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Case Report

## The PIPE Model and Core Tools for Teaching Innovation and Entrepreneurship in Chinese universities

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### Abstract

There are quite a few questions related to entrepreneurship education (EE). For example, why do we teach entrepreneurship? What to teach? How to teach, How to assess the learning? Many previous studies answered the question about why. These papers aim to address the questions on what and how. This paper reports a PIPE Model (Problem-Idea-Product-Enterprise) which aims to motivate and inspire students to actively learn along the process from discovering problems, generating new ideas, proposing new products to planning new enterprises. It has been enriched by considering Chinese culture along the process of teaching and learning entrepreneurship. The PIPE model has been implemented at City University of Hong Kong for over 10 years and a MOOC course was recently launched based on the PIPE model. A MOOC course was designed on the PIPE model as well. It was shared in over 100 seminars and workshops in Chinese universities as well as other Asian countries. It is easier to be adopted and implemented.

**Keywords:** Creativity, innovation, entrepreneurship, the PIPE model, cre8map, 9P canvas.

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### INTRODUCTION

Entrepreneurship has been widely recognized as a major driving force behind economic growth. Entrepreneurship education has developed very rapidly cross the world, for example, Levie, 1999. The Netherlands Koch, 2002, Arasti *et al.*, 2012, Sun, 2011 and Hamzah *et al.*, 2016, and so on. Entrepreneurship has become one of the fastest-growing subjects at colleges and universities, not only in schools of business but also in engineering, social science and arts Kuratko, 2005.

There are academic studies reporting that entrepreneurial education (EE) can influence students' entrepreneurial intention Autio *et al.*, 1997, Davidsson, 1995, Kolvereid, 1996, Tkachev and Kolvereid, 1999. Chen *et al.*, (1998) found that entrepreneurship students have significantly higher self-efficacy than non-entrepreneurship students, which significantly determines entrepreneurial intention. This is also supported by Lütjhe and Franke 2002, that students who studied

entrepreneurship in undergraduate curriculum were more likely to create own businesses.

However, these previous studies only answer the question whether EE is important and whether EE influences on students' entrepreneurial intention. They did not answer the question how to teach. Entrepreneurship is very complicated and is related to creativity, discovery, technology and entrepreneurship. Almost all models for teaching entrepreneurship start with ideas. Yet experience and research have shown that, a) it is still difficult for young students to generate new ideas, and b) even when they do, their ideas will hardly reach the market because the entire process from idea to market is rarely taught and practiced.

Some creative thinking methods for students to generate ideas from nothing and for nothing. Our research and experience shows that creativity or innovation is not sufficient. Creativity, innovation and

entrepreneurship must be integrated into one process from multi-disciplinary perspectives, Sun 2010.

This paper will report a PIPE Model (Problem-Idea-Product-Enterprise) to motivate and inspire students to actively learn along the process from discovering problems, generating new ideas, proposing new products to planning new enterprises. The model was based on 20 years of research and teaching experience in innovation and entrepreneurship. The PIPE model will be introduced in the following sections.

The Chinese government recently recommended that an entrepreneurship course should be offered for all university students so that they can have a preliminary understanding of innovation and entrepreneurship. If they find it interesting and they can go further to take more and advanced courses on entrepreneurship management and practices. The PIPE model introduced here is particularly for a general education course for junior university students.

Culture is identified by scholars as one of the key factors influencing innovation in China as well as other countries. According to Hofstede 1997, one of the leading empirical researches on culture, "National Culture is about the value differences between groups of nations and/or regions." China has a very long history, a rich culture, and different religions and philosophies such as Confucianism, Taoism, Buddhism, and others.

It had a glorious history of science and technology as well in the past, Needham, 1954. However, research reveals that contemporary Chinese culture does not support innovation as much as some other cultures Sun 2009. While there is no 'good' or 'bad' about cultures - they are just different - pertinent cultural issues have to be considered while learning about innovation and entrepreneurship in China, perhaps other places as well. Therefore, some cultural issues will be touched in relevant places as well.

## **THE PIPE MODEL**

The PIPE is an acronym stands for Problem, Idea, Product and Enterprise. The PIPE Model is a summary of the four steps of teaching Problem discovery, Idea generation, Product proposal and Enterprise plan as illustrated in table 1. It is an effective teaching model for motivating student-centered learning from multi-disciplinary perspectives. Students are motivated to actively look for what they need along the process from problem, idea, product for enterprise plan. The PIPE model aims to help students (from any field) to discover problems in daily life, generate new ideas aiming to solve these problems, design new product accordingly and develop a simple business plan for the enterprise. If sufficient support is ready, the team can produce the prototype of the product and prepare an integrated yet simple business plan to present.

How to measure and assess discovery and innovation has been a difficult task not only in education but also in industry. It is even more difficult for freshmen who may not be able to come out very technical and visual physical products. Additionally, there is a big confusion in innovative education on what is assessed. Some tools assess creativity while other assesses innovation. Assessment may be about personality, attitude, ability and/or accomplishment.

The student outcomes under the PIPE model are mainly about accomplishment in terms of problems, ideas, products and the enterprise plan. The accomplishments are measurable and assessable. The assessment will cover the number of problems discovered, the number of ideas generated, idea assessment and screening, assessment of technical feasibility, assessment of market feasibility, assessment of financial feasibility as well as the assessment of the business plan and the whole course.

Entrepreneurship is related to innovation, creativity, invention and discovery, which are very confused and difficult to be taught in one course. The PIPE model distinguishes and then integrates discovery, creative thinking and innovation into entrepreneurship so that the confusion about the differences or similarities among creativity, innovation and entrepreneurship is removed. The PIPE model supports the following teaching and learning philosophy and/or methods. It is process-oriented from multidisciplinary perspectives. It supports problem-driven learning (PDL) where students identify problems themselves, which is different to problem-based learning (PBL) where problems are given to the students. It suggests that a product or service has to be proposed. It requires a simple business plan to integrate the problem, idea, product and basic market information. It supports team and project-based learning. It also considered Chinese culture issues for problem identification and idea generation. Finally, it provides creative teaching tools along the PIPE process which will be elaborated below.

## **TEACHING TOOLS ALONG THE PIPE PROCESS**

Entrepreneurship education is different to normal education. In addition to lecturing and case studies, games, teaching tools and learning activities are needed to support participative and experiential learning.

### **The 7W4H questioning and observation for problem discovery**

Entrepreneurship started with an entrepreneurial opportunity, Timmons *et al.*, 2004. Have you ever wondered how entrepreneurs can find such opportunities? Research suggests that it is their own working experiences that help entrepreneurs to find opportunities,

**Table 1.** The PIPE model for teaching innovation and entrepreneurship

<b>PIPE Details:</b>	<b>Problem discovery</b>	<b>Idea generation</b>	<b>Product development</b>	<b>Enterprise plan</b>
Pedagogical focus	Exploration and discovery	Creativity and creative thinking	Innovation and new product development	Entrepreneurship and business plan
Learning objectives	To discover problems from daily life	To generate new ideas to solve the problems	To conduct basic but comprehensive feasibility study of a new idea (for the product).	To incorporate all the above factors into a simple business plan (of the enterprise).
Teaching and learning activity(LTA)	Eye and mouth (Explore, observe and ask)	Brain (Creative thinking)	Hand (Design and make)	Feet (Go and do market search)
Warm-up games	2 groups of tourists -Complexity, -Commonality	Purpose of a glass	Air plan	Toilet
Assessment criteria of the learning outcome	-Number of problems discovered -Observation and curiosity	-Newness, - originality and attractiveness -Number of ideas generated	-Technical feasibility, -Technology availability, -Cost-effective feasibility	-Market feasibility -Financial feasibility - Team spirit and collaboration
Teaching & learning tools	7W4H	Cre8map	BAH	9P Canvas

**Table 2.** Examples of using 7W4H questions while observing AMT

<b>WH</b>	<b>Questioning</b>	<b>Potential problem</b>
What?	Can ATM process coins, tuition, postage and investment?	ATM cannot process coins
Where?	Are there ATM in the supermarket, living area, campus, train, etc.?	There are ATM inside some supermarket
Which?	Which bank does the AMT belong to? Can it use be used by all people?	ATM is specific to a bank
When?	Is it 24 hours? Is it save in night?	It is not safe during the night
Who?	Who use it? Can old people, handicapped, child use AMT?	It may not easy for handicapped people
Whom?	Whom is being served?	
Why?	Why it only have one screen in an ATM?	
How?	How to be recognized?	Only password is used
How much?	How much money is withdrawn?	ATM is out of money sometimes
How many?	How many people use one ATM?	
How Long?	How long time is needed?	Queuing for long time in sometimes
How Often?	How often people use the ATM?	

Lambing and Kuehl, 2006. In China, up to 90% of startup opportunities comes from the practical working experience of a person Zhang *et al.*, 2013. As you can imagine, this is exactly the practical working experience that university students are missing! So it is not feasible

for students to identify an entrepreneurial opportunity. For students without practical working experiences and relevant knowledge, observing daily life and finding problems is the best way to identify entrepreneurial opportunities. What is a problem? A problem is a perceived

gap between the existing state and the desired state. As long as we observe a gap between the two states, and this gap makes people feel uncomfortable and uneasy, causes them pain, or makes their life difficult, then the gap is a problem. Even if you are not quite sure what the expected state will be, as long as you are not satisfied with the current state, it is also a problem!

Observing and questioning are the main methods that help you to find problems. You can use the WH questions to get you started: Who, What, When, Where, Why, and How. What is it about? Whose lives can be made easier? How can it make their lives easier? If you can, try to observe and ask these questions about the phenomenon that you are interested in, you will find many problems. This works with students as well as real-life entrepreneurs. Table 2 illustrates the questions that students observe an ATM, the questions and the potential problems.

This WH questioning and observation has been tested in our course of decades of years. It works. It has been demonstrated to be very successful in terms of problem discovery, idea generation, product proposal as well as an enterprise plan by university students. It can motivate a class of 50 students to discover about 100 problems. About 10 potential ideas will be selected after a series of multi-disciplinary assessment and screening.

It must be pointed out that not all questions may lead a problem and not all problems will lead to entrepreneurial opportunities. Some problems are non-entrepreneurial problem. For example, a person may have pain in the head. That is indeed a problem. But it is only a temporary problem. He/she can take medicine or see a doctor. The pain may disappear.

There are many personal problems, management problems or engineering problems that are temporary and can be solved with existing method. Not all problems are entrepreneurial problems. Only those problems that last for long and really cause pain can be regarded as entrepreneurial problems. Many startups fail, not because they cannot produce the product they promise, but because they try very hard to solve the wrong problems. Therefore, the assessment and selection of problems from the entrepreneurial perspective are needed.

The core to find the problem is not the tool but the attitude. Problems exist everywhere. Yet, some people may not see problems at all. Other people avoid them, and still others see problems, but ignore them. Entrepreneurs, however, not only see problems, but they also turn them into opportunities. Some entrepreneurs even discover problems that are not visible to others and then imagine how the problems can be turned into great opportunities. So it is the attitude that determines whether a person can find problems or not.

This attitude is influenced by the local culture. In Chinese society, the culture of "Satisfaction is happiness" may have a heavy negative influence on finding

problems. By the way, there is a linguistic pitfall about problem in Chinese language. The Chinese translation of Question and Problem are exactly the same! Question and problem are obviously different in English, but very difficult to explain in Chinese. The question may help people to find the problem, but a question may not be a problem yet.

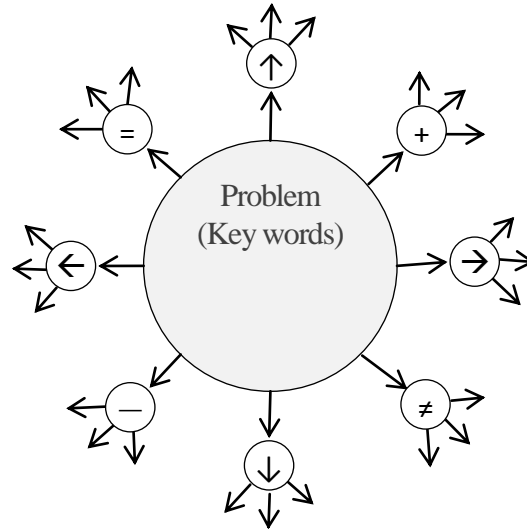
### **The Cre8map for idea generation**

Finding problems is the first step. The next step to learning is to find solutions to solve the problems. This is related to creativity and idea generation. There is some confusion about the word "creativity" in the Chinese language. Creativity has been translated into at least three Chinese words with quite different meanings. One of them is "creative idea". When teaching about "creativity" in a Chinese context or working with Chinese students or employees, what must be emphasized is that "creativity" is different from "creative idea". In current creativity education in China, "creativity" is often misunderstood as a mere snap of the fingers. "Creativity" is actually a process while "creative ideas" are the outcomes of the process. This week we want to emphasize that the creative process takes time. There are other misunderstandings about creativity in contemporary China. Two such common misunderstandings are that creativity is just like a flash of light that appears out of nowhere, or that creativity requires only the right side of the brain.

The well-known Graham Wallas model may help us understand that creativity is a process from Preparation, Incubation, Illumination to Verification, Wallas, 1926. This model is still influential today, Runco, 2014; Sadler-Smith, 2015. Wallas' model will also help us to understand why both sides of our brains are needed for the process of creativity. It will also help us to understand why a Diamond Style of Thinking is needed at each stage of the PIPE Model. The Diamond Style of Thinking starts with divergent thinking and ends with convergent thinking, Couger, 1995.

After clearing all these confusions, we will come to idea generation. There are hundreds of tools for idea generation. A website collects over 50 different methods, Creative Minds, 2015. The most popular methods include brainstorming, mind map and SCAMPA etc. However, perhaps not everybody knows that the mind map is not really a tool for idea generation. It is a tool mostly for recording, organizing or memorizing ideas. Other tools like TRIZ or SCAMPA are either too complicated or not easy for fresh students in a general education course. Idea generation cannot rely on a tool that people check like using a manual. It has to be learned by heart and inspired spontaneously.

In this paper, a Cre8map (i.e., creating an idea map) is introduced. The Cre8map is a tool based on the mind map and 8 simple mathematical signs, standing for



**Figure 1.** The Cre8map for generating ideas

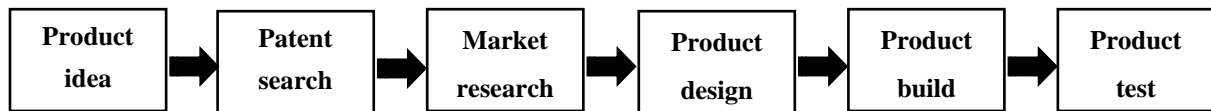
**Table 3.** Explanation and examples of the 8 sign in the cre8map

Formula	Examples
Combine $A + B?$	Mobile phone + camera; clothes + heart monitor; earphone + radio; earphone + earring; necklace + wireless microphone
Eliminate $A - B?$	Radio - loud speaker $\Rightarrow$ portable music player; sales - middleman $\Rightarrow$ direct sales
Increase, enlarge $A \uparrow?$	Low speed prop plane $\uparrow \Rightarrow$ high speed jet plane; cassette tape audio player $\uparrow \rightarrow$ digital music player with thousands of songs
Decrease, shrink $A \downarrow?$	A Sonar system for navies $\downarrow \Rightarrow$ smaller one for fishermen $\downarrow \Rightarrow$ even smaller for hobby fishing; House vacuum cleaner $\downarrow \Rightarrow$ keyboard vacuum cleaner
Forward $A1 \rightarrow A2?$	iPhone5 $\rightarrow$ 6; penicillin $\rightarrow$ amoxicillin
Backward, reverse $? A2 \leftarrow A1$	Simple phone for senior citizens $\leftarrow$ mobile ( $\rightarrow$ smart phone)
Association, analogy $A = f(B)?$	Inkjet printer = principle of capsule coffee maker; digital camera sensor = insect eyes; airplane = bird
Alternative, substitute $A \neq f(B)?$	Mobile phone case made of: plastic $\neq$ leather $\neq$ metal $\neq$ nano-material

combining (+), delete (-), similar principle (=), different principle ( $\neq$ ), increase ( $\uparrow$ ), decrease ( $\downarrow$ ), reserve ( $\leftarrow$ ), and forward ( $\rightarrow$ ), as illustrated in figure 1.

These 8 mathematical signs are universal in most countries and can visually inspire us to generate new ideas. It is visual and easy to remember and use. We can use the Cre8map to help us to generate ideas and use a table to organize and record these ideas. Table 2 lists examples of new ideas following the 8 signs. Table 3 lists the examples and the illustration of the 8 signs.

In teaching, the students must select a problem first, without a problem, creativity will be just for the purpose of creating and generating many ideas for no purposes. Cre8map is problem driven. For each problem, there can be decades of ideas to solve it. Not all ideas are suitable for entrepreneurship. Some ideas may be a temporary solution. Whether an idea is a good and useful idea of entrepreneurial perspective depends on whether the idea can be developed into an independent product or service. Cultural wise, the Chinese are very flexible in thinking and



**Figure 2.** The NPD process of entrepreneurship

behavior, Hall 1976.

However, the Chinese are mostly shy! In a brainstorming session, either nobody talks or everybody talks. IN this case, the controlled version may be used. The 635 Brainstorming was quite good with is quite proper for Chinese students. The 635 method recommends a group size of around 6 students. With each turn, everybody is supposed to generate 3 ideas so that everybody has an equable chance. Then team members submit their three ideas to the moderator so that people don't need to feel shy or feel that they have no confidence. Each round can take about 5 minutes, which can be adjusted according to the speed and productivity of the participants.

### The BAH Model for product development

A product or service is the core of a business and is essential for business success. New Product Development (NPD) is the process of turning an initial idea into a product or service. New product development is nearly missing in EE in Chinese universities now. Most EE teachings are focused on business model development even without a product. It may be because most EE courses are taught by business school teachers who are not familiar with NPD. There are many models of NPD and a generic model is introduced here based on the BAH model by Booz, Allen & Hamilton, 1982). This model includes the following steps: the generation of a product idea, patent search, market research, product design, product development, and product test, as illustrated in figure 2.

After the problem and the idea to solve the problem. The team needs to turn and solution idea into a product idea. It must first make sure that no other company or person owns the idea behind its product. So the startup needs to conduct what is called a 'patent search'. It can do this by students, although hiring a professional patent attorney or agent is also possible in some universities. Patent search websites are one of the best and most rapid ways to carry out this task. If the product idea is similar to existing patents, the idea does not necessarily have to be immediately dropped. Sometimes a new startup can be inspired by these patents and create new products, or improve the products and generate some new product ideas. If it is a service, market search is also needed to see if there are similar services already. Students are recommended to a physical product so that they can learn all the steps of NPD. A patent search report can be required if patent search resources are

available. When the patent search is done, the next step is to carry out what is called 'market research'. Market research is conducted to understand the potential market and collect the necessary information to make good business decisions.

There are two types of market research. One is secondary market research, which is how you should start. Secondary market research means the method of collecting second hand information which is already available from other parties.

This information can be collected from the internet, magazines, books, reports, conference proceedings, etc. The information can be very helpful to understand the size of the potential market, similar products in the market, and the competitors you may face.

After that, primary market research should be conducted to collect particular information related to your product idea and to get feedback from potential customers. The information is usually collected through surveys, focus groups, and interviews. In this kind of research, however, you should keep in mind that you should not release detailed information about the product if it is not already protected under copyright law.

Product designers should do their best to provide features in the new product which will benefit future customers. However, that doesn't mean a product should contain as many features as possible. The concept of Minimum Viable Product (MVP) advocates that a startup should first develop a product which has as few features as possible and the features should be just enough for what is known as a 'user test'. For students in a fundamental course, the level of the product development can range from high to low: it could range from a verbal description of a 2D model drawing or even to a 3D printout or a digital prototype. A prototype, whether physical or non-physical, really functions and can be used for user tests or studying user experiences. The level of new product development you can reach is determined by how much support you have.

In a user test, the students ask some likely customers to test the product and especially to find problems or weaknesses with it. The comments on the product performance should be collected at this stage. And as you can see, to conduct a real user test you need a functioning prototype. Although the BAH model is introduced, it doesn't mean that every group shall go through every step of the process listed above for developing a new product. Furthermore, sometimes the process is not so linear and can have a lot of back and forth.

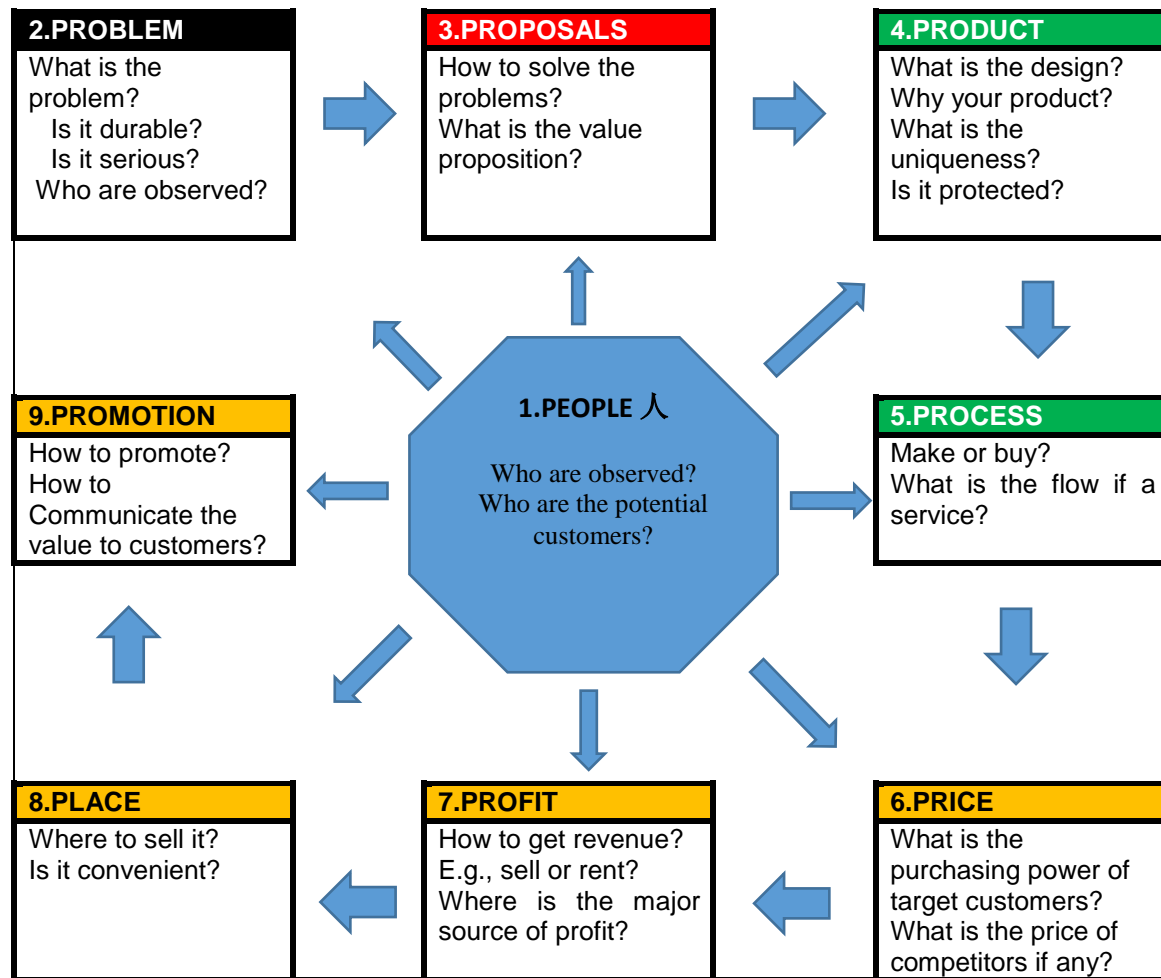


Figure 3: The 9P canvas for developing a simple business model

### The 9P canvas for developing business model and business plan

A business model describes how a business will make money. Business models can range from simple to very complex. In either case, the design of a business model does need to specify the core elements of a business and identify the relationships among these elements. There are a few well-known canvases or tools for developing a business model, for example, business model canvas by Osterwalder (Osterwalder and Pigneur 2010) and Lean canvas model by Maurya (2012). However, there are obvious shortcoming for teaching these models for junior undergraduate students. With these two canvases.

As Maurya (2012) himself pointed out, the Osterwalder Canvas was based on cases that have been successful and did not use the canvas at all, e.g., Apple and Skye. It does not clearly specify the problem to be solved. He believes that most startups fail, not because they fail to build what they set out to build, but because they waste time, money, and effort building the wrong product. "I

attribute a significant contributor to this failure to a lack of proper "problem understanding" from the start", he said. Ironically, both canvas misses a block of product. It may be because many cases are IT or website businesses without obvious physical products. Additionally, the logic and flow are quite complicated for students.

Additionally, very few people talked about that there are pre-requisite knowledge for developing business models based on these canvas tools. Crittenden *et al.*, 2015 suggests that Operations Management and Management Accounting are needed for developing business models, while Zhang *et al.*, 2013 recommended that knowledge's in management, managerial economics, strategic management, marketing and finances are needed to learn entrepreneurship and business models. According to Crittenden et al 2015, p.119, before taking operations management and management accounting, the business model is a black box! However, students learning general education courses on entrepreneurship do not have any of this knowledge. Before taking operations management and management accounting, the business model in

foundation of management and entrepreneurship is a black box.

In this paper, we introduce the 9P Canvas for business model development. The 9P's include people, problem, proposal, product, process, price, profit, place, and finally promotion, as illustrated in figure 3. The 9P Canvas is a fundamental, people-centered tool. All the other elements revolve around people. As a beginning learner in entrepreneurship, it is important to ask the following questions guided by the 9P canvas, corresponding to each of the 9 blocks.

- 1). The first block is about people, questions include: who is been observed and studied for the problems? Who are the potential customers?
- 2). The second block is about the problem: you need to ask, what is the problem connecting all of these people? Is the problem durable and serious?
- 3). The third part relates to the proposal to solve the problem: How can you solve the problem? Which proposal leads to a product idea? What is the value proposition from this proposal?
- 4). The fourth block is about the product. What is the product idea? Is it predictable? What is the uniqueness?
- 5). The fifth block is related to the process to produce the product or deliver the service. Questions may include: to make or buy? What will be the cost to produce? What is the flow of the operations?
- 6). The sixth block is about price. After the product design and the process decision, you can ask what will be the price and what are the purchasing capability of the potential customers and what should be the reasonable price?
- 7). The seventh block is about profit or revenue source. Do you sell your product or rent it? Assuming a price is decided, what will be the estimated profit?
- 8). The eight blocks is about the place. Where will be the place for you to sell your product, is it convenient to customers?
- 9). The ninth block is about the promotion, how will you promote your product? How can you communicate the value of your product to customers?

The 9P business model canvas is not only for documenting your business model step by step. It is a tool to explore, analyze, revise and justify a business model. There will be a lot of back and forth revision. There could be Plan B or Plan C. So keep in mind that it takes time to develop a viable business model. The 9P canvas can be expanded and include other factors in advanced courses. Partners, resources and performance, etc. can be considered in related blocks. Very often students are confused by the business model and a business plan. The business model explains the rationale while the business plan provides the details. The business plan builds upon a business model and explains the implementation steps to achieve the goals of your business model. Although business plans may vary, they usually include: executive summary, company

description, market analysis, organization and management, product line, marketing and sales, funding request, financial projections, and appendix. There are three types of business plans. They are mini-plan, standard plan, and working plan.

A mini-plan is only a one-page summary. It is used to offer a very quick overview of a business. A standard plan is the most common type of business plan. It is used for further meetings with investors. A working plan must be rich in details. It is a tool to be used to operate your business. Due to time and knowledge limitation, in a foundation course for university students, a mini-plan is good enough.

## CONCLUSIONS AND FUTURE WORK

For GE students who do not have much technical knowledge, it is very useful to start the discovery of problems in daily life. All students can join this course. All students who join this course will have the chance to practice the discovery of problems and idea generation following the PIPE model. The mindset and methodology will influence students in the future when they join more technical or professional courses.

There are basically two strategies for innovation and entrepreneurship, namely market-pull versus technology-push. The PIPE model is a typical market-pull approach. In the future, we will explore the TIME model, (i.e., from Technology, Idea, Market finally to Enterprises). The TIME model is suitable for senior students with technical knowledge. If technical issues are involved, colleagues from relevant technical departments/units can be invited to be additional supervisors to the entrepreneurship teams.

A further development of the PIPE model is to discover problems in industry and invite managers from relevant industry to be the mentors and/or assessors. The PIPE model only touches some aspects of local Chinese culture. Previous research demonstrated that national cultural does influence innovation capability, Sun, 2009. Future research will investigate how local Chinese culture will influence the teaching learning activities as well as assessment tools in the PIPE model.

Another future research will be theory-based research to validate that the teaching and learning activities can really enhance innovation attitude and ability of students taking courses under the PIPE model, Ajzen, 1991. Due to time limitation, the paper cannot introduce those warm-up games. These games are not only for warm-up but also the way to explain the basic theories and concepts. These games are available in other reference books as well and readers can develop their own versions.

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