Communication Skills Course: Enhancing Presentation and Proposal Writing Skills of Chemical Engineering Students

Dr. Kamarza Mulia, Chemical Engineering Department, Faculty of Engineering, Universitas Indonesia

Kamarza Mulia is a faculty member of the chemical engineering department at Universitas Indonesia. He received his bachelor degree in chemistry from Bandung Institute of Technology in 1984 and doctor of philosophy degree in chemical engineering from Colorado School of Mines in 1992. His research interests are thermodynamics, controlled release of bioactive compounds, and innovative teaching-learning methods.

Dr. Elsa Krisanti, Chemical Engineering Department, Universitas Indonesia

Elsa is a chemical engineering faculty member at the Department of Chemical Engineering, Faculty of Engineering, Universitas Indonesia. She received her bachelor degree in Chemistry from Bandung Institute of Technology in 1984 and doctor of philosophy degree in Applied Chemistry from the Department of Chemistry and Geochemistry, Colorado School of Mines, USA, 1992. Since 2000 she is implementing Problem based Learning (PBL) method in Analytical Chemistry, Introduction to Polymers and Basic Chemistry courses in the Department of Chemical Engineering, Universitas Indonesia.

Communication Skills Course: Enhancing Presentation and Proposal Writing Skills of Chemical Engineering Students

Introduction and Overview

Higher education students must be prepared to work in a very different working world than existed twenty years ago. The problems that they have to solve will be more complex and interdisciplinary and will demand applying certain skills. ABET had identified communication skills early on to be one of the most useful skills in the working world[1]. This was confirmed by our own survey results. In 2002, the curriculum task force of the Chemical Engineering Department at Universitas Indonesia (ChE-UI) carried out a survey to receive feedback on the performance of the department's alumni who graduated within five years prior to the survey. Feedback was received from more than 105 respondents consisting of our alumni, chemical engineers who graduated from other institutions, task force members, our students, an expert in the field of education, three industry executives, and one entrepreneur. The survey results, given in Appendix A, indicate that the communication skills of our alumni at that time was not satisfactory, having a score of only 52 on a 0-100 scale and ranking 10 among the 13 performance indicators used. Ninety percent of the respondents recommended that a course on communication skills be added to the curriculum.

In 2010, the World Bank published a report entitled "Indonesia Skills Report: Trends in Skills Demand, Gaps, and Supply in Indonesia"[2] indicating the perception of their survey respondents that communication and team skills are the most needed skills, yet these skills are not the most lacked. The report mentioned that English language proficiency is considered the skill that Indonesian university graduates lacked the most. In response to the results of our survey in 2002, a two credit hour course entitled "Communication Skills" was offered starting in 2003 as an elective course in the second semester. Due to its importance, the status of the course was changed into a required course in the subsequent year. Presently, ChE-UI includes the ability to communicate effectively and to work in a multidisciplinary team as one of its undergraduate curriculum learning outcomes, listed in Appendix B. Communication skills are considered an important component within engineering curricula, either as stand-alone classes or integrated into a program curriculum along with other important process skills. In the integrated approach, all of these skills are covered progressively in a series of courses. Examples of the integrated approach are those at the Virginia Tech's Materials Science and Engineering Department[3] and the University of Queensland's Project Centred Curriculum in Chemical Engineering for the third and fourth year students[4].

The communication skills course in our program is a stand-alone class, nevertheless, it has been developed as part of our effort to improve our students' awareness, problem-solving skills, creativity, interpersonal and group skills, assessment skills, and self-directed learning skills. Recently, these skills have been integrated into the ChE-UI curriculum through eight courses based on the problem-based learning (PBL) format listed in Appendix C. To improve the targeted process skills, the instructors conduct process skills workshops, facilitate in-class exercises, and give take-home assignments. Since seven out of the eight courses are required courses, our students have sufficient opportunities to improve their process skills as they progress in their program.

The concept of audience analysis was emphasized throughout the course[5]. Students were asked to analyze the audience in terms of the audience's objectives, needs, and characteristics. This approach was emphasized throughout the course since audience analysis is an essential step in creating an effective communication product. The focus of the communication course is mastery of the fundamental elements of effective communication: reading the communicative situation, understanding the audience, creating a well-crafted message, and projecting confidence and competence through an appropriate communication style. For each topic, there is a short overview, followed by in-class activities, and take home assignments. By the end of the semester, students are expected to demonstrate an ability to identify the key elements of effective oral and written communication, write clear and accurate summaries or proposals, and make an effective oral presentation that addresses the audience wants and needs appropriately. In 2012, we updated our curriculum and moved the course from the second into the first semester so that students would learn the basics of communication skills early in their program and would have ample time to improve their skills before they graduate. The schedule of the communication skills course was also updated as shown in Table 1.

Table 1. Schedule of the communication skills course.

Meeting #/topic or activity	Practice and/or assignment
1 / Effective communication and audience analysis	Practice shaking hands and audience analysis for making a presentation
2 / Oral presentation, visual aids, assessment criteria	Practice one minute impromptu presentation; assign topics for the two minute presentation
3 / Two minute presentation without visual aids	Peer assessment (presentation)
4 / Two minute presentation without visual aids	Peer assessment (presentation); assign reading materials for teaching note writing
5 / Effective reading, summarizing, teaching notes writing guidelines	Practice writing a summary for teaching notes; peer assessment (teaching notes); assign students to find reading materials for their final report
6 / Memo writing and assessment criteria	Practice memo writing; peer assessment (memo writing); verify reading materials for the final report
7 / Proposal writing guidelines	Practice making a proposal outline based on the reading materials; assign 1st draft report (introduction)
8 / Referencing	Practice making a reference list; peer assessment (1st draft report); assign 2nd draft report (body and conclusions)
9 / Scientific poster	Practice making an outline for a poster; peer assessment (2nd draft report)
10-11-12 / Five minute presentation (final report)	Peer assessment (presentation)

The topics covered in the course aimed to be useful in subsequent courses, especially in the PBL-based courses where students work in groups and conduct peer-teaching intensively. The skills relevant to peer-teaching such as finding relevant information, preparing summaries and teaching notes, are covered before the midterm exam. The students' skills are again improved and extended when they carry out their final report assignment. After the midterm test, each student begins to focus on individual projects that will culminate in writing and presenting a technical proposal based on papers published in peer-reviewed journals.

The communication skills course usually meets at least 12 times during the semester and each meeting lasts for 2 hours. Class meeting time consists of 20-30 minute mini-lectures in the beginning of the class (if necessary), followed by hands-on exercises, and assessment sessions either by the instructor or the students themselves. At the end of each class time, instructors usually give new assignments for the next class meeting. Students are given many opportunities to carry out self- and peer-assessment throughout the semester. The final grade is calculated using a grading scheme given in Table 2. As the consequence of the significant amount of time and effort devoted to improving the presentation and the proposal/technical writing skills of the students, these two components are given weighting factors of 30 and 35%, respectively.

Table 2. Grading scheme.

Grading component	Weighting factor (%)	Assessor
Summarizing & teaching note writing	25	Instructor
Memo writing	10	Instructor
Two-minute presentation	15	Peer
Five-minute presentation	15	Peer
Proposal/technical writing	35	Instructor

We evaluated the communication skills course for possible improvements and decided to emphasize more peer-assessment in the oral presentation part. What is unique about this course is that since 2012, we no longer use our own format for the technical writing assignment, but a format used for our campus-wide contest on creativity proposals funded by the Indonesian ministry of education. In a simulated contest situation, students are given the opportunity to propose ideas as an intellectual response to real-world problems facing society. We believe this scheme allows first semester students to face higher-level challenges, usually experienced by more advanced students. In writing up their proposals, students are expected to carry out audience analysis and apply problem-solving strategies that are important in subsequent PBL-based courses. This paper presents the details, challenges, and the results of the new approaches implemented in our communication skills course.

Enhancing presentation skills of students

To improve students' presentation skills, we asked them to do a one-minute impromptu presentation followed by a two-minute prepared presentation early in the semester. No visual aids were used and students chose the topic themselves as the emphasis was on building their confidence and not on the technical content of their speech. Students who used English in

their presentation were given extra credit since English was not their native language. Approaching the end of the semester, students delivered a five-minute PowerPoint presentation on the proposal they submitted. We expected that what the students experienced in their previous two-minute presentation, including each individual video recording, would improve their five-minute presentation. A presentation assessment form with the following six criteria, each having an equal weight, was used:

- effective use of time
- materials are concise and to-the point
- eye contact with audience
- clear speech with good intonation
- use of figures and other visual aids for effective presentation
- appropriate outfits.

Students assessed their peers and gave them a score based on a 6-point Likert scale from 1 (strongly disagree) to 6 (strongly agree) on each of the six criteria. The assessment criteria helped students to focus on important issues both when they are giving presentations and when they are assessing peers. Since peer-assessment is an important part of the overall assessment of students, a class discussion was held on how to carry out assessments in a fair and consistent manner. The presentation scores collected from students were checked for variability and consistency using simple statistics, and then, the data set was compared to the scores given by the instructor to see if there were significant discrepancies between them. If the resulting statistics indicated that the assessment by students was already sufficient, the scores from the instructors were used only to detect unusual or unacceptable scores assigned by students and then these scores were not be included in the calculation of students' presentation scores.

Enhancing proposal writing skills

In 2012, we modified our communication skills course by requiring students to write a technical proposal following new assessment criteria listed in Table 3.

Table 3. Assessment criteria of the submitted proposal.

Grading component	Weight (%)
Format: cover, paper size, typeface, layout, number of pages	5
Proper use of language	5
Suitable sections	10
Correct referencing	5
Creative ideas	20
Feasibility of implementation	20
Consistency between idea and source of information	15
Accurate and up-to-date information	5
Prediction of the results	15

The proposal writing activities started with the selection of a topic related to the field of chemical engineering profession, taking into account its feasibility implementation. Students

were encouraged to use their creativity in finding a good topic. We also added a requirement that the proposal should be based on what has been reported in articles published in peer-reviewed journals. Students must submit at least one main paper, preferably with additional supporting papers. After the instructor agreed with the topic and the journal articles, students were given approximately a four-week time period to complete writing the proposal. The first and the second drafts of the report were assessed by peers based on the criteria given in Table 3 and the assessment forms were returned to the writer as feedback. Finally, after making the required revisions, students submitted the final report to the instructors for grading and prepared a PowerPoint file for class presentation.

Results and discussion

Students chose topics that they were familiar with for their two-minute presentations, usually related to their extracurricular activities or topics of interest to them. Most of the students shared their interests or experiences with the class enthusiastically, and the instructors provided constructive feedback on the performances. Many students actually gave a presentation in English for the very first time. Several students did not talk for the entire two-minute presentation time. The performance of the rest of the class became much better in the subsequent week, indicating that these students trying not to repeat the same mistakes made by their peers previously. For the final presentation, each student was required to give a presentation for five minutes. Since the students had sufficient time to practice, they performed better than they did at the beginning of the semester, as indicated in the graph given in appendix D. The students improved their performances significantly relative to all of the assessment criteria. The statistics of presentation scores for 42 students, obtained from peers, the instructor, and self-assessment data is given in Table 4.

Table 4. Statistics of the presentation scores.

Presentation	n	m	Peer		Instructor	
			Average score	Average SD**	Average score	Average SD**
2 min	42	5	4.7	0.4		
5 min	42	12	5.1	0.3	5.2	0.5

* n and m are total number of students in the course and the number of peer-assessed scores for each student, respectively; ** SD=standard deviation.

The results show that the presentation scores (relative to the maximum value of 6) assigned by peers increased from 4.7 to 5.1 for the two-minute and the five-minute presentation, respectively. The t-test results indicate that the difference between the two data sets is significant (t_{calc}=4.4, α=0.05, n=82), indicating that the improved presentation scores of the students at the end of the semester compared to those in the beginning of the semester are statistically significant. The average scores for the five minute presentation at the end of the semester assigned by peers and the instructor were 5.1 and 5.2, respectively. The t-test results indicate that there is no significant differences between the overall instructor assessment of all students and the students' peer-assessments (t_{calc}=1.2, α=0.05, n=82). We also calculated the confidence intervals of the presentation scores obtained from the peer-assessment using the significance level of 0.05 and found that 55% of the instructor's scores were included in the individual students' score confidence intervals, indicating that more than half of the students' assessment were in agreement with those of the instructor. Although this percentage

is moderate, it is an indication that the assessment skills of students are improving. We consider this to be a significant.

The average score obtained from the students' reflective journals was 4.6. This average class score was obtained not from actual presentations, but from the self-assessment part of the journal. The low value of the self-assessed presentation skills score obtained at the end of the semester is similar to the peer-assessed score of 4.7 at the beginning of the semester. This result indicates that the students did not display the level of assertiveness and confidence they probably should have; moreover, this trend is consistent with the data on Indonesian students in general[2]. This is unfortunate because the instructors did observe significant progress of the students' presentation skills over time. However, both findings, though divergent, underline the importance of the communication course and further opportunities for students to give more presentations in subsequent courses, and, in doing so, gradually improve their self-confidence. With improved implementation of the communication skills course, we expect that we can rely more on students' assessment of presentation skills of their peers. In our present grading scheme, presentation scores are assigned by the students participating in the course and not by the instructors; this accounts for 30% of the final grades as indicated in Table 2. By asking students to grade the presentations of their peers, we expect them to learn more from the mistakes and the achievements of their peers, and subsequently improve their own presentation skills.

While presentation skills development in students has somewhat matched the expectations of the instructors, students have had more difficulties in improving their technical writing skills. For example, some of them found that finding suitable research topics, understanding and summarizing journal papers written in English, and integrating relevant information into coherent paragraphs are all challenging tasks. This observation was somehow expected since, in general, these skills were not developed much in high schools where learning takes place in a predominantly one-way teaching environment. During the proposal writing phase, students discussed their ideas and proposals with the instructors. Since it turned out that most students needed individual tutoring sessions, we devoted two class meetings to this purpose. The submitted proposals were assessed by the instructors and the average proposal score was found to be 5.0 ± 0.2 ($\alpha=0.05$, n=42, SD=0.6), higher than 4.5 ± 0.3 ($\alpha=0.05$, n=42, SD=0.9), which is the average proposal score based on students' self-assessed score taken from their reflective journals.

The statistics of the proposal writing scores confirmed our observation that first-semester students have difficulty integrating creative ideas and source of information in a consistent way. Comparison between the instructors' assessment and the students' self-assessment results indicates that, for proposal writing skills, students tend to underestimate their own skills. In spite of this finding, we would like to find ways to help students improve their technical writing skills to match the requirements as given in Table 3. As peer-assessment seems to help improve presentation skills of our students, we would like to use a similar approach in our next communication skill class. We would let students do more peer-assessment to facilitate their own learning. It seems that when students are given more responsibilities in the assessment process, they inevitably learn to recognize the mistakes made by their peers and avoid making the same mistake themselves.

Writing a technical proposal to meet the assessment criteria used to select creative ideas intended to solve societal problems certainly requires a measure of creativity. We tried to elicit balance quality of creative ideas and feasibility of implementation, two grading criteria with the highest weighting factors, by asking students to consider both factors in the selection

of the topic for their proposal. We hope that our students not only improved their communication skills, but also learned that they could contribute to the society through engineering profession. In addition, by asking students to read papers published in high-impact, peer-reviewed journals, we hope that the students will be motivated to explore the scientific aspect of the engineering profession, when they are still university students as well as after they graduate. A few example titles of the submitted proposals have already suggested that students are learning to be more creative:

- Manufacturing limonene from citrus peel waste
- Diesel fuel from rapeseed oil as prepared in supercritical methanol
- Biodiesel production from algae as renewable energy source
- Utilization of recycled and waste materials in various construction applications
- Converting waste plastics into fuel
- Tidal Energy as a new energy source for power plant
- Dissolved air flotation to separate pollutants from restaurant effluents
- Biofouling control in cooling water
- CO_2 capture from atmospheric air via consecutive CaO-carbonation and $CaCO_3$-calcination cycles in a fluidized-bed solar reactor
- Ion removal by reverse osmosis
- Utilization of TiO_2 photocatalysts in green chemistry
- The improved photocatalytic for V_2O_3/CNT/TiO_2 composite under visible light
- Microalgae: the potential for carbon capture

Conclusions

A communication skills course for chemical engineering students has been updated to enhance the students' presentation and proposal writing skills, including summarizing journal papers, teaching note writing, and memo writing. All of these skills will help prepare these students for undertaking courses in the subsequent semesters that emphasize small group, interdependent, and self-directed learning approaches such as PBL. The course emphasis on in-class practice, take home assignments, and peer assessment, resulted in a significant improvement of students' presentation skills over time, and also closely matched the intended course outcomes at the end the semester. We found that 55% of the presentation scores assigned by the instructor were included in the confidence interval of students' presentation scores assigned by their peers, indicating improved assessment skills. On the other hand, students had more difficulties improving certain skills in proposal writing, such as finding suitable research topics, understanding and summarizing journal papers written in English, and integrating relevant information into coherent paragraphs. Individual coaching was required to help students overcome the preceding challenges. Comparison between the instructors' assessment and the students' self-assessment results obtained from reflective journals indicates that, for proposal writing skills, students tend to underestimate their own skills. One of the lessons we learned as instructors is that when students are given more responsibilities in the assessment process, they learn to recognize the mistakes made by their peers and then avoid making the same mistake themselves. The approach has been shown to be effective for improving our students' presentation skills; thus, we will ask our students to assess peers' technical proposals next time around.

References

1. Lisa R. Lattuca, Patrick T. Terenzini, and J. Fredricks Volkwein (2006), Engineering Change: A Study of the Impact of EC2000, ABET, Inc., page 11.
2. World Bank, 2010, Indonesia Skills Report: Trends in Skills Demand, Gaps, and Supply in Indonesia, Report No. 54741-EAP.
3. E.C. Pappas, S.L. Kampe, R.W. Hendricks, R.G. Kander, 2004, An assessment analysis methodology and its application to an advanced engineering communications program, Journal of Engineering Education, 233-246.
4. C. Crosthwaite, I. Cameron, P. Lant, J. Litster, 2006, Balancing curriculum processes and content in a project centred curriculum: in pursuit of graduate attributes, Education for Chemical Engineers, 1(1): 39-48.
5. Donald R. Woods, Communicating Effectively, McMaster University Bookstore, 1996.

Appendix A.

Feedback on ChE-UI alumni performance (105 respondents).

Knowledge/skills/attitude assessed	Score (0-100 scale)
Basic engineering knowledge	80
Basic chemical engineering knowledge	85
Chemical engineering processes	48
Knowledge of contemporary issues	53
Communication skills	52
English language proficiency	51
Ability to adapt to changes	67
Entrepreneurships	24
Lifelong learning	72
Problem-identification skills	63
Problem-solving skills	56
Leadership	72
Group skills	83
Average score	62

Appendix B.

Expected learning outcomes of the ChE-UI undergraduate chemical engineering program.

1. Able to communicate effectively and work in multidisciplinary teams.
2. Capable of critical, creative, and innovative thinking, and also have the intellectual ability to solve problems independently and interdependently
3. Good at both spoken and written Bahasa Indonesia and English for academic and non-academic activity
4. Capable of utilizing communication and information technology
5. Able to apply knowledge of mathematics and science in solving engineering problems
6. Able to apply the concept of mass and energy balances in solving chemical engineering problems
7. Able to apply thermodynamic concepts in solving chemical engineering problems
8. Able to apply concepts of transport phenomena in solving chemical engineering problems
9. Able to apply the concepts of chemical reaction engineering
10. Able to use modern chemical engineering tools
11. Able to conducts experiments and analyze the data obtained
12. Able to design components, systems, processes, and products related to chemical engineering profession with careful consideration of the engineering, economic, social, health and safety, energy, environment, sustainability, and ethics aspects
13. Able to provide solutions to various problems occurred wherever they live and work
14. Able to identify the kind of entrepreneurial approach needed based on innovation, self-reliance and ethics
15. Continuously develop oneself to contribute in solving local and global problems.

Appendix C.

PBL-based courses in the chemical engineering curriculum and their corresponding process skills improvement emphasis.

Course name (semester, credit hour)	Skills development emphasized
Communication Skills (1,2)	Teaching note preparation; oral presentation, technical writing, assessment (presentation) skills
Organic chemistry (2,3)	Effective PBL sessions
Instrumental analytical chemistry (3,3)	Awareness; concept map; creativity
Physical chemistry (3)	Interpersonal and group skills
Chemical engineering thermodynamics (4,4)	self-directed learning; problem-solving strategy
Heat transfer (4,3)	Peer and self-assessment
Engineering economics (5,3)	Successive approximation and optimum sloppiness; tacit knowledge
Controlled release of drugs (6,3)	Problem solving: Kepner-Tregoe approach

Appendix D.

Student scores on the 2-minute and the 5-minute presentation.