate Design Thinking for creative enquiry and problem-solving

[INSERT FIGURE 12.3 HERE]
[FULL PAGE LANDSCAPE}

Framing the challenge: Creating a problem statement

At the start of the process, the participants are told that they are going to work as a team to engage in a creative problem solving exercise; they are provided with a map of the process (Figure 12.3) and told that this process will help them generate many new ideas some of which might be highly innovative. The process is explained in terms of a series of techniques for facilitating divergent (opening-up) and convergent (narrowing down) thinking – the sort of strategy that a design team trying to come up with an innovative idea might engage in. The map acts as a navigational aid and the facilitator draws attention to the map as each new technique is introduced in order to reinforce understanding of the process and how the techniques are connected.

Participants are invited to formulate a powerful question that will be the focus for creative enquiry. This is a negotiated process in the sense that participants are encouraged to form a "How can I?" question, to address the problem of "designing courses or teaching /learning situations to improve students' creativity". The question is written across a wall of flip chart paper. In our Creative Academy, we used the question: "How can **I** design a rich experience so that learners are inspired, empowered and enabled to use their creativity?" The emphasis on **I** is important as this is all about individuals being able to change something in the teaching and learning situations that they have control over.

Having created a problem statement, the next stage is to reveal some of the complexity in the problem by posing many supplementary "How can I?" questions that are triggered by the main question**.** Participants are instructed to write down their supplementary questions on a post-it – one question per post-it. After a few minutes, participants are invited to read out their question to the rest of the group to trigger further ideas and the facilitator then posts the question on the wall under the heading "Questions".

Examples of these questions include:

- How can I create the space within a module to create a rich experience?
- How can I secure the necessary resources?
- How can I find out what sorts of experiences, problems would inspire and motivate learners?

In our experience, a group of ten people can generate up to 100 supplementary questions in ten minutes. After a lot of questions have been generated, you can invite a pair of participants to cluster the questions into themes and then label the theme, while other participants continue to pose questions. Typically, the following kinds of themes will be revealed: resources; people; training; organisational structures; barriers; and leadership.

Once the themes have been identified, the group can be invited to identify any obvious gaps in the themes and pose further questions to fill the gaps. This process is negotiated, in the sense that, the facilitator is merely helping the group to explore their understandings of the problem and what emerges from this questioning process is the product of their collective minds, not the knowledge of the facilitator

Generating potential solutions

Having explored the problem statement (principal question) and thought about the complexity within the problem through the many supplementary questions, the group can now start to generate potential solutions**.**

Brain storming techniques

You could use traditional 'brainstorming', but we use a quieter and more introverted collaborative process called "*Brain Writing",* in which participants write down their ideas in silence. You explain that there will be four rounds of brain writing, with each

round declining in length: 4 minutes, 3 minutes, 2 minutes and 1 minute. You introduce the first round of four minutes and invite the participants to write down, in silence, as many possible solutions to the question that forms the problem statement - one solution per post-it. In doing this, they can draw on all the supplementary questions that have been posed since they also relate to the problem. So, rather than offering solutions to one question, the students are being asked to offer potential solutions to more than a 100 questions relating to the problem. During the process of the four minutes, you repeat the problem statement three times and encourage the students to make their solutions as concrete and practical as possible.

At the end of the four minutes, you ask the group members to stick their post-its together in a long list, put their name at the top of the list, and pass the list of post-its to the person sitting on their right. The person receiving the post-its looks quickly at the list and uses the ideas to trigger new ideas and add further post-its (one idea per post-it) to the bottom of the list, but this time, only three minutes are given to idea generation. The process is then repeated with two minutes and one minute being given to generate ideas. After the final round, the lists of post-its are given back to the person whose name is at the top of the list. Typically, each person might have between 20 and 30 ideas. The participants are then invited to post their ideas on the papered wall in a nice, orderly fashion under the heading “Possible solutions”. With over 200 ideas on the wall, you can draw attention to the wealth of ideas grown in just a few minutes from the creative minds of the participants.

You can adapt this technique to any PBL context where you want students to think imaginatively about a problem; it can be a very effective trigger for helping learners to find creative solutions.

Associative thinking techniques

The next stage in the challenge of "Thinking Like a Designer" is to utilise associative thinking techniques (see Figure 12.3) In Creative Academy, we use the techniques to generate solutions to our problem of "How can **I** design a rich experience so that learners are inspired, empowered and enabled to use their creativity?" But here, we will modify this exercise to the sort of PBL context that you may encounter using a problem that you could pose for a group of students in your PBL sessions like, "How can I contribute to my PBL group in ways that will enable us to harness our collective imaginations to create novel solutions?"

Start the exercise by explaining that you are going to try to encourage learners to seek more unusual or novel solutions to a problem by encouraging them to think differently. There are many associative thinking techniques that can be used to encourage learners to generate ideas that have the potential for creating novel solutions to a problem. All work on the principle of picking a word/idea within the problem statement, and then encouraging, through an associative thinking process, the generation of ideas that seem to be far removed from the original idea. In introducing the idea of associative thinking, you might point to a student and say "... if I say bicycle you say…(student may respond with 'ride') … you repeat pointing at the

next student … if I say bicycle you say…(student may respond with ‘wheel’).” The students quickly get the idea.

Flower association technique

Before you begin this exercise, it is a good idea to draw the shape of a flower with its petals on the wall (see Creative Academy Wiki for the facilitation process). Pick a word from your problem statement that is likely to generate some interesting ideas – words like “contribute”, “enable”, “harness”, “imagination”, “novel” and “solution” – and put the word at the centre of the flower. You then ask the students “What do you associate with the WORD in the centre of the flower?” As words are shouted out, the facilitator writes them in the petals – one word per petal. The inner petals are quickly filled up. But this is only the brain dump of obvious associations, what the facilitator is really interested in are ideas that are far removed from the starting point. Therefore, the facilitator should try to nudge the participants further away with remarks like “think of another context in which [WORD] happens”. Eventually, some unusual words start appearing, for example, “ballroom dancing” might emerge. Using the unusual word as an illustrative example, you then say, thinking of ballroom dancing, how can I contribute to my PBL group in ways that will enable us to harness our collective imaginations to create novel solutions?

Write your new ideas down, one per post-it, and, after a few minutes, ask the students to call out their ideas and post the written ideas on the wall. Students will be surprised at some of the novel ideas that emerge.

Analogies technique

In this associative thinking technique you invite students to name ten animals that are bright and vivid or interesting. You list the names of the animals on the wall as they are called out and then invite the participants to identify one of the animals and ask them to name ten things about the animal. These ten things are also listed. You then ask the participants to identify one of these characteristics. For example, a distinctive characteristic of an "ant eater" might be "a long sticky tongue". Using the words that describe the characteristic as an illustrative example, you then say "thinking of a long sticky tongue, How can I contribute to my PBL group in ways that will enable us to harness our collective imaginations to create novel solutions?" Write your new ideas down, one per post-it. After a few minutes, ask the students to call out their ideas and post the written ideas on the wall. The act of calling out the idea triggers further ideas in the group. You and your students will be amazed at the way such bizarre associations stimulate imaginations.

Generating more ideas from ideas already generated.

To encourage deeper exploration of interesting and novel ideas, you might draw attention to an idea on a post-it, and then, invite participants to use the idea as inspiration to generate further ideas, for example: thinking of this [novel idea] … How can I contribute to my PBL group in ways that will enable us to harness our collective imaginations to create novel solutions? This process helps students to make sense of and be stimulated by someone else's idea.

In all of these techniques, your role as facilitator is to encourage divergent, associative thinking that is connected, albeit tangentially and remotely, to the problem statement. Design thinking is not a process that has right or wrong answers, nor is it a process where one knowledgeable person is imposing his or her thinking on others. In that sense, all of these activities involve negotiation and the movement to democratic social relations among groups of learners and teachers (see Chapter Nine for more on the importance of democratic social relations in PBL teams) .

Evaluating potential ideas

Having generated hundreds of ideas and possible solutions, the next stage of the process is to engage the participants in a process of evaluation and decision-making. Out of all of these ideas, which ideas are just ordinary and which ideas are truly inspiring? Which ideas are great ideas and can be implemented now, and which ideas are great, but they are just not feasible at the moment? With a group of 8-10 people, over 200 ideas/possible solutions should have been generated on post-its by this stage of the process. Referring to the map of the process (Figure 12.3), you explain to the students that they have now completed the divergent thinking part of the Design Thinking process and that they are now going to embark on a more convergent, analytical, and judgmental thinking process. You explain that the students are going to use a simple tool to help them to evaluate the ideas (see Figure 12.4) and go through the criteria. You invite participants to spend about five minutes looking at all of the ideas and, during this time, they

must select three ideas that they feel are particularly good/inspiring/useful ideas. Using the criteria shown in Figure 12.4, the participants are invited to place the ideas that they have selected in one of three boxes (three sheets of flip chart paper stuck on the wall labeled BLUE, RED and YELLOW

Figure 12.4 A simple framework for evaluating ideas and possible solutions to the problem

[INSERT FIGURE 12. 4 HERE]

If there are many ideas, it is a good idea to number the ideas to help with the next stage of the process. When the ideas have been numbered, invite the participants to spend five minutes looking at all of the ideas and to make a selection in their minds. The students are given three circular stickers which represent three chances to vote for the ideas that they believe, if they could be implemented, would make a real difference, i.e., it is their individual evaluation of the best potential solutions to the problem that they think can be implemented.

After five minutes, you instruct the participants to get ready to vote and when you give the signal they vote together. After voting, you can ask the students to organise the ideas so that those with the most stickers are at the top and those with fewer or

no stickers are underneath. You can then review and discuss the ideas considered to be most useful by the participants.

Discussion

The exercises that we have outlined above are all designed to contribute to the creation of a safe and supportive, but demanding and challenging environment for sharing beliefs and trying out new techniques. The purpose of the exercises is to introduce the thinking and facilitation skills used by designers to promote thinking that will lead to imaginative and innovative designs; these ways of thinking and behaving are rarely encountered in disciplinary problem working. These exercises also create reaffirming spaces for teachers who care about their students' creative development and who want to be creative themselves.

We argue that PBL tutors, teachers, and students can benefit from being able to utilise design thinking skills, when confronted with problems that require innovation. Teachers who want to create innovative curricular designs provide a good example of a professional problem situation, where the use of design thinking skills would be useful. And students facing the challenges of PBL can benefit from learning creative, divergent dynamics associated with design type thinking.

PBL practitioners will find it useful to have these types of thinking and facilitation techniques in their toolbox and, by extension, student learners will also benefit from

being able to facilitate collaborative problem working processes using these techniques. Other practical examples of the use of thinking and facilitation techniques are described by Feathers (2003) and Reeves (2003).

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contains film clips and other resources to support the process described above.

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