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The Current and Future Implementation of Safety Curriculum For Chemical Engineers in GCC Countries

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Abstract:

The safety topic became a global issue which is demanded for engineering colleges. It was evaluated and proposed to be a core issue for chemical engineering curriculums. The challenge has been attempting to develop proper academic curriculum or concentrate on the occupational applications. This paper highlights the actual curriculum that is being taught in regards to loss prevention and safety for chemical engineers. The issue went further in this study to suggest the needs for safety curriculum for chemical engineering in GCC countries that comprises five countries in Arabian Gulf countries (Saudi Arabia, Bahrain, Kuwait, United Arab Emirates, Qatar, and, Oman). Those countries had moved forward to promote their national economy towards industrialization.

Keywords: GCC countries, Safety curriculum, chemical Engineer, loss prevention, education

1.0 Introduction

In a review of the accident the past within the chemical process plants, one will find that the number of large accidents continues to increase every year. The consequences are fatality, injuries, and environmental damage and loss of preventions. There is currently no sign that this accident performance will stop or advance. The causes are the complexity of chemical processes, reactions and heat evolved when the older age of chemical plants, and larger industrial plants. It is also likely that a contributing factor is that university's educational environment disregards the significant subject of chemical process safety. Only a fraction of practicing of applied chemists and chemical engineers have the correct safety culture to confidently impact this negative performance. Just as a professional culture is developed in the university, a proper safety culture can and should be progressed in the university. There is a need that universities to implement and apply the teaching safety exercises to solve with methodologies of safety concepts, and theoretical imagination of the process. Also it is imperative to teach students the series of consequences of neglecting and ignoring the safety principles and notions. It has to motivate students to prolong their education in process safety and the life saving practices after graduation.

An evaluation of safety education experiments within three chemical engineering departments has been commented. Propositions concerning the future development and amelioration especially from the ethical and social process point of view, safety processes were suggested, but challenges to implement safety are massive.

The chemical engineering occupation is known more for the number of extreme chemical disasters that have occurred in the sector than anything else. Some of the most devastating chemical disasters occurred in Mexico City, Texas City, Blaye, Pasadena, and Lyon, just to name a few. The impact of these accidents has made an impact on the industry as a whole.

Additional emphasis is being given to urge universities to include safety and hazard training into their chemical engineering curriculum. The challenge has been attempting to develop a proper academic curriculum that delivers the core principals required to become a chemical engineer, as well as the proper safety training that may need to be employed during employment of duties. This paper highlights the actual curriculum that is being taught in regards to loss prevention and safety for chemical engineers.

In an attempt to keep the chemical engineering industry safe, operations needs to be supported by employing the assistance of multiple leaders. These leaders will need to provide multiple layers of protection, thus increasing security for workers, the public, while also increasing the bottom line. Safety leaders can help ensure that factories are moving forward in the right direction.

Multiple safety leaders may be appointed with the task, or a solidarity leader may take on the responsibility of educating any and all workers within the industry. The safety leader's primary objective should be centered on the assurance of safety. By focusing on safety in the workplace, the safety leader will help ensure that families continue to profit from the works of the employee and that all partners are employed in a safe environment.

Arab chemical engineers and European chemical engineers, although, performing the same tasks study the subject in a different manner. When it comes to institutions that teach the basic principles of becoming a chemical engineer, it is vital to remember that not all institutions are created equally. A lot of the curriculum that is taught in GCC or Arab populated countries may differ vastly from the information that is taught at European learning institutions.

2.0 Reasons To Teach Chemical Engineering Safety

Harvey, B.H., a member of the third report advisory committee on major Hazards in 1984, stated the justifiable reasons why safety protocols in chemical engineering curriculum should be including in the teachings of this art. According to Harvey, students that are introduced to safer design concepts, have a better understanding that safety within plant operations must be taken into consideration throughout the execution of design studies. Safety protocols must be taught in a stimulating and rigorous manner by staff members that have an adequate amount of experience; Departments that do not possess an adequate amount of expertise in the field of safety should use outside sources from the industry, universities, or consulting firms. The chemical engineer is most often the individual that fills the position as the responsible party throughout the design and operation stages at a plant.

Kletz, an author who is responsible for various compositions in regards to safety and student teachings, developed three arguments to further support his views on the subject. One of the principals developed by Kletz was to treat safety as an integral part in the design of plants and aim for safer designs throughout processes. Another principal developed by Kletz, was that whatever subjects he taught to university students, he would always involve practicing chemical engineers in all subjects relating to safety. Kletz believed that he had a legal and moral responsibility to teach his students the proper curriculum, and in doing so, he would face an immense amount of issues. The third principal argument that Kletz brought to light was that safety along with loss prevention involve other basic principles(Kletz;1988).

In the composition, titled Teaching Process Safety, Marshall, ranked safety and loss prevention as a vital subject within the chemical engineering field; Marshall argued that in order for a subject to qualify it must meet certain criterion. The subject should:

(a) Be an acknowledged piece of literature, such as an academic culture composition,
(b) Be recognized as something that is relevant to students,
(c) Demand intellect,
(d) Possess a corpus that is rich in knowledge, organized, and can clearly define underlined principles,
(e) Be quantitative, making it capable of subjection to mathematical evaluations,
(f) Possess unifying principles and content taken from authoritative textbooks,
(g) The subject matter should be administered by specialists,
(h) Be a subject that is normally passed,
(i) Be evaluated formally.

Marshall went on to review over the extent that safety and loss prevention meet his proposed criterion. At the time when Marshall proposed his criterion, there were only a few safety courses that fulfilled the criterion of mainstream courses, and none of the process safety courses fulfilled all of the proposed criterion. There are now considerable libraries that are full of process safety compositions, but there are limited amounts of textbooks for students to study from. Integrated approaches of teaching process safety are attained with common classified structures and taxonomy, along with a few unifying principles and concepts. Safety is still not acknowledged as a primary subject within the chemical engineering curriculum.

3.0 When Should Safety In Chemical Engineering Be Taught?

With Europe continuing to implement the three cycle degree system, cleverly referred to as Bologna, it is useful to present this survey for GCC "Health, Safety and Environment" education within a Bologna study organization. This three stage structure will highlight the goal of the Bologna process, in regards to a simplistic exchange during European studies. The GCC structure is based off of the three primary cycles of the License Master Doctorate, or LMD for short. LMD is the equivalent to the Bachelor-Masters-Doctorate method.

The final two semesters, showcased as L5 and L6 in the GCC departments are equal to the final semesters of a three year first degree. M1-M4, which represents four semesters, corresponds with a two year second degree. Teaching approaches of the SHE method are developed within the three year curriculum studies. Presently, the inclusion of loss prevention and safety over three years of curriculum can be admonished within Table 1.

Year	**Semester**	**Subject to be covered**
1	**L5**	**Laboratory safety awareness course and industries safety procedures and the effect of medical health occupation On curriculum**
2	**M1-M2**	**Core courses (49 credit hours) that include modeling**
3	**M3**	**Industrial training and on-job applications**
	M4	**Project Design**
		Medical Engineering
		Leadership related to engineering

4.0 How Should Chemical Engineering Safety Courses Be Taught?

An important question that needs to be answered at the beginning of every chemical engineering course is:

1. Should the hazard and safety aspects of chemical engineering be included as part of the chemical engineering course?
2. Should the hazard and safety aspects of chemical engineering be taught by professionals as a separate course?

The final decision of how to teach the course is going to depend upon the teaching department's philosophy. However, when deciding on how to teach the course, the following points will need to be taken into consideration. The first way to teach the course possesses its own set of advantages; hazard and safety aspects can easily be integrated into the remaining course materials. There are a lot of links that tie together regular subjects and safety topics within the chemical engineering curriculum.

There are six regular subjects within the chemical engineering curriculum that certain safety topics can be integrated into. For example, chemistry and Thermodynamics can be taught in conjunction with chemical toxicity and hazards training, along with flammability limit training and explosion energy training.

Fluid mechanics is another regular subject that could be taught in conjunction with a safety topic; when teaching students about fluid mechanics, flashing liquids, venting, and proper dispersion methods can also be taught. The same goes for heat transfer studies. While students are learning the basics on heat transfers, additional safety topics such as vaporization of cryogenic liquids can be discussed.

Finally, mass transfers, simultaneous mass transfers, social sciences, and chemical reaction engineering are taught to chemical engineering students as part of their regular curriculum. In conjunction with teaching these subjects, instructors can include safety topics that relate to social acceptance of risks associated with chemical engineering, how to create safer designs for chemical reactors, etc.

By integrating safety topics into the present regular curriculum, over a three year span, students will be better equipped to deal with issues that could arise in their primary studies. It is not expected that the staff teaching the regular chemical engineering subjects will be equipped with the necessary experience to expand their curriculum to include additional safety topics. At the present time, implementing regular studies with safety topics into the chemical engineering curriculum is difficult to do because faculty members lack the interest and background to successfully teach the said material.

The arguments have weight, forcing a promotion towards creating separate courses in regards to safety. In following this second way, of teaching an entirely separate course on safety, the disadvantages mentioned would disappear. The course would be better coordinated and coherent. The primary advantage of having a separate course that is dedicated to safety and hazard aspects is that such a course will be able to concentrate on the subject, presenting it in a systemic approach.

5.0 What Safety Solutions To Teach In Chemical Engineering?

The answer to this pressing question is not intended to be trivial. Presently, there are a lot of chemical engineers that have a difficult time grasping the concept of safety; the main reason being that there is no methodological or systematic approach in which to examine safety challenges. Another explanation of this concept lies in the analytic approach that is disproportionately favored within the French educational system. The main problem exists in the "vertical" training chemical engineers are receiving, since these are taught in narrow, specialized fields. HSE requires that a horizontal approach be taken, in opposition to the traditional vertical approaches of the past; the need for a horizontal integration and vision of expertise and knowledge has never been required more. This requires further actions to be taken to make instructors aware of the multidisciplinary approaches. While practicing the field, chemical engineers are required to take complex situations into consideration, often times these situations also involve multiple disciplines. Due to this fact, training courses are moving towards an integrated approach, that includes a variety of disciplines and concepts (which include humanities and social sciences) to expand chemical engineers perspectives and advertise a multidisciplinary approach to making decisions.

To treat perceived phenomenon's as complex systems, establishment of the fact that knowledge pertaining to the phenomenon is subordinate to knowledge of the part that make it a whole, interactions occurring between the parts, of the interaction with the environment and the primary objectives of the actor or observer of the whole. Systematic approaches propose methodological principles for investigation of artificial and natural systems with a primary focus on improving the conception, management, and function. The MADS model, or Analysis Methodology for Malfunctions in Systems model considers hardware, installation, software, decisions made by management, organizational designs, and humans all integrated as a whole (Laurent, 1999).

The MADS model is taken into consideration in its complexity, totality, and dynamics. The primary area of focus needs to be applied to the functionality and characteristics of the entire system. The analysis of the hazard techniques based on the expanded model provide a way to obtain necessary information to safely design systems and determine vital parameters that require monitoring during operation, and how to properly respond.

During the L5 semester, which occurs in the first year, process safety as it relates to chemicals is introduced to three departments through existing lab work courses in chemical engineering and chemistry. During each cycle of the experiment, safety procedures for the pilot plant and laboratory courses are further investigated. Summer positions and plant visits for work related training that adds additional emphasis to health and safety aspects are organized for students (Perilhon et al., 2001).

The 12 hour Nancy courses consist of six courses that are dedicated to teaching students the ins and outs of safety and occupational health lessons. The courses familiarize the engineering students and faculty with the occupational safety and health concerns that should be discussed in each study. Because engineers are often times called upon to be responsible for the construction and design of industrial facilities and the protocols relating to the operation, involvement with employee related issues, improved processes, new materials and a mixture of the two are constantly introduced to the industry requiring increased awareness in the health effects that take place at the design stage, engineers should never relegate health related considerations to fall in line with retrofitting practices.

Following that, the primary objective of the content of the safety course is compromised of the following subject matters:

1. Technical knowledge (includes accident analysis, definitions, probability and statistics, risk assessment methods);
2. Organizational knowledge (responsibilities and roles of stakeholders, relevant regulations and laws, financial and economic aspects, decision-making processes, safety and business management systems);
3. Human/Social Knowledge (to include risk communications, human factors, and soon ethical problems and concerns).

The detailed list of different course topics is similar to a lot of accounts that take place within the practice, in particular safety course information that is given in literary works. The core content of the course was to propose an agreement with environmental guidelines and safety guidelines that the Accreditation Committee of Institution Chemical Engineers recommends (IChemE, 1990). The SHEPC also referred to as the Safety and Health Environment Committee decided to advertise a matrix approach. The approach forced divisions in the topics. The topics were further divided into design projects, basic principles, mandatory integral, special topics, along with other separate optional and mandatory topics (Smith, 1997). The comparison of the primary content emulates the detailed guidance content that bears the name Lehrprofil Sicherheitstechnik, which was initially purposed by the GVC Committee. Finally, the proposed safety curriculum encompasses recommendations of the simplified EFCE Working Party Education guide, along with the ECTS Bologna scheme (Pohorecki, 2005).

Example content that was a part of the core courses delivered in 2007, are presented below. Take into account that the lecture portions of the course were given in two weekly sessions that lasted ninety minutes per. written examinations force students to read through their course books. A three hour open book examination is given (Laurent, 1999).

During 2007, there were a total of twenty different lectures that were given. However, each lecture did not cover a different topic. Each subject required two sets of lectures that lasted approximately ninety minutes long per lecture given. The first two lectures, reviewed over basic concepts, risks, hazards and rules of hazards. The next step of lectures focused on rules that the European legislation has set forth in regards to chemical engineering hazards. Atmospheric dispersions are covered in two lectures, along with dust explosions, and other issues that could and do occur when performing chemical engineering tasks. One thing to note is that even though there are a total of twenty lectures given, only ten topics are covered (Dechema/GVC).

Throughout the curriculum students are given the opportunity to obtain various certifications, one of which is a certification as a first-aid employee. The administration of this certification has been validated by the health ministry, under the student's association responsibility. The courses required for this validated certification are integrated into the ENSIACET-Toulouse curriculum. However, when it comes to first aid courses, taking the course once is never going to be enough. Without regularly practicing and repeating the necessary steps of the action, students will begin to lose command of the proper administered techniques. First aid courses are useful for many different reasons, they not only help to save lives of individuals, but they also heighten attention for individuals causing a stimulating health promotion (Ilo-Osh-International Labour Organization, 2002).

6.0 Who Should Teach Chemical Engineering Safety?

The three teaching departments that have been presented utilize three different teaching techniques for chemical engineering safety lessons. Shortly after the ENSIC-Nancy began integrating this curriculum, outside contributors from the industrial sector chose to create a teaching team that consisted of four teachers. Presently, 95% of the hazard and safety courses are taught by the four teacher team.

The curriculum is shared, with fifty percent of the curriculum being taught by certified teachers whose training is focused on safety, and the other portion of the curriculum is taught through conferences, where industrialists who are employed in the chemical engineering field, share their personal experiences. Based on the location where the course is being taught, workers may need to report to a classroom setting, or may be taught basic safety handling techniques while on the job.

7.0 What Should Be The Depth of Chemical Engineering Safety Teachings?

One practical answer to this question was proposed by J.E. Gillett, along with S.F. de Azevedo in regards to the depth that chemical engineering should be taught (Gillett, 2001; Azevedo, 2001). The answer was to take into consideration SHE subjects, reflecting that there are three learning stages. The first stage involves providing a basic awareness of the subject (beginner level), a second stage provides increased appreciation to the work in conjunction with subject experts (practical level) and the third stage provides a complete understanding, resulting in expertise (expert level). Taking these three levels into consideration, has helped SHE curriculum design and has been used to introduce difficult subjects at a gradual pace, thus assisting with providing a deeper understanding of the proposed subject matter. Just like with other core SHE subjects, risk analysis and basic concepts had to be taught in deeper depths.

Curriculum based knowledge is based off of information that is taken from textbooks. However, practical knowledge can be difficult to learn. When emergencies occur, it is important for workers to know what to do during these adverse times. Giving hands on practical training is the only way to prepare workers for occupational hazards. A few examples of practical training would involve having workers perform basic fire safety drills, and also to have employees follow other drills that they may eventually have to use if a disaster were to strike.

8.0 What Safety Teaching Aids to Use For Instruction?

The individual that has been chosen to teach process safety will be able to utilize some of the answers proposed to "when, why, how and what to teach in regards to chemical engineering, the individual will be able to refer to the questions of " what should be the depth of chemical engineering safety teachings". The last question, (what chemical engineering teaching aids?) could have been referred to as "Can we teach teachers to successfully teach chemical engineering safety protocols?" . Teaching is considered to be a craft that is associated with distinct skills along with practice. There are some individuals who are naturals (coincidentally referred to as "natural born instructors") and develop their skills intuitively; most do not possess this ability and need to attend years of training before teachings can be conducted at a perfect and uniform level. Sportsmen, Doctors, Engineers, and high school teachers routinely are expected to go through training; but professors that teach at universities, most of which possess a PhD, choose to join a faculty, enabling them to teach their first courses without reviewing over five seconds on exactly how an individual completes a specified task… The absence of further university teacher training is not a problem that goes unrecognized, there are plethora's of schools that offer teaching graduate courses. But, an individual cannot easily be turned into a skilled professional by attending a one-semester course; much less they cannot gain this title by attending a three day workshop or a simple two hour consultation. Skill development occurs with repeated practice and consistent feedback, teaching aids are an essential way to improve the quality and end result of the course.

Certain subjects of HSE used a lot of teaching aids that were readily available. The teaching aids are categorized as films, books, role playing, computerized models, videos, and automatic devices made for teaching. Mandating mandatory work training at the closing month of the first year, along with secondary industrial training, four to six months ending the second year, are different approaches to further integrate HSE into the current curriculum.

9.0 What Safety Barriers Should Be Used In Safety Decision Making?

Organizations that utilize hazardous and complex technology to create products or provide special services face a plethora of occupational challenges. The activities carried out by workers in these hazardous places have the potential of resulting in a significant amount of deaths, injuries, or things going adversely wrong, to be able to avoid the adverse from occurring, employees need to perform operations conservatively. They also face a lot of the same commercial and normal pressures of the industry, to reduce operational costs while maximizing production. Accident literature compositions are full of cases where organizations failed to correctly achieve their primary balance.

Being able to achieve an appropriate balance in regards to these two priorities is going to require owners to take a multi-faceted approach, operating regulators and organizations that address design, maintenance, operations, and engineering. One of the key aspects of operations personnel is to make short-term decisions that promote balancing organizational goals so appropriate actions can be taken. Reliability researchers have emphasized a need for operational personnel to be mindful (Wick and Sutcliffe, 2001), more recently, engineering researchers have put additional emphasis on sacrificial decisions-sacrificing their long term targets to be able to balance short term safety protocols (Woods, 2006). A recently released report delivered by the Presidential commission in regards to the Deepwater Horizon accident, put additional emphasis on the importance of safety decision making as it relates to operations.

A lot of the safety research is based on observations that are taken on the field. The literature boasts accounts of social scientists and their personal experiences that took place in flight decks, control rooms, operating theatres, as well as emergency rooms. Another decision making genre focuses on decisions made by management in meeting rooms and offices that are well removed from the coal face. The work included in this paper does not focus on either of these perspectives; instead it looks to explain the space that is between both of these principals. In order to avoid accidents from occurring, reviews have to be made to determine what went wrong in previous occurrences. Day to day decisions must be investigated to draw lessons where things could have gone a different way if plans were carried out accordingly.

Research shows that operational managers take on two different types of occupational identities. As employees, operational managers are mandated to take direction from their superiors in regards to the rules and certain cultural norms. In addition to the employee identity that operational managers possess, they also have a strong professional identity that helps drive their decision making process by adding value to qualities such as dedication to their job, loyalty to their peers, public trust, and an immense amount of technical knowledge. The experience that operational managers possess also gives them a understanding of the system, the complexity that exists within it, as well as the potential consequences that could result if things were to go wrong. The aspects of professional and organizational identity of operational managers are complimentary exerts to things that are further discussed in this paper.

10.0 Chemical Process Safety: A Review Of The Protection Layers

The mission of chemical plants is geared towards four specific elements. Focus is given to: provide optimum customer service, provide safe work environments for employees, protect the environment, and cut production costs. Over the last ten years, a plethora of organizations have chosen to adopt the challenges of incorporating US occupational safety and health processes into their jobs, along with process safety management practices. Increased worker protection has been the focus of PSM, enhancing environment preservation efforts is just a bonus of the process.

Corporations that have accepted the challenge to promote safety in the workplace are being rewarded for their efforts. Access to information is important in any well-operated organization. A lot of locations that have chosen to adopt the approved safety precautions set forth by the Bureau of Labor have developed extensive electronic databases to help them cope with the requirements set forth by PSM.

The decision process that chemical plants go through is enhanced by the readily available information that is required by the PSM OSHA standards. The continuous efforts to provide a strong mechanical integrity program will reduce the risks of leaks and also help to extend the intervals occurring between shutdowns (Elsevier B.V., 2004).

What occupation is seen to be the most hazardous occupation to have? The answer to this question may astound you. Coincidentally, workers are not the first people that come to mind when it comes to hazardous occupations. The United States Bureau of Labor statistics has an interesting insight that it provides when discussing the safety of workers in specific situations. Guy Toscano, who is employed as an economist with the Office of Safety, provides an easy to understand article that he has entitled “Dangerous Jobs”. The article composed by Toscano is based on statistics from 1995. Since his composition was published, there have been some variations throughout the past years, but Toscano’s work is still one of the most comprehensive up to date publications. (Toscano, 1995).

According to Toscano, “there are multiple ways to identify hazardous occupations. Depending on the methods that are used, there are various occupations that could be deemed as hazardous. One method to identify a hazardous occupation is to count the amount of job-related fatalities that have resulted from the job, in a particular occupation or within a group of workers. The second method that can be used to identify a hazardous occupation is to take the fatalities and average them out over a specific amount of time.

However, the easiest method to use to understand Toscano’s work is to utilize the risk method. This method expresses the risk that a particular occupation has based on an index of relative risks. This measurement is calculated for groups of workers as the rate for the group to rate all of the employees within a specific group. The index of risks compares the fatality risks of groups of workers against all of the other workers that are employed in the same or different occupations. For example, when it comes to evaluating the relative risks for truck drivers, their risk level is 5:9. This means that truck drivers are five times more likely to be inflicted by a fatal injury while on their job, then average workers that are employed in other types of occupations.

Some of the most dangerous occupations in 1995 were in fishing, small plane pilots, timber cutters, taxicab drivers, and structural metal workers. There has been some variance that has occurred in the worst occupations from year to year, since 1995.

11.0 Who Provides Layer of Protection For Employees?

Chemical plants have put the OSHA process safety management training into the hands of people who possess the right motivation and have gone through the right type of training to be able to teach these safety processes. The people that have been appointed to teach these lessons include chemical process operators, energetic supervisors, competent craftsmen, trained specialists, and other employees that work behind the scenes providing administrative and clerical duties.

12.0 Conclusion: What Prospects Exist In Future French Safety Education?

Educating chemical engineers in safety principals has been a main priority in France for fifteen years. The French model could be a good philosophy for educating engineers in GCC countries. Even though integrating safety with chemical engineering curriculum is important, it is not a commonly practiced teaching method. Notes have concluded that a barrier to integrate safety into the crowded chemical engineering curriculum puts added pressure on the course. There appears to be a plethora of short term obstacles that exist for the full integration of safety education in the chemical engineering curriculum. This may be the next challenge that individuals in France will need to develop to perform the extensive integration that is desperately needed.

Marshall, an author of The Process Engineer supports the proposal for a better way to integrate curriculum pertaining to safety, environmental protection, and occupational health with an added constraint on social acceptability of process and chemical industries. The experience and proposition of Lemkowitz, in the Delft University of Technology with developing unique programs for health integration, safety integration, social and environment aspects into the curriculum for chemical engineering will be beneficial to the application. Lemkowitz, the same author, further extends multiple disciplinary societal approaches in conjunction with the sustainability concept (Lemkowitz et al., 1999,2000).

Teachers agree that engineering ethics is a vital component of the curriculum for chemical engineers. But the question pertaining to how to introduce the topic within the present curriculum is still up for debate. Mr. Harris a creditable author made an intuitive proposition that engineering ethics is something that engineers should know in conjunction with various other factors, such as testing procedures, safety, and ways to design items for durability, reliability and the economy. There are still a lot of open-ended issues that go along with any chemical engineering task, along with potential applications provided without ethical consideration, resulting in ethical dilemmas. Chemical engineering is a global market, students should be well equipped to work anywhere in the world, where their expertise may be required. Ethics not only involves the ability to recognize ethical values, but it also involves the ability to realize how these values can be interpreted and then applied in culturally diverse context. Ethics should be assessed as a section in every module that is done for chemical engineering. However, this proposed proposition raises a lot of the same difficult dilemmas that relate to teaching safety.

Complete examples of the opportunities were discussed in detail by an influential author who goes by the name Ocone. In a composition, composed by Ocone in 2005, she goes on to explain that there are two possible routes in which ethics in chemical engineering can be taught. In her composition, she expresses the need to teach ethics, but leaves the way that the course is taught to interpretations, experiences, and personal views. In the same retrospect, Lemkowitz, another influential being in the chemical engineering field noted in his 2004 composition that the industrial ecology approach to teaching distinguishes the necessities that exist amongst ethical questions and epistemological.

What is known and proposed about safety ethics? Presently, cohesive models within the safety ethic module have been identified and are being applied (Hill, 2003). The model reviews five different elements. A few of these elements refer to accepting sole responsibility for the safety and caring of others, as well as promoting safety protocols whenever possible.

Detailed content in regards to these five crucial elements is better described in a reference published by Hill. This simplistic model for safety ethics provides a superb opportunity to be able to reach new levels in attention to safety.

The future in chemical engineering education, along with the potential application of the trends summarized is as follows:

1. Contributions to safety programme learning in chemical engineering curriculum, emphasis on the introduction of safety concepts
2. Improve knowledge in the fields of "safety, health, and environment" strengthening the role that engineering and science improve the awareness of ethical practices in safety, risk management
3. Establishment of a culture concentrated on safety that will be the primary objectives for requisite improvements in teaching chemical engineering curriculum as it relates to safety.

Chemical process safety is critical issue for practicing and protecting life and environment. The most effective means of ensuring the safety of a process is to recognize all possible hazards, and to safeguard against all expected and dubious sources. In order to realize and address possible hazards within a chemical process, one must understand the fundamentals of chemical process safety, and the hazards linked with chemical processes and reactions. Achieving a safety culture within the university may be the beginning step for ultimately reducing safety and environmental hazards in our chemical processes.

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