



A Study on the Inclusion of the Process Safety in Chemical Engineering Curriculum and Student responses at Isfahan University of Technology

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After many decades of appearance of chemical industries in west and rest of the world, still “Process Safety” has not found its right place. Osborn [1] reports that most often the issue of safety has been treated as a tag-along kid among the others in a playground who while is annoying some times yet could not be thrown away. However one can see much improvement in the world view toward “Process Safety” compared to decades ago. In the recent years the same improvement has been developed in Iran. Most of the time “Safety” and “Environment” are two closely related issues, and coming short in one subject causes huge and irrecoverable consequences in the other one [2]. Parallel developments in “Safety Education” in Industries as well as in Academic institutions are visible in different countries [3-5].

As the processes become more complex and with increase in importance of implementing the safety rules and regulation in chemical industries and Need to pay more attention on teaching the problems and challenges that are related to “Safety” and “Industrial Hygiene”, the need to expand these educations to the topics related to “Process Safety” techniques, and need to increase the students awareness on “Inherent Safety” is felt more than before. It is more than two decades that some efforts has been initiated toward inclusion of safety in chemical engineering curriculum [5]. In Iran as well some scattered works has been initiated to include some process safety related courses into main curriculum of some chemical engineering departments at few universities. However still there is no much evaluation and study of these programs regarding the number of such departments, whether these courses are offered as elective or compulsory, as two or three credit hours, and as graduate or undergraduate level? Louvar and Hendershot have listed some basic rules that universities and chemical engineering departments should consider in development of a “Professional Process Safety Culture”

- ❑ Teaching of “Safety Problem Solving Methods”, “Safety Concepts”, and related theories
- ❑ Teaching of “Consequences” of ignoring Safety to students
- ❑ Encouraging the undergraduate students to continue their studies in process safety at graduate level



Methods:

From three years ago, a two credit hour elective course in process safety subject at undergraduate level has been initiated. The course has been offered by the author in September 2005, January 2007, and current semester (January 2008). In past two semesters, every time an evaluation questionnaire has been designed and implemented in the E-learning site of the university and student responses to 18 different questions in two categories of multiple choices (13 questions) and descriptive (5 questions) has been collected. Questions covered students opinion on the course content as well as teaching methods and free suggestions and opinions regarding improvement of course and ways to make it more attractive. Among the most important questions, are those which compare the mental imagination of students about safety issues before and after this course. Also there were questions about the students evaluation on group activities like solving the homework problems and doing the course project.

Results and Discussion:

Student replies to some multiple choice questions of surveys are shown in table 1. Also a summary of main points in replies to four descriptive questions are shown in table 2. The results show that about 92% of students had felt various degrees of improvement on their mental expectations of this course before and after taking the course. Also about 86% of the responses show that student see the group work in solving the exercises and course project as useful and positive. Furthermore, about 68% of students evaluated the cooperation in their group as very good; while 20% other evaluated it as good. In addition 72% of the students were satisfied on the quantity of homework and class works. In the degree of cooperation in their group, 70% have said that they work together in their group, while 22% have said that although every one in their group works, however they are not working as a group meaning that they work by turn and not together. Also a small percentage have said that in their group, all work is done just by a single person. At last, a big majority of students have felt that this course should be offered as a 3 credit hour compulsory course, at least for student who major in petrochemical industries.

Results of multiple choice questions and collective information of descriptive questions as presented in this article can be a good indicator for necessity of inclusion of "Process safety" courses in the Chemical Engineering curriculums. The next step is inclusion of "Process Safety Concepts" in all core courses of chemical engineering departments in order to prepare them for more important problems when they take the specific process safety course. We should not get to this illusion that just by providing a 2 or 3 credit hour course in process safety even as a compulsory one we can do much to change the status quo.



What has been started in IUT by author or in other Iranian universities is just at a level to introduce a portion of future chemical engineers of the nation to main concepts of process safety, and still is far from an acceptable point. However educating students in process safety can include detailed diverse topics such as: Resources Loss Prevention, Process Design Safety, Process Hazard Analysis (PHA), Consequences Modeling, Quantitative risk Analysis, Loss Control, etc.. Each of these can be topic of a separate course.

Table 1: Answers to Multiple choice questions

Question	Semester	Total Ans	No Ans	Close (100%)	Highly (75%)	Some what (50%)	Little (25%)	Far (0%)			
1 How close was the course content to what you had in mind before registration	1- 1384	31	0	4	10	13	3	1			
	2- 1385	19	0	0	12	3	3	1			
	Sum	50	0	4	22	16	6	2			
	percent	100	0.0	8.0	44.0	32.0	12.0	4.0			
2 Usefulness of group works	Semester		Total Ans	No Ans	Very high (100%)	High (75%)	Doesn't Matter (50%)	Not much (25%)	Useless (0%)	Harmful (0%)	
	1- 1384	31	2	12	14	2	0	1	0		
	2- 1385	19	0	11	6	1	0	1	0		
	Sum	50	2	23	20	3	0	2	0		
	percent	96	4.0	46.0	40.0	6.0	0.0	4.0	0.0		
3 Your opinion on the number of assignments and problems	Semester		Total Ans	No Ans	Fair	Little High	High	Very High	Not Enough		
	1- 1384	31	0	9	13	9	0	0			
	2- 1385	19	0	9	5	3	1	1			
	Sum	50	0	18	18	12	1	1			
percent	100	0.0	36.0	36.0	24.0	2.0	2.0				
4 How homework problems solved in your group	Semester		Total Ans	No Ans	By all members and consultation	Problems divided, review of soln by all	Problems divided, solved independent	Problems solved by turn	Only one member worked	Not member of a group	
	1- 1384	31	2	8	13	1	7	0	0		
	2- 1385	19	0	7	7	3	0	1	1		
	Sum	50	2	15	20	4	7	1	1		
	percent	96	4.0	30.0	40.0	8.0	14.0	2.0	2.0		



5	What you think of cooperation in your group	Semester	Total Ans	No Ans	Very Good	Good	Little Weak	Weak
		1- 1384	31	1	20	7	1	2
		2- 1385	19	0	14	3	2	0
		Sum	50	1	34	10	3	2
		percent	98	2.0	68.0	20.0	6.0	4.0
6	Two or three credits hours	Semester	Total Ans	No Ans	Two credits	Three Credits		
		1- 1384	31	1	10	20		
		2- 1385	19	0	9	10		
		Sum	50	1	19	30		
		percent	98	2.0	38.0	60.0		
7	Is Process safety important such that a 3 credit compulsory course is needed for it?	Semester	Total Ans	No Ans	For All	Only for Petrochemical	Elective for all	
		1- 1384	31	2	11	10	8	
		2- 1385	19	0	10	4	5	
		Sum	50	2	21	14	13	
		percent	96	4.0	42.0	28.0	26.0	

Table 2: Answers to Descriptive Questions

Question	Collective Answers
1- Overall opinion about the subject to the survey date (one month before the course ends)	<ul style="list-style-type: none"> • Subjects were new, useful and attractive and have not been raised in any other course • Learning these information is a must for chemical engineers, but it was better if there was more time to present them in more details • Better to increase the ratio of practical and conceptual problems related to industries to the theoretical part in order to increase the motivation • It is necessary to have industrial visits to see the consequence of not following the safety rules • In teaching each subject, it is needed to bring real world examples of incidents which were caused by not following that subject



<p>2- Knowing that this course is not taught every where, do you think this will increase your job opportunity?</p>	<ul style="list-style-type: none"> • It is better to use more audio-visual aids in teaching this course • For sure it is useful. An engineer who is aware of safety issues is different than one who is not familiar with these issues. So he would have better opportunity for job. • It will increase contingent to increase in public awareness to importance of safety issues. • If coupled with introducing and learning of related software, it will be more useful. • Some students have mentioned the effect of this course in increase of their job opportunity as their main reason for taking the course. • For some students importance of widening their view was more important than increase in job opportunity • Not as a spate job, but joined with chemical engineering knowledge it helps to find better jobs • There was some negative replies too reasoning that in Iran, safety is the last issue in importance or mentioning that “In Iran not much attention is paid to safety of employees and same is true for industries”
<p>3- In addition to professional issues, do you think that what you have learned in this course may affect your daily life and view to different issue.</p>	<ul style="list-style-type: none"> • Pronounced view of students show that for sure their view has changed and to most of issues around them which they were indifferent now their awareness has increased and they would pay attention to safety related issues. • More responsible feeling in regard to safety issues and keeping environment around them safe for themselves and for others. • Alertness to scattered non safe conditions that they used to them before and which were not visible to them before this course • Increased attention to economical aspect of safety and long term benefits of it. • It has strong effect on importance of safety and its economic in decision making in industries and daily life.

In addition, process safety education needs a complete package including available software and educational aids for effective demonstration of concepts and training. Off course a more important approach as suggested by Osborn [1] may be considering and teaching the safety concepts in all major chemical engineering courses such as thermodynamics, fluid



mechanics, heat and mass transfer in a way that students while solving problems as usual, additionally they analyze their answers based on safety issues. Then at the final year student take one or more courses on specific process safety issues. Unfortunately in most of the cases, chemical engineering instructors are not much aware of importance of attracting students to safety issues and making idea of inherent safety pivotal in design and commissioning of processes. Anyhow, only by enthusiasm in mentioning it at each appropriate point while teaching all courses these concepts find their places in the mind of students.

On the other side, need for more cooperation between local chemical industries and chemical engineering departments is felt more than before. By such cooperation, students benefit from industries experience, and industries too gain benefits from fresh and open minds of young students in finding the weak or improvable points. In the current course at chemical engineering department of IUT, many students have to visit different chemical industries and write a report on their finding of weak and strong safety points with regard to what they have learned in the classroom. Unfortunately in many cases industries don't want that any student talk to them about their safety issues and accident history. Usually they think of students same as inspectors of regulatory agencies and in limited cases they allow them in with a condition that they don't mention the name or place of the industry. They are ignoring the fact that real danger is in having unsafe conditions, not finding such conditions by students. Even these industries should be thankful to students who make such reports for them free of any charges.

One of the main goals in teaching the process safety course at IUT, was to highlight the importance of cooperation and group works. To achieve this goal, students are divided into groups of 3 or 4 members. All home works and course project should be done by groups. This is done to train the students in methods of group working and to let them know that in achieving a safe environment no one can do much work alone. But as in many other sectors, some times students resist to work in groups, or don't do their duties in a group raising a variety of different excuses such as members living in dorms or city, having different habits and life styles, or being from different entry years etc. However the main goal of group work is to overcome these same differences. While experience in group work is much appreciated at most of the companies and industries at international level, and while group work is encouraged in most of the top ranking universities in the world, still due to past and even current cultural backgrounds and official practices which encourages personal achievements rather than group works, in this field too much obstacles and problems are visible. But it should not be forgotten that group work experience should be an essential part of any program of safety education. Finally more studies and research in field process safety education in chemical engineering departments are needed.



References:

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