

A Real-Life Supply Chain Game to Enhance Problem Based Learning for Industrial Engineering Students

Jianguo Wang, Yew Chan Fong
School of Engineering, Republic Polytechnic
9 Woodlands Ave. 9, Singapore, 738964
wang_jianguo@rp.sg, fong_yew_chan@rp.sg

Abstract - The paper introduces the implementation of Problem Based Learning (PBL) pedagogy in the School of Engineering, Republic Polytechnic, Singapore. To enhance the PBL, many activities have been introduced in the school for students to gain more real life experiences. The paper describes the development and implementation of a real-life supply chain game for industrial engineering students. The objective of the game is to help students to gain hands-on experiences in managing demand, supply and inventory in a supply chain.

The activity is managed as a part of creative engagement (CE) module in which every student is required to accumulate certain amount of CE points from different kinds of CE activities in order to pass the module. The paper presents the framework of Republic Polytechnic's new holistic educational approach by combining PBL and creativity engagement. The details of the development and implementation of this game, student outcomes, and some interesting phenomena observed from the game will be shared. The impacts of the game to the problem based learning pedagogy adapted in the programme are also discussed.

Key Words- Creative Engagement, Problem Based Learning, Supply Chain Game, Industry Collaboration

PROBLEM BASED LEARNING

In the School of Engineering at Republic Polytechnic, Singapore, problem based learning (PBL) has been adopted to deliver the engineering curriculum.

At Republic Polytechnic (RP), the problem based learning takes on a one-day one-problem approach [1]. The one-day one-problem approach is RP's formula to apply PBL to meet its specific mission of training technical professionals. The strength of the approach is that it affords students opportunities to reflect on a daily basis how they have been learning. It also gives students the chance to develop and practice processes that underpin the quality of their learning. Finally, it also exposes students to concepts in clear and decisive manner, and that helps students able to apply

knowledge to unique situations by virtue of their familiarity when dealing regularly with the context of real world problems.

To enhance and broaden the learning experience of the students in the School of Engineering, activities outside the classroom are organized to complement the PBL [2] process. The real-life supply chain game is one of the activities designed for the students under the Diploma in Industrial and Systems Engineering.

REAL-LIFE SUPPLY CHAIN GAME

The real-life supply chain game is developed from MIT's beer game. The beer game is a widely used board game in MBA courses to demonstrate the bullwhip effect along the supply chain. There are four players in the beer game to act as manufacturer, distributor, wholesaler and retailer. Tokens and chips are used as cans of beer to be delivered from one player to another. The target of the game is to reduce back-orders and inventory holding, thus minimize the total cost of the supply chain.

Based on the similar concepts, the real-life supply chain game is played not on board, but in real life. It is run as a real business in campus with real products, real buying and selling and real financial transactions.

To make the game more like a real world business and help students to understand logistics and supply chain practices in industry, the game is organized collaboratively with a local logistics company, a 3rd party logistics service provider, as our partner. The logistics company brings in the product used for the game, a newly developed canned drink through one of its customer, a local drink manufacturer.

The whole supply chain consists of supplier, manufacturer, distributor, wholesaler, retailer and customer, as shown in Fig.1. Among them only manufacturer, distributor, wholesaler and retailer are played by 4 students. The office of the School of Engineering plays the role of the 'supplier', using its store room as the warehouse of the products and issuing drinks to student players everyday. Customer can be any one in or outside of RP's campus.

For transactions, the logistics company has customized their live e-logistics portal for this game. Students are given user IDs and password to access the portal to do transactions of buying, selling and inventory management just like real customers of the company. Fig. 2 shows the screen capture of the e-logistics portal for the game.

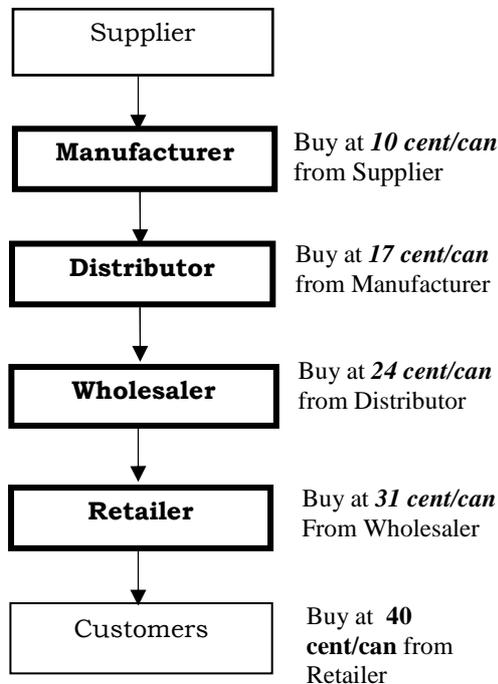


FIGURE 1
SUPPLY CHAIN AND PRICE STRUCTURE

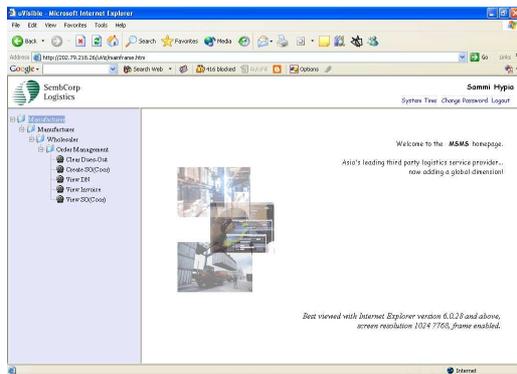


FIGURE 2
SCREEN CAPTURE OF THE E-LOGISTICS TRANSACTION PORTAL

To play the game, students follow the rules of the game as shown below:

- At the beginning of the whole game, 10 cans of drink are free.
- Each player places order to purchase certain quantity of drinks from his upstream member.
- Each play fulfills and delivers the order made by his downstream member.

- There is only one order per day.
- Order quantity for each order is not restricted.
- Each player's inventory and backlog is checked at 12am every day through e-logistics portal.
- Backorder cost is 2 cent/can/day and inventory holding cost is 1 cent/can/day.
- The recommended price of the drink in the supply chain is shown in Fig.1.
- Target of the game: minimize the cost in the whole supply chain.

The students from the Diploma in Industrial & Systems Engineering are very enthusiastic to the game. Almost 70% of the cohort participate the game and form 14 supply chains. Starting with their common knowledge of buying and selling, students have experienced the order placement and inventory management through e-logistics portal, customer order fulfillment with transportation and home delivery, daily book-keeping using EXCEL spreadsheet and basic accounting. They are taught to observe the fluctuation of order quantity and information distortion along the supply chain through talks given by industry partners and to understand the complexity of the supply chain management. Fig. 3 shows 2 students are checking their inventory online and collecting the drinks from the warehouse.



FIGURE 3
STUDENTS IN THE REAL LIFE SUPPLY CHAIN GAME

Most of engineering schools in other higher learning institutions organize the activities in this nature as extra curriculum activities [3-4]. As the one-day one-problem PBL pedagogy is adopted in the Republic Polytechnic, solving real-life problem daily is part and parcel of students' academic life in campus. Self initiated discovery through real life experiences with industry involvement becomes critical for students to understand and reflect the problem statement in their classroom. Thus a separate academic module, Creative Engagement, is created to manage all these activities in Republic Polytechnic.

CREATIVE ENGAGEMENT

Creative Engagement (CE) is one of the total 30 modules needed for graduation in RP. The objective of CE is to get students meaningfully involved with diverse opportunities that arise within RP and surroundings and contribute towards betterment of the outcomes, to attract student volunteers to activities organised by RP and to get RP staff to organise activities which are meaningful to students.

Students will be awarded points for taking part in various activities. All activities are categorized by two binary characteristics: Passive/Active and Diploma-related/Not Diploma-related. To obtain a pass for CE Module, a student has to accumulate 40 points, of which at most 10 points may have been earned from Passive type engagements, and at most 20 points from Not diploma-related type ones. Since CE is an academic module, it will be assessed by an academic staff. Normally students earn one point for each three hours of work with satisfied level of achievement.

The real life supply chain game is an activity proposed under CE module as an active diploma-related activity. As such, students are more motivated to sign up and complete the whole activity. Table 1 below shows the various CE activities and the CE points students may earn.

TABLE I
CE TYPES AND POINT AWARDING

	Diploma-related	Not Diploma-related
Active	Professional workshop, industry visit, mini R&D project, etc. e.g. Real life supply chain game Manage demand, supply and inventory level.	School open house, school outreach, community activities, freshman orientation, etc.
	Up to 40 DA (diploma active) points	1NDA (Non Diploma Active) points per 3 hours of work
Passive	Attend diploma-related training, seminars and industry talks e.g. in the real life supply chain game, training of using e-logistics portal, game briefing by academic staff and industry partners.	Attend not diploma related trainings, seminars and talks, etc.
	1DP (Diploma Passive) point per session	1NDP (Non Diploma Passive) point per session

The School of Engineering focuses more on active, diploma related CE activities with industry involvement. To engage students more actively, students are normally required to complete a worksheet or reflection journal in these activities.

OBSERVATIONS AND FINDINGS

Throughout the game, participating students are very enthusiastic and innovative in their buying and selling. They have discovered some phenomena which will be covered in their future lessons, such as “bullwhip effect”, re-order point replenishment, forecasting and IT tools for supply chain management. Below is an extraction from one student’s reflection journal:

“I am delighted to have joined this game because I have learnt new terms such as ‘bullwhip effect’ in this 45-day game period. Through the game I also realize the importance of communication and cooperation within a supply chain in order to reduce unnecessary cost. Tools such as electronic data interchange can be used to supply chain efficiency. Work with each other to build up relationship along supply chain so that information is shared as you might not know, for example, the trends of their customers. Overall I think that these experiences would certainly aid me on my studies or even my future career.”

In the following few semesters, students who have participated the real life supply chain game can easily relate the problems in their PBL class to the game they had played, in the modules such as Inventory Management, Global Logistics Management, Warehousing & Storage, as well as Supply Chain Management. It shows the game has provided the concrete experiences for students as part of their learning process as shown in Kolb’s model [2] in Fig. 4.

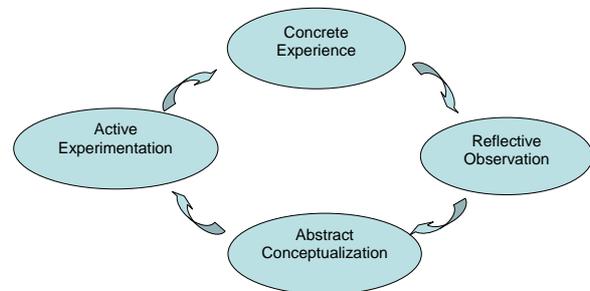


FIGURE 4
KOLB'S DESCRIPTIVE MODEL OF LEARNING PROCESS

CONCLUSION

The real life supply chain game has helped students tremendously in their understanding to abstract concepts and phenomena in supply chain and industrial engineering. The introduction of the Creative Engagement module in RP's PBL environment has provided a new platform for staff and students to initiate various activities collaboratively with industry. Together the platform provides the concrete experiences at the beginning of students' learning process.

REFERENCES

- [1] Jianguo Wang, Yew Chan Fong, W.A.M. Alwis, "Developing Professionalism in Engineering Students Using Problem Based Learning" Proceedings of the 2005 Regional Conference on Engineering Education, December 12-13, 2005, Johor, Malaysia
- [2] Jianguo Wang, Yew Chan Fong, "Leveraging On Simulation To Enhance Problem Based Learning In Engineering", Proceedings of International Conference PBL 2006 ABP, July 2006, Peru
- [3] Kang Yi, K-H Jung, "Partnership between re Companies Universities through Students' Extra-Curriculum Activities", Proceedings of the 2005 IEEE International Conference on Microelectronic Systems Education (MSE'05), USA
- [4] J. H. McMasters, et al. "Industry-University-Government Roundtable for Enhancing Engineering Education (IUGREEE)", Working Paper, March 1999, http://www.eng.iastate.edu/iugreee/Docs/iugreee_WP_final.pdf