US-China Education Review A 7 (2011) 936-945
Earlier title: US-China Education Review, ISSN 1548-6613

Engineering Communication Interface: An Engineering Multi-disciplinary Project

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Well-developed professional communication skills, collaborative work practices, effective self-management and a clear understanding of social responsibility and ethical practices are essential for the new engineer who hopes to contribute to the profession and build a career. These attributes are in addition to the traditional sound knowledge of engineering theory and practice. The CEN (College of Engineering) at the AUS (American University of Sharjah) has recognized this reality with the development of a course in language enhancement and professional communication based around engineering multi-disciplinary projects. This paper first outlines the context of the engineering multi-disciplinary projects emphasizing the interface between engineering and communication. Evidence from a number of studies is referred to concerning the importance of professional communication for engineering students. The paper then reports the procedures employed to teach professional communication skills through engineering multi-disciplinary projects. The paper discusses the role of Halliday's (1985) systemic-functional linguistics in guiding the linguistic integrity of the revision and shows how Bloom's higher order cognitive domain skills relate to the course learning outcomes. The pedagogical underpinning of the course and its role in developing students' meta-cognitive capacities is briefly discussed. Students' feedbacks, course assessment surveys and the final exam results point to the success of contextualized teaching and learning.

Keywords: communication, collaborative, multi-disciplinary, professional, syllabus, contextual, engineering

The Need for Communication Skills

It is no longer sufficient to graduate engineering students from tertiary institutions with a sound knowledge of engineering theory and practice alone. There is considerable documented evidence to support such a claim. In a recently published Australian study undertaken with 300 engineers between five and 20 years experience, Male, Bush, and Chapman (2010) have shown that competency deficiencies in engineering business, communication skills, self-management and attitude, problem-solving and teamwork are areas for improvement in engineering curricula. These findings reflected other studies which have also highlighted such competencies as in need of improvement. Bodmer, Leu, Mira, and Rutter (2002), in a European and US survey of 1,372 engineers, identified leadership, social skills and communication to be lacking in graduates, and an international survey (WCEC (World Chemical Engineering Council), 2004) of 1,091 chemical engineers during

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their first five years of employment found deficits in management, effective communication and leadership. Male et al. (2010, p. 56) asserted "Communication is the competency that features most frequently as a deficiency in Australian surveys" and work conducted by Ashman, Scrutton, Stringer, Mullinger, and Willison (2008) and Nair, Patel, and Mertova (2009) concurs.

Inter-disciplinary Skills

These studies have in common a focus on competencies that are deemed essential but often deficient in engineering workplace situations either by engineers identifying their self-perceived shortcomings or more experienced engineers observing the limitations of junior colleagues. Either way, the necessity for effective communication and management skills is clear. The impact of ICT (information communications technology) has necessitated attainment of these skills by virtue of the abundant opportunities available for collaboration and communication between professional colleagues. This communication increasingly engages an educated, informed and concerned public.

Recognition of this reality is embodied in the Carnegie Mellon University Department of EPP (Engineering and Public Policy) which seeks to develop in students an understanding of the interface between society and technology and the skills that will enable effective work at that interface. Students in the EPP department study their engineering degrees in the context of the social and ethical expectations that are increasingly important for the engineering professional and learn how to "seek advanced assistance…in areas beyond the traditional expertise of engineers" (Carnegie Mellon University; as stated by Department of Engineering and Public Policy, 2008). Furthermore, the Carnegie Mellon degrees recognize the need to develop collaborative work practices as students are expected to "demonstrate an ability to integrate conventional technical analysis with behavioral and other social issues, where the engineer is a participant in teams composed of many disciplines" (Carnegie Mellon University; as stated by Department of Engineering and Public Policy, 2008). This recognition of inter-disciplinary study resonates with the work at the AUS (American University of Sharjah), described later in the paper.

Harrison, Macpherson, and Williams (2007), Spinks, Silburn, and Birchall (2006), Royal Academy of Engineers (2006) and Martin, Maytham, Case, and Fraser (2005) also reiterated the need for promoting inter-disciplinarity in engineering teaching. The study of Harrison et al. (2007) was concerned with empowering engineering students with cross disciplinary preparation for their future work in the hydropower industry. The course realized a number of outcomes including appreciation of other engineering disciplines, experience of teams where different skills and expertise, which are available and demonstration of the links between engineering design and economic viability and introduction to non-technical areas essential to the UK standard for professional engineering competence.

Other research emphasized the need for engineers to be able to integrate technical expertise with behavioral and societal issues, and to work on solving complex problems in teams composed of professionals from many disciplines and exhibit high level communication skills. The OECD's (Organization for Economic Cooperation and Development) DeSoCo (definition and selection of competencies: Theoretical and conceptual foundations) project is foundational to many of these studies. The project work, published under the editorship of Rychen and Salganik (2003), developed a conceptual frame of reference for key competencies. It was based on theoretical and conceptual approaches to competence informed by political and practical considerations. The rationale for the work took into account the fact that rapid and continuous change in technology required adaptability rather than mastery, social diversity necessitated different kinds of personal relationships (more contact with those different from oneself), and globalization created interdependencies with actions subject to influences and consequences beyond regional and national boundaries (economics and pollution for instance).

Investigations based on the DeSoCo conceptual frame of reference, such as that conducted in Malaysia by Zaharim, Yusoff, Omar, Mohamed, and Muhamad (2008), recognize that changes in economic growth patterns are creating higher demands for engineering employability skills. The study identified deficiencies between the perceptions and the expectations of employers and showed that significant gaps exist between the skills actually possessed by employees and those thought to be important by employers. Significant deficiencies were found in teamwork, communication and problem-solving with associated weaknesses in understanding professional, social and ethical responsibilities. A qualitative study conducted by Martin et al. (2005) with chemical engineering graduates in South Africa revealed similar findings. The study showed that the foundations of success for the respondents, technical knowledge and technical skills were not sufficient for success in the profession. Attributes necessary for success in industry (interpersonal skills, communication, teamwork and management) needed to build on this foundation. In particular, this study emphasized that communication is dependent on interpersonal skills, and teamwork and management are dependent on communication.

Finally, in a mid-decade study of the Indian engineering education sector, Goel (2006, p. 48) found that traditional resource-based approaches were still very much in evidence rather than the outcome-based approaches which would address the perceived lack of requisite competencies, such as “ability to apply knowledge, design skills, problem solving skills…ability to work in multi-disciplinary teams, communication skills, sensitivity towards global, societal, and environmental issues, and sensitivity towards ethical and professional issues”. Goel’s proposal to alleviate this lack was the adoption of a three-dimensional framework of competencies to categorize the skills that address existing deficiencies and emerging needs. The framework included firstly, attitudes and perceptions then productive habits of mind and finally acquisition and meaningful use of knowledge.

Engineering and Communication at the AUS

The AUS (American University of Sharjah) CEN (College of Engineering) takes the view that English fluency is a necessary condition for success in a global economy and therefore, to help develop fluency, and all instruction is conducted in English with a strong emphasis on developing excellence in communication skills, both written and oral. The United Arab Emirates is located on the crossroads between East and West and most AUS graduates will work in an international environment, so value is placed on global awareness and cultural sensitivity. All undergraduate degree programs in the CEN are accredited by the Engineering Accreditation Commission of the ABET (Accreditation Board for Engineering and Technology) of the United States. ABET accreditation requirements have compelled course planning to address the need engineers have for competencies beyond a sound technical knowledge, engineering skills and technical writing ability. Cross discipline planning and course development has transformed a technical writing course, into a language and communication training course for undergraduate engineers in profession-oriented collaborative, communication and academic skills.

Background of Change

Prior to the Spring Semester 2010 the CEN, acting upon a recommendation made by ABET, designated a technical writing course, ENG207: English for engineering a prerequisite study for engineering students. Apart from the ABET recommendations, this move was also made in response to employers' and students' complaints that engineering trainees and graduates lacked the skills needed for communication with co-workers, supervisors and employers. As a consequence, it is now policy that engineering students will study ENG207 during their third academic year before conducting their senior design projects and prior to internship. ABET also made a firm recommendation that engineering students from different majors should participate in multi-disciplinary engineering projects that require individual input from each of the students in the team. Since this proved difficult to implement in specialized engineering courses, where students from different majors study separately from others, the most suitable context for this has been ENG207 which comprises students from all engineering disciplines and from different cultural and ethnic backgrounds.

In response, an EMDP (engineering multi-disciplinary project) component has been incorporated into ENG207 in order to provide engineering undergraduates training in a range of collaborative communication and academic skills typically found in engineering workplaces. Since the course contents cover in addition to research skills other vital communication and academic skills, the writers have incorporated the skill sets in the body of the engineering multi-disciplinary project. EMDP-based teaching and learning provides an appropriate context for introducing, developing and implementing both research and professional communication skills.

Contextualizing the Change

The revised course syllabus requires students to work in multi-disciplinary teams, drawn from different majors, make a succinct collaborative oral presentation and produce a written report on their multi-disciplinary projects. The course also aims to instill leadership qualities anchored in moral and ethical principles. This reflects the need engineers have for competencies beyond possessing sound technical knowledge and engineering skills. Again, this is an ABET determined requirement. Perusich, Davis, Laware, and Taylor (2007), have observed "Most engineering and technology graduates will work in business on projects that have significant complexity and require multiple skill sets". These graduates will require teamwork attributes of mutual accountability, interdependence and complementary skills in order to achieve common goals and a common purpose. It is important to understand that such attributes are not the same as those required by or developed in group work. In the teamwork in the AUS course, students need to demonstrate socially responsible, ethical procedures and principles, a point which cannot be over emphasized.

Other important aspects of the revised course facilitate the multi-disciplinary project work. Students are trained to conduct effective meetings, plan and document decisions, set planning goals and meet deadlines, manage themselves and their peers, show leadership and evaluate their peers. There is emphasis on responsibility at personal, inter-personal and community levels developing the sense of a community of professional practice.

The teaching and learning of requisite professional communication skills (i.e., presenting proposals, writing reports, calling for meetings, preparing meeting agendas, minuting meeting procedures, documenting teamwork decisions, distributing work tasks and setting timelines) out of their appropriate settings does not guarantee full student involvement in the learning process and may be futile (Mercer, 2006; Yu, 2008; Chun, 2010). Contextualizing the teaching of these skills within the engineering multi-disciplinary project demonstrates their appropriate uses in authentic communication situations (Amare & Brammer, 2005; Predmore, 2005).

Managing Syllabus Change

A key element of ABET accreditation is the requirement that programs continuously improve the quality of education provided: The move to include the EMDP as the core element in the revised course is an example of ABET driven program improvement. Under the former syllabus, students worked individually and were required to choose an engineering research topic, research it, give an in-class oral presentation and finally submit a written report. The new syllabus uses the multi-disciplinary dimension of the engineering project as a tool for teaching and providing students hands-on collaborative, research experience through planning, presenting and writing about team-driven undertakings. In this work, there is a strong commitment to and expectation that students will emulate authentic contexts in order to practice workplace communication skills.

These syllabus elements are shown as follows.

Former Syllabus

Individual technical presentations are as the follows:

(1) Proposal;

(2) Progress report;

(3) Technical presentation;

(4) Written report.

New Syllabus

EMDP includes the following aspects:

(1) Team topic choice and approval;

(2) Collaborative proposal submission;

(3) Collaborative oral progress report;

(4) Collaborative final oral presentation;

(5) Submission of collaborative written progress report;

(6) Submission of collaborative final written report;

(7) Meeting, planning and documentation;

(8) Minutes of official team meetings;

(9) Documentation of informal team meetings;

(10) Documentation of key decision-making;

(11) Documentation of team meetings with academicians and advisers;

(12) Documentation of timeline based planning-task identification, allocation and realization;

(13) Timeline(s) for EMDP planning, researching, execution and submission.

Theoretical Bases

Language

The revision of the course syllabus to include communication skills, teamwork and management was underpinned by language, the essential base from which all else is developed. It was important that the changes be guided by a model that gave due emphasis to the primacy of language in the process of change implementation. Halliday's systemic-functional linguistics, an approach to linguistics that treats language as foundational for the building of human experience, provided such a model. Three key notions, field, tenor and mode (Halliday, 1985, p. 12) which collectively constitute the register of a text, offered a linguistic framework for guiding the changes and giving due importance to the language that underpins the course.

Field is defined as what is happening, as the nature of the social interaction taking place. Tenor relates to those taking part, to the participants, their social/professional roles, their relationships and their status. Mode refers to the organization of text and rhetorical modes, such as persuasion, exposition, didacticism, description, narration and so forth, to the channel of communication whether spoken or written, monologic or dialogic, whether with visual contact or via computer-mediated communication or telephone, and so forth. The framework assumes language functions common in engineering (definition, description, instruction, exemplification, comparison and contrast, sequencing, hypothesizing and drawing conclusions) and thus the language structures that convey these functions. For instance, in terms of document organization, an internship letter (realization) is in the “field” of an applicant to unknown professional/specialist, the “tenor” of the participants is novice to expert so the relationship is an inferior to superior relationship, while the mode is written, descriptive, expository and persuasive. These relationships are fully set out in appendix A.

Bloom’s Taxonomy and Course Outcomes

ABET requires Bloom and Krathwohle’s educational objectives to be addressed in courses which come under it accreditation appraisal. In this course, the objectives, program outcomes and assessment activities address educational objectives in Bloom’s three domains, affective psychomotor and cognitive. The course objectives embody particularly affective and cognitive skills and especially the higher order skills in the affective domain: valuing, organizing and characterizing, and in the cognitive domain: analysis, synthesis and evaluation. Furthermore, the course objectives address the competencies that the studies cited earlier in this paper have identified as essential to a successful engineering career. CEN students at AUS, through the work they undertake in the EMDP, are expected to attain the following objectives:

(1) Exhibiting use of appropriate and effective standards and strategies in professional (engineering) communication;

(2) Demonstrating writing and presentation style sensitive to audience and message function;

(3) Exhibiting individual, collaborative and multi-disciplinary technical communication skills;

(4) Demonstrating understanding of appropriate content, format and graphics for professional (engineering) documentation and presentations;

(5) Displaying awareness of ethical and social responsibility issues that arise in technical research and documentation.

At an affective level these objectives embody skills of valuing information, accommodating diverse ideas and ideals. Attainment of these skills enables students to compare and elaborate on what is known and what has been learned in order to establish beliefs and standards. Preparing and presenting the EMDP as oral and written discourse with supporting organizational documentation exemplifies cognitive skills. The project work requires students to use analysis, inference and synthesis in the compilation and patterning of the discourse and the information. The skill of evaluation, in the presentation and defense of project work requires making judgments about information and attesting the validity of ideas and quality of work based on given criteria.

Overall the revised course shows a coherent relationship to degree program outcomes specified by the university in the following terms:

(1) Evaluate written and oral communication, identify key ideas and establish hierarchies of information, work collaboratively in teams;

(2) Structure clear and persuasive arguments based on an analysis and presentation of evidence.

Pedagogy

Figure 1 shows the phases and procedures undertaken by the students working on the EMPP. The EMDP "package" can be viewed as a pedagogical tool and as having considerable agency in promoting attainment of the course learning objectives. The enhancement of students' professional communication skills is effectively achieved by development of their meta-cognitive capacity enhanced by syllabus change and emphasis on team-role behavior place with resulting prominence given to personal, inter-personal and team learning. Students engage in team-building informed by the use of the Belbin® Team Role Inventory and engage in management of teamwork development via Gantt chart time-based planning and meeting documentation. Furthermore, they employ interactive information sources hosted via a Libguide to resource personal and collaborative team problem-solving.

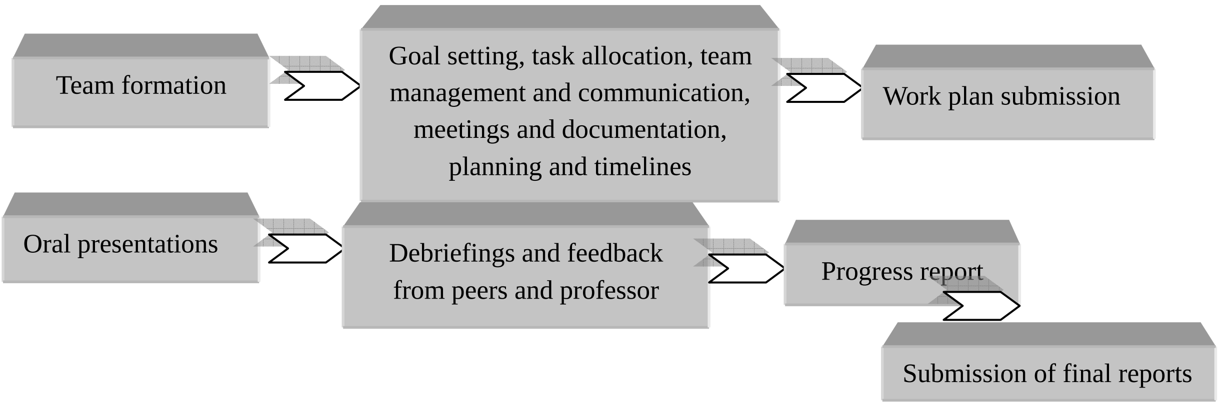

Figure 1. EMDP (development and implementation model).

Work by Paris and Winograd (1990) has showed that transferring responsibility for monitoring learning to students through development of problem-solving strategies improves their learning because of an increased awareness of their thinking in applying these strategies. Improved levels of motivation and positive self-perception may also result and the social exchange environment of effective teamwork reveals aspects of Vygotsky's (1978) theory of socially mediated learning. The learner-centered approach, where students are actively engaged in the discovery and construction of their own knowledge and meaning through attempting solutions to real problems from their surrounding environment (see appendix B) reflects Choo (2007) who aptly states, "There is an increasing need to train students to solve real-world problems so that they can handle complex problems in their workplace" (p. 187).

Reflection

The multi-disciplinary projects and the developments described in this paper have proven to be an effective and successful vehicle for developing junior engineers' professional communication skills. Professors' and students' deliberations on the course and the way it is conducted indicate that EMDPs have helped achieve the following:

(1) Shift focus from teacher-centered practices to students' collaborative learning-centered environments, resulting in improved student autonomy, positive self-perception and responsibility;

(2) Realize Swales' (1990) and Mercer's (2006) concept of "community membership";

(3) Provide learners with real opportunities to create their own texts, engage in real communication tasks

and reflect on the outcomes of their communication processes;

(4) Use language for real purposes. Rilling and Dantas-Whitney (2009) rightly argued that "The goal of using and creating language for real-world purposes within language instruction is to bring authenticity to the learning experience…" (p. 2);

(5) Develop in students' "transferable skills and knowledge" (Chun, 2010, p. 24);

(6) Provide an "interdisciplinary, student-centered approach to teaching focused around student-generated projects" (Stipe & Yasen, 2009, p. 130).

Conclusions

Initial evidence for the course success is based on the students' achievement as exhibited in overall grades and course evaluative responses given in the course assessment sheet that they are required to complete art the conclusion of a semester. Overall grade results expressed as percentage for the last two semesters for classes involved in the trial of revised syllabus have averaged 84.77 with a median of 84.84. Classes studying under the former syllabus (Fall Semester, 2009) averaged 83.93 with a median of 84.37. The gains may appear modest, but it should be remembered that the revised syllabus requires students to undertake a far greater variety of tasks, there is a greater quantity of work and the cognitive demands are more consistently higher order. There is also a significant increase in personal responsibility mandated in the revised syllabus. Given these factors, the results are encouraging.

Worth noting here that the researchers are in the process of applying a more objective measure to assess the course's efficiency in achieving its learning objectives outcomes through pre- and post- course administration of the Belbin® Team Role Inventory. This procedure will allow for measurement of changes in students' team role preferences over the course of a semester of work in ENG207.

References

Amare, N., & Brammer, C. (2005). Perceptions of memo quality: A case study of engineering practitioners, professors, and students. *Journal of Technical Writing and Communication, 35*(2), 179-190.

Ashman, P. J., Scrutton, S., Stringer, D., Mullinger, P. J., & Willison, J. (2008). Stakeholder perceptions of chemical engineering graduate attributes at the University of Adelaide. *Proc. Chemeca*. Newcastle City Hall, New South Wales, Australia.

Belbin® Associates, 2007-2010. Retrieved from http://www.belbin.com/rte.asp

Bloom, B. S., & Krathwohl, D. R. (1956). Taxonomy of educational objectives: The classification of educational goals, by a committee of college and university examiners. In *Handbook I: Cognitive domain*. Longmans, New York.

Bodmer, C., Leu, A., Mira, L., & Rütter, H. (2002). *SPINE: Successful practices in international engineering education* (pp. 92-102). Retrieved October 14, 2005, from http://www.ingch.ch/pdfs/spinereport.pdf

Carnegie Mellon University, Department of Engineering and Public Policy. (2008). *Undergraduate catalogue*. Retrieved from http://www.emagister.net/double+major+engineering+and+public+policy+degrees-ec170119721.htm

Choo, C. B. (2007). Activity-based approach to authentic learning in a vocational institute. *Educational Media International, 44*(3), 185-205.

Chun, M. (2010). Taking teaching to (performance) task: Linking pedagogical and assessment practices. *Change, 42*(2), 22-29.

Goel, S. (2006). Competency focused engineering education with reference to IT related disciplines: Is the Indian system ready for transformation? *Journal of Information Technology Education, 5*, 27-52.

Halliday, M. A. K. (1985). *An introduction to functional grammar*. London: Arnold.

Harrison, G. P., Macpherson, D. E., & Williams, D. A. (2007). Promoting interdisciplinarity in engineering teaching. *European Journal of Engineering Education, 32*(3), 285-293.

Male, S. A., Bush, M. B., & Chapman, E. S. (2010). Perceptions of competency deficiencies in engineering graduates. *Australasian Journal of Engineering Education, 16*(1), 55-67.

Martin, R., Maytham, B., Case, J., & Fraser, D. (2005). Engineering graduates' perceptions of how well they were prepared for work in industry. *European Journal of Engineering Education, 30*(2), 167-180.

Mercer, J. A. (2006). A madness to our method: Congregational studies as a cross-disciplinary approach to contextualizing teaching and learning in theological education. *Teaching Theology and Religion, 9*(3), 148-155.

Nair, C. S., Patel, A., & Mertova, P. (2009). Re-engineering graduate skills—A case study. *European Journal of Engineering Education, 34*(2), 131-139.

Paris, S. G., & Winograd, P. (1990). How meta-cognition can promote academic learning and instruction. In B. F. Jones, & L. Idol (Eds.), *Dimensions of thinking and cognitive instruction.* New Jersey: Lawrence Erlbaum Associates.

Perusich, K., Davis, B., Laware, G., & Taylor, K. (2007). Assessing teamwork for accreditation: Understanding what needs to be known and its integration into engineering and technology curricula. Proceedings from *the 37th ASEE/IEEE Frontiers in Education Conference, Session T3E.* Milwaukee, W. I..

Predmore, S. R. (2005). Putting it into context. *Techniques, 80,* 22-25.

Rilling, S., & Dantas-Whitney, M. (2009). Authenticity, creativity, and localization in language learning. In S. Rilling, & M. Dantas-Whitney (Eds.), *Authenticity in the language classroom and beyond: Adult learners*. TESOL, USA.

Rychen, D. S., & Salganik, L. H. (Eds.). (2003). *Key competencies for a successful life and a well functioning society*. Cambridge, M. A.: Hogrefe & Huber.

Spinks, N., Silburn, N., & Birchall, D. (2006). *Educating engineers for the 21st century: The industry view*. Royal Academy of Engineering: London. Retrieved from http://www.raeng.org.uk/news/releases/henley/default.htm

Stipe, M., & Yasen, L. (2009). Climate change and other hot topics on campus: Project-based learning. In S. Rilling, & M. Dantas-Whitney (Eds.), *Authenticity in the language classroom and beyond: Adult learners*. TESOL, USA.

Swales, J. M. (1990). *Genre analysis: English in academic and research settings*. Cambridge: Cambridge University Press.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.

WCEC (World Chemical Engineering Council). (2004). *How does chemical engineering education meet the requirements of employment?* Frankfurt.

Yu, H. (2008). Contextualize technical writing assessment to better prepare students for workplace writing: Student-centered assessment instruments. *Journal of Writing and Communication, 38*(3), 265-284.

Zaharim, A., Yusoff, Y. M., Omar, M. Z., Mohamed, A., & Muhamad, N. (2008). Employers' perceptions and expectation toward engineering graduates: A study case. Proceedings of the *6th WSEAS International Conference on Engineering Education.* Retrieved from http://www.wseas.us/reports/2008/venice/index.html

Appendix A: Application of Halliday's Framework to ENG207 Reveals the Following Relationships

Text		Field	Tenor	Mode
Document organization	Curriculum vitae	Engineering student to engineering/recruitment professional	Novice/expert Inferior/superior relationship	Written Descriptive Factual
	Internship letter	Applicant to unknown professional/specialist	Novice/expert Inferior/superior relationship	Written Descriptive Expository Persuasive
Multi-disciplinary oral presentation	Topic choice and approval	Engineering students to English and Engineering faculty	Learners/experts Inferior/superior relationship	Written Descriptive Expository Factual
	Proposal submission	Engineering students to English faculty	Learners/expert Inferior/superior relationship	Written Descriptive Expository Factual
	Progress report	Engineering students to English faculty and peer audience	Learners/expert Students/peers Interpersonal	Oral Factual Persuasive Explanatory Collaborative

(to be continued)

	Final presentation	Engineering students to English faculty, PG students and peer audience	Learners/expert Students/educated non experts Students/peers Interpersonal	Oral Factual Persuasive Explanatory Collaborative
Meeting, planning documentation	Minutes of official team meetings	Engineering students to team members and English faculty	Students/peers Interpersonal Learners/expert	Written Factual Transactional Collaborative
	Documentation of informal team meetings	Engineering students to team members and English faculty	Students/peers Interpersonal Learners/expert	Written Factual Transactional Collaborative
	Documentation of key decision making	Engineering students to team members	Students/peers Interpersonal	Written Factual Transactional
	Documentation of planning	Engineering students to team members	Students/peers Interpersonal	Written Factual Transactional
	Timeline	Engineering students to team members	Students/peers Interpersonal	Written Transactional
EMDP (engineering multi-disciplinary report)	Proposal and draft	Engineering students to English faculty	Learners/expert Inferior/superior relationship	Written Factual Explanatory Coherent
	Executive summary	Engineering students to English faculty	Learners/expert Inferior/superior relationship	Written Factual Summative
	Final report	Engineering students to English faculty	Learners/expert Inferior/superior relationship	Written Factual Explanatory Expository Persuasive
Peer evaluation	Six point attribute rating scale	Engineering students to team members	Students/peers	Written Evaluative
Test and examination	Mid-semester reflection	Engineering students to English faculty	Learners/expert Inferior/superior relationship	Written Reflective Analytical Critical
	Final examination	Engineering students to English faculty	Learners/expert Inferior/superior relationship	Written Analytical Explanatory Evaluative

Appendix B

Student engineering multi-disciplinary project topics as examples of attempting solutions to real problems from their surrounding environment:

(1) Design of an artificial hand;

(2) Green buildings: Power generation and conservation using hydrogen fuel cells;

(3) Integration of sustainable technologies in green buildings;

(4) Feasibility study of green technologies in energy-smart communities;

(5) Using game technology as a learning tool for engineering students;

(6) Healthy and efficient ventilation system design;

(7) Unmanned aerial vehicle to detect landmine locations in a given field;

(8) MEMS (micro electro mechanical systems) in accelerometers.