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ABSTRACT
                A discipline-specific writing center is the nucleus of a
writing-in-the-disciplines (WID) program in engineering, in the Department of
Electrical and Computer Engineering (ECE) at the University of South
Carolina. As a writing program, the writing center serves student writers and
faculty in ECE and integrates writing consultation into the engineering
curriculum, especially into ECE's sequence of five mandatory lab courses.
This approach to creating and maintaining a WID program grew out of theory,
research, and experience in the fields of composition and rhetoric and
engineering education. The program was designed in the contexts of theories
of literacy or language acquisition as central to the process by which
students become members of a professional, or discourse community. A major
goal of the program was the development of pedagogical methods, grounded in
theory, that would support students as they acquired the literacies of
engineering. (Contains 4 references.) (Author/CR)

Developing a Writing Program in Engineering: Teaching Writing to Teach Engineering Literacies
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Overview of the ECE Writing Program

In the Department of Electrical and Computer Engineering (ECE) at the University of South Carolina, a discipline-specific writing center is the nucleus of a writing-in-the disciplines (WID) program in engineering. As a writing program, the writing center serves student writers and faculty in the ECE Department and integrates writing consultation into the engineering curriculum, especially into ECE's sequence of five mandatory lab courses. Writing Center consultants work with individual students and faculty as well as with small groups of students from the beginning ECE lab course.

This approach to creating and maintaining a WID program grew out of theory, research, and experience in the fields of Composition and Rhetoric and Engineering Education. The program was designed in the contexts of theories of literacy or language acquisition as central to the process by which students become members of a professional, or discourse community. A major goal of the program was the development of pedagogical methods, grounded in theory, that would support students as they acquired the literacies of engineering.

The principal research method for the program, which program advisors call **Interactional Inquiry**, is a version of action research adapted from Reason and Rowan, *Human Inquiry in Action.* This method focuses on learning from interactions— including the faculty, students, professionals, texts, environments, and events. Interactional Inquiry uses groups to explore ideas and generate knowledge. In Composition literature, this group process is called **collaboration**; in Engineering, it is known as **teaming**.

In applying this research methodology to the ECE project, faculty and staff focused on both the learners and the learning environment, drawing from learning theories developed by Vygotsky and Hillocks, and from Geertz's theory of local knowledge and principles of ethnographic research. Two ethnographic techniques— cycles of interviews, and participant observations--proved especially valuable in studying the discourse conventions of engineering. These theoretical and methodological underpinnings provided the foundation for the overall program structure and for its principal components: interviews with faculty, faculty workshops, group discussions with students, observations, and analysis of texts.

Qualities of Successful Writing in Engineering

At the beginning of the project in the fall of 1995, the writing program staff interviewed six engineering professors, roughly 1/3 of the department. The staff used a standardized interview form and a uniform procedure to gather input from faculty in analyzing student writing. Using a Primary Trait Assessment Scale as a heuristic, writing consultants asked engineering faculty to articulate their

criteria for assessing abstracts, introductions, procedures and analysis sections, and conclusions of reports. These initial interviews began the process of identifying the qualities of successful writing in ECE.

Following the interviews, a faculty workshop was conducted to begin identifying writing techniques and curriculum innovations would fit the particular environment. After discussing theories and pedagogy of composition, faculty expressed particular interest in writing-to-learn and further use of heuristics to clarify standards of good engineering writing. Both the interviews and the faculty workshop were examples of Interactional Inquiry that helped to identify those views of effective communications shared by the writing consultants and ECE faculty, as well as divergent views. The program continues to use Interactional Inquiry and ethnographic methods to understand the role and nature of communications in the ECE culture.

Acquisition of Engineering Literacies

In subsequent rounds of interviews and through observations, the Writing Center staff sought to determine what counts as writing in engineering, and where lab reports fit into the culture of engineering. They learned that writing in engineering is a complex activity requiring multiple literacies, sophisticated design skills, and internalization of a value system that emphasizes practical, technological solutions. In the engineering academic culture, the ability to use multiple literacies and produce an acceptable lab report is taken as evidence that the student has begun to write and "sound" like an engineer.

Research on the engineering culture also suggests that solutions to practical problems are valued more than the individuals or team producing the solution. As a result, engineering texts emphasize the steps and technologies used to solve practical problems, not the people who performed the operations. These texts seldom include personal pronouns or references to individuals. According to the professionals, the ideal engineering persona is both invisible and detached. This ideal engineering persona explains the prevalence of passive voice in engineering texts. Perhaps more important, absence of personal voice resulting from the profession's insistence that the writer remain invisible may explain why engineering students often have difficulty seeing themselves as "writers."

The Lab Report as a Foundation of Engineering Literacy

The ethnographic research also provided insight into the significance and endurance of the lab report genre in the engineering curriculum. Even though engineering writers in the workplace claim that they seldom, if ever, write lab reports, engineering faculty revere the form. Professors often equate their own writing— proposals, reports, etc.— with the lab report genre. The professors' comments, when examined through the lens of ethnography, suggest that the lab report and the professional report are related, at some deep level, in both structure and technical information. In other words, the lab report is a foundational document in the knowledge structures of engineering discourse. Writing lab reports facilitates acquiring these knowledge structures, an essential process in learning to be an engineer.

The students' frustration in learning to organize lab reports and deciding what information is needed reveals part of the process of internalizing knowledge structures. Students are required to use formats but cannot fully understand what is expected in each section of the report before they have not yet internalized the structure. Students also have difficulty learning to integrate circuit diagrams, graphs, and equations into their texts to create a coherent interpretation of the laboratory experience. Although it is tedious, students must experience this process in order to learn how to compose an engineering report. Observing students as they wrote lab reports led the researchers to conclude that writing lab reports is an instance of writing-to-learn. In this process, student learn to merge the various symbolic systems that go into engineering discourse in order to communicate engineering knowledge.

Conferences and Team Work as Foundations of Engineering Literacies

Other ethnographic observations led to deeper understanding of other ways students acquire the literacies of engineering discourse, especially through conversing with professors and peers. Students often seek a professor's help in office conferences, where they may write a problem on the white board, work on the calculations or diagrams, and then discuss the solution with the professor. In this interaction, students acquire both the notational and verbal languages of engineering and learn to create the designs that constitute engineering texts. Texts in engineering **are** designs, compositions of images, diagrams, symbolic representations, and words used as design elements as well as in more traditional syntactical structures. The texts often begin as sketches on a white board; they eventually appear as texts on paper or on a computer screen, on in a PowerPoint presentation for an oral presentation.

The Writing Program's ethnographic research included examination of communications in the processes of collaborative learning and teaming. The specialization and the dynamic expansion of technology make teamwork essential. As complex problems require unique combinations of talents, the workplace relies on teams. Employers seek individuals with excellent individual abilities, plus experience in working with teams. Thus, the ECE department, in addition to providing a quality education, also designs its program to instill in students a commitment to high ethical standards and individual responsibility, along with the willingness and ability to work successfully in teams. Teaming challenges students to learn how to contribute to the team's success while developing their individual strengths. Students also must learn to hold each other and themselves accountable for individual work and team results.

Working with student teams gave Writing Center staff an ideal situation for teaching writing and for acting as participant-observers in ethnographic research. As they taught students how to write team reports, the writing consultants observed the students move toward understanding the relationship between the team writing process and the engineering design process. In analyzing an assignment together, outlining their team report, assigning parts based on individual interests and strengths, these students begin to see writing as a way of achieving a purpose – as part of the work of engineering.

Working with groups of students also gave the writing consultants insight into connections between talking, writing, and problem solving. As students in groups would begin to discuss their own approaches to solving the specific problems presented by a writing assignment, they would "awfulize" about the report writing process. This form of complaining contributes to students' knowledge of the professional engineer's work. When students talk about how hard technical writing is, or how long it took to complete a particular graph or table, or what problems they encountered, these students are building knowledge about the process of composing as an engineer.

This "awfulizing," which provided insight into the students' learning experiences, influenced the staffing of the writing program. Listening to the discussions, the Writing Center staff realized that students needed exactly the kind of educational support that Vygotsky and Hillocks describe–someone ahead of them who could help them move forward. Subsequently, two technical consultants—junior and senior engineering students with excellent technical knowledge and writing abilities— were added to the Writing Center staff. These technical consultants provide both individual and team consultation to freshmen and sophomores. With their addition the Writing Center staff has become a collaborative, interdisciplinary group seeking to help engineering students learn to write as insiders within the engineering discourse community.

Theories of Group Learning in Composition

Although teaming was a full-blown concept in ECE before the Writing Center program began, the Composition and Rhetoric faculty advising on the project were conversant with instances of the concept in their own field, both through theory as well as practice. The English Department's

Writing Studio, a program for developing writers, operates on the principles of Interactional Inquiry. In the Writing Studio, cooperative inquiry groups go through rounds and rounds of action and reflection to keep building and refining ideas. Each person in the group is a researcher who contributes their interest and expertise (Grego and Thompson 75-76). Like the Writing Studio, the ECE program includes small group learning. Small groups in the Writing Center repeat the concept of a team situation that is so important to the engineering culture. This teamwork creates a context for learning to occur— students in teams to learn from each other as well as from the teacher.

Small group learning is grounded in Vygotsky's theory— that learning language occurs from the outside in. When small children, for instance, hear language used over and over, they create mental models of how language functions. Likewise, as engineering students read engineering texts, hear discussions, and see drawings— all outside manifestations of literacies— they form internal mental models that are the bases for external literacy practices. Teams and groupwork in engineering provide the context for these outside-in experiences to occur. Further, as Vygotsky suggests, what a person can do with the help of someone else today, they can do on his or her own tomorrow (87). Working in Vygotsky's "zone of proximal development," the place between the student's level of working independently and the level that could be achieved with the help of someone further developed (86), the students bootstrap their way to further development. Learning, according to Vygotsky, precedes development. The social situation of groupwork creates the context in which the student can get the help and practice for himself.

In applying Vygotskian principles to his concept of environmental learning, Hillocks observes that apparently "in environmental instruction . . . various components of the teaching provide an environment in which students can move well beyond the levels of their independent functioning." The higher-level processes made possible by the support of the instructional environment and externalized in the group collaboration become internalized and a part of the student's repertoire of strategies that can be called upon later in independent situations." (74)

Future Research in Engineering Literacies

Literacies for engineering go beyond the basic use of written verbal language. In this era of unprecedented technological development of communication tools, the basic alphabetic literacy of written verbal language is no longer sufficient for the engineer who must communicate in a myriad of ways specific to the field. The language of our culture is no longer limited to basic alphabetic text, and the concept of literacy must be expanded to include the messages that can be constructed and transmitted through new technologies, such as visual graphics and computer programs. These new language technologies are just as much a part of the language of the engineering culture as traditional written and spoken language.

In the freshman year, engineering students are expected to acquire the following literacies: calculus, notation systems of physics and electronics, MATHCAD, AutoCAD, MAPLE, email, Unix, computer languages, Schematics, and the formats of engineering reports. They acquire these multiple languages in an Interactional Inquiry learning environment, through group interaction and through discussion with professors, advanced undergraduates, teaching assistants, and even writing center consultants. And as students learn, the teachers learn also. Keeping up with the constant changes in software, web page development, in graphics capabilities requires new levels of collaboration between teachers and students. The continuing expansion of electronic communications in our culture also challenges composition teachers to expand their definitions of literacies. The engineering environment is a rewarding site for Interactional Inquiry, and for ethnographic research into literacy acquisition, because in environments such as this, the definitions of literacy are constantly being redefined by design.

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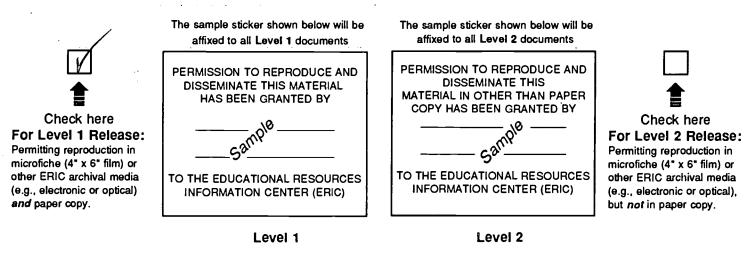Author(s): Nancy S. Thompson and Elisabeth M. Alford

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