AC 2008-2443: DISCOURSE-BASED COMMUNITIES OF PRACTICE: DEVELOPING GRADUATE STUDENTS' ABILITIES TO COMMUNICATE THEIR RESEARCH ACROSS DISPARATE DISCIPLINES AND EXPERIENCE LEVELS

Linda Anthony, Rutgers, The State University of New Jersey

LINDA J. ANTHONY is Program Manager for the NSF IGERT Program on Integratively Engineered Biointerfaces at Rutgers, The State University of New Jersey. She joined Rutgers shortly after the IGERT grant was awarded, following over twenty years as a Member of Technical Staff in the Research Division of AT&T/Lucent Technologies Bell Laboratories, Murray Hill, New Jersey. Her research interests included capillary microcolumn separations, submicron particle sizing, and process analytical chemistry for optical fiber manufacturing, chemical-mechanical polishing, and wireless and photonic electronic packaging. She served on the admissions and steering committees of Bell Labs' Fellowship programs for under-represented minorities and women, and she mentored undergraduates and graduates in these programs. She received a Ph.D. in Analytical Chemistry and an S.M. in Interdisciplinary Science from M.I.T. and an A.B. in Chemistry from Mount Holyoke College. Contact information: Rutgers University, 599 Taylor Road, Room 316, Piscataway NJ 08854; telephone: 732-445-4500 x6316; fax 732-445-3753; e-mail: lanthony@rci.rutgers.edu

Marjory Palius, Rutgers, The State University of New Jersey

MARJORY F. PALIUS is Assistant Director of the Robert B. Davis Institute for Learning at the Graduate School of Education of Rutgers, The State University of New Jersey. She conducts research, supports development of new projects, coordinates collaborative research projects and professional development programs, and manages fiscal and administrative operations for the grant-funded institute. She is also a doctoral student in mathematics education at Rutgers and has worked on studies of middle school students' informal mathematics learning in after-school programs and of teachers making the transition from practitioner to researcher. Her primary research interest is the role of community in learning environments. She earned a M. Ed. in Social and Philosophical Foundations of Education from Rutgers University and an A.B. from Smith College in Sociology. Contact information: Rutgers University, 303 George Street, Suite 610, New Brunswick, NJ 08901; telephone, 732-932-0124, x8159; fax: 732-932-0130; e-mail: mfpalius@rci.rutgers.edu

Carolyn Maher, Rutgers, The State University of New Jersey

CAROLYN A. MAHER is Professor of Mathematics Education and the Director of the Robert B. Davis Institute for Learning at the Graduate School of Education of Rutgers, The State University of New Jersey. She is Editor of the Journal of Mathematical Behavior on the editorial panel for the Journal for Research in Mathematics Education. Her research focuses on the development of mathematical ideas and mathematical reasoning in learners. It includes a longitudinal study of mathematical thinking of a cohort of students doing mathematics in and out of classrooms, now entering in its nineteenth year and tracking the subjects as young professionals. Other research includes middle school students' informal mathematics learning in an after-school setting in an urban NJ school district. She has served as President of PME-NA and was an elected to the international committee of PME. She earned a B.S. in Mathematics and M.Ed. and Ed.D. in Mathematics Education – all at Rutgers. Contact Information: Rutgers University, 10 Seminary Place, Room 232, New Brunswick, NJ 08901; telephone, 732-932-9496, x8112; fax: 732-932-1318; e-mail: cmaher@rci.rutgers.edu

Prabhas Moghe, Rutgers, The State University of New Jersey

PRABHAS V. MOGHE is Professor of Biomedical Engineering and Chemical and Biochemical Engineering at Rutgers, the State University of New Jersey. He is Principal Investigator and

Program Director of the Rutgers-NSF IGERT Program on Integratively Engineered Biointerfaces. His research interests in bioengineering include design of cell-interactive biomaterials, nanobiotechnology, and cell and tissue engineering. He is a Fellow of the American Institute of Medical and Biological Engineering (AIMBE), member of the Editorial Board of the journal Acta Biomaterialia, and a recipient of an NSF CAREER Award and Johnson & Johnson Discovery Award. He is the coauthor on a recent book on Numerical Methods in Biomedical Engineering published by Academic Press. He received a B.S. (Distinction) in Chemical Engineering from University Department of Chemical Technology (UDCT), University of Bombay, a Ph.D. in Chemical Engineering (Bioengineering) at the University of Minnesota, and postdoctoral training at Harvard Medical School. Contact Information: Rutgers University, 599 Taylor Road, Room 315, Piscataway NJ 08854; telephone: 732-445-4500 x6315; fax 732-445-3753; e-mail: moghe@rci.rutgers.edu

Discourse-Based Communities of Practice: Developing Graduate Students' Abilities to Communicate their Research Across Disparate Disciplines and Experience Levels

Introduction: We present the design, development, and on-going assessment of a novel forum to foster research communication skills among doctoral graduate students who are engaged in thematically intertwined research projects but who belong to diverse engineering programs and related programs in life sciences and physical sciences. All doctoral students must learn how to disseminate their research and learn from the research of others. However these challenges are amplified by the major differences in knowledge base, terminology, and culture that exist in the increasingly multi-disciplinary and cross-functional contexts of engineering in the 21st century. We are exploring how our forum for research interchange, developed as a core activity for research fellowship recipients of an Integrative Graduate Education Research and Training (IGERT) grant from National Science Foundation[1], can contribute towards the development of the requisite communication skills to help equip students for success in their graduate education as well as future professional employment in both academic and industrial settings.

Theoretical Framework and Motivation: Our project is framed within a socio-cultural perspective that views learning as a process situated within a community of practice that encompasses observing, internalizing and modeling the practices of that community[2]. We have adopted a situative approach to learning[3], where the focus of analysis is on an activity system (i.e., graduate students, faculty, presentation materials, and the physical environment), rather than on individual learners. From this perspective, there is opportunity to learn in activity, which can be studied by making observations over time about people's experiences in the activity and conducting analyses that "can explain how and why activities in a setting result in changes in what people can do" [3, p.80]. In particular, we are interested in examining how activity within a purposefully designed community of practice can support graduate students as they make the transition from student to nascent professional researcher during their doctoral education.

For most of their graduate student careers (after finishing core courses and qualifiers), the community of practice for graduate science and engineering students typically centers on the faculty, post-docs, and other students in the laboratory where they do their doctoral research. Within this relatively insular community, discussion of research may be predominantly focused on the strategies and techniques for conducting experiments, with little time spent discussing the motivation for the research or the broader impact of the research on related fields of inquiry. Yet the making of clear connections among the motivation for the research, the details of experiments and their results, and the implications of those results for academic and/or commercial ventures is an essential skill for doctoral students to acquire.

Within the context of our IGERT project, we are concerned with addressing both the learning challenges and the dissemination challenges that our group of doctoral students face. That is, we have sought to broaden the community of practice for these doctoral students to enable them to meet the dissemination challenges of presenting research and fielding questions from a multi-disciplinary, diversely experienced audience, and also to meet learning challenges by developing skills in thinking critically about research presented by others and making sense of it in light of the varied knowledge and experience that each member brings to the community.

Hypothesis and Design of Community of Practice/Activity System: We hypothesized that these learning and dissemination challenges could be effectively addressed by bringing students together at regular intervals in a semi-structured and facilitated forum that we call the IRIF, for IGERT Research Interchange Forum, in which students would present brief accounts of their research and engage in extended discussion/question period with their cross-disciplinary peers and selected faculty. Each approximately one hour IRIF is split about 50/50 between a student's presentation and ensuing discussion. We have chosen to hold the IRIFs within an 80-minute instructional period at mid-day and include a sandwich buffet or pizza lunch. It is scheduled for a large conference room where students can gather informally before and/or remain after the event as their schedules permit. We also make it a point to commence with brief self-introductions by all present. These are beneficial for guests in attendance (transient members of the community; see below), as well as for review of video data from IRIFs.

Instructions that are given to the presenting students for their ~25-30 minute PowerPoint ™ presentations reflect our design of the IRIF as an activity system for a cross-disciplinary community. First, students are to include both (i) a description of the context/motivation for the work and explanation of key terminology or concepts that may be unfamiliar to attendees who work in other disciplinary areas and (ii) presentation in reasonable detail of a research "nugget," e.g. a recent accomplishment/milestone, nascent hypothesis, newly proposed protocol, etc. (i.e. subject matter that might also be presented within a meeting of the home research group). Second, students are asked to spend a few minutes raising any issues for which it would be useful to have advice, assistance, or perspective from attendees. Third, they are to comment upon the research horizon, projected milestones, timelines anticipated, roadmap to publications, etc.

These instructions help the presenting students to address the dissemination challenges of explaining the research to the uninitiated while also continuing to engage the experts - i.e the cross-disciplinary challenge that is not typically present within one's own research group – while also developing their presentation and pedagogical skills more generally. The presentation also helps attendees with their own dissemination challenges by providing them with opportunity to observe both practices perceived as effective and those in which presenters may need to improve their clarity. The discussion period provides opportunity for all students to further hone both learning and dissemination skills by actively engaging in dialogue and/or by observing and modeling the actions of others. What transpires through the dynamic interaction of students, faculty, presentation, and their physical environment constitutes situative learning by activity[3].

We emphasize that, while it is possible to use a research presentation forum as a communal practice for developing specific communication skills of the presenters[4], that is not our primary intent. The focus of our research has been the mutual learning by presenter and attendees that occurs in the ensuing discussion period[5]. However, our research design involves collection of data that can serve more than one purpose (see next section). Therefore, individual students can, if they wish, review the video of their IRIF and thereby learn about their presentation skills and how they fielded questions during the discussion. Similarly, we prepare blinded-author copies of questionnaires that we administer at the IRIFs (a data source that supplements the videos during analysis) and make these available to the presenters as a source of anonymous feedback on the clarity of their presentations.

The core participants in IRIFs are the graduate students and faculty/staff researchers who are associated with the IGERT grant. The present IRIF activity system was instituted about 6 months after Cohort 2 was admitted, i.e. when the core group of graduate students reached a critical mass with enough diversity of disciplinary backgrounds and research pursuits to make the IRIF experiment feasible. Students in Cohorts 1 and 2 numbered 17, and the group has grown to a total of 36 with the addition of three successive cohorts since then. It is noteworthy that students in the first two cohorts began by participating in activities that were organized by faculty/staff researchers to coalesce emergent community. That process is described in detail elsewhere[6] and was preliminary to the IRIF activity system that is the focus of this paper. Students in Cohorts 3, 4 and 5 began attending IRIFs immediately following their acceptance as graduate training fellows in the grant program, making what appeared to be seamless integration into an established community of practice. Although these students began attending IRIFs from the outset of their affiliation with IGERT, they (as well as prior Cohort 1 and 2 students) typically do not present a talk until well into their second IGERT year.

IRIFs have now been held for almost three calendar years, meeting at approximately three-week intervals during both academic semesters and the summer, resulting in over 30 IRIFs to date. All IGERT graduate students attend the IRIFs, in addition to other grant programmatic activities, not only during their two years with grant sponsorship (graduate years 2 and 3), but also after they return to other funding sources but remain active as IGERT Associates. Thus, IGERT student participants represent a range of experience levels (graduate years 2 through 4 or 5) and graduate programs (engineering, life sciences, and physical sciences), all loosely focused about the research theme of biomaterials and biointerfaces (further information on research themes available at www.igert.rutgers.edu).

Core graduate student attendance averages about 20-25, with a few away at conferences or otherwise unable to attend on any given date, and some from early cohorts having graduated. In addition to students, the faculty/staff core group that convenes and facilitates each IRIF includes the IGERT PI, co-PI, Program Manager and educational research partners. Complementing this core group of regularly-attending students and faculty is a "transient" or "variable" group consisting of the presenting student's primary and cross-disciplinary thesis advisors, postdoctoral associates and other graduate and undergraduate researchers from these groups, and occasionally, other faculty and students particularly interested in the topic being discussed. This transient group can range from as few as 3 or 4 people to as many as 10 or more. The student to faculty ratio is typically 4:1 or higher. The preponderance of students is an intentional part of the IRIF design, to promote student participation in discourse and a student-centric environment while also enabling the students to interact with faculty beyond their immediate research groups and customary research spheres.

Data sources and analysis: Our research design was conceptualized from our hypothesis founded in a situative approach to studying learning.[3] Our experimental protocol is based on using grounded theory[7] to iteratively analyze and code the discourse from the IRIFs, focusing mainly on the discussions, and based on prior experience in mathematics education using video data to study learning *in situ*.[8]. We have designed and deployed four data-gathering instruments: (i) video recording of each IRIF (both presentation and discussion), subsequently transferred to DVD for iterative viewing, (ii) questionnaires with Likert-scale and short-answer questions administered to all attendees at each IRIF, (iii) a retrospective written questionnaire and focus group administered (by us) to all IGERT students after about one year of IRIFs, and (iv) focus groups and questionnaires administered to IGERT students and separately to faculty advisors by an independent external educational evaluator (as part of a larger program assessment) near the end of year 3 of the IGERT program. A new method for video data analysis emerged from our project and is discussed in detail in the following sections, along with how data from questionnaires were incorporated into the new analytical methodology.

Development of Graphical Record of Discourse (GROD) as a new research tool: Early on, we recognized that the approaches for tracking the development of mathematical ideas among small groups of learners[8] were not directly applicable to the much larger and diverse groups and different types of interactions in the IRIFs. Therefore, we also drew from techniques employed in Interaction Analysis[9] to develop a new analytical tool and process, which we call the Graphical Record of Discourse (GROD).

Briefly, the GROD is a two-dimensional plot of discourse turns and interactions against time that yields a graphical pattern of the flow of conversation. Analogous to an infra-red spectrum or an electrocardiogram, it provides a distinct and feature-rich "signature" of each IRIF that can be read by investigators to (i) make comparisons among IRIFs regarding numbers and durations of distinct discourse events, percentages of students participating, frequency of faculty facilitation, etc., and (ii) identify, by their signature patterns, specific portions of IRIFs for detailed transcription and analysis.

GRODs from the discussion periods of three illustrative IRIFs are shown in Figure 1, and a portion of one of these is expanded in Figure 2 to illustrate the process of generating the graphical signature (Part A), as well as the nature of the annotation (Part B) and coding (Part C) that ensues. The GROD can be generated directly in spreadsheet software such as Excel™ or started manually on graph paper and later transcribed.

In what follows, we summarize the key steps in generating and using the GROD, and comment on insights gained about this emerging new research instrument and methodology in our on-going research since our first report[5].

Generating the GROD: To construct a GROD, one first determines the characteristics of the discourse community that one wishes to study, constructs appropriate classifications (bins), to which to assign all attendees (whether they participate in discourse or just listen). In the present study, reflecting the cross-disciplinary emphasis of the IGERT grant in which our research is situated, we have chosen to group students and faculty according to their research group and graduate program and its proximity to that of the speaker. Thus, the presenting student is placed in a bin on the far left adjacent to the time code, and other attendees are placed in bins that represent categories according to their diverse research groups and graduate programs. Categories range from same research group and closely-collaborating research groups on the left, to different research groups in same graduate program and then to different graduate

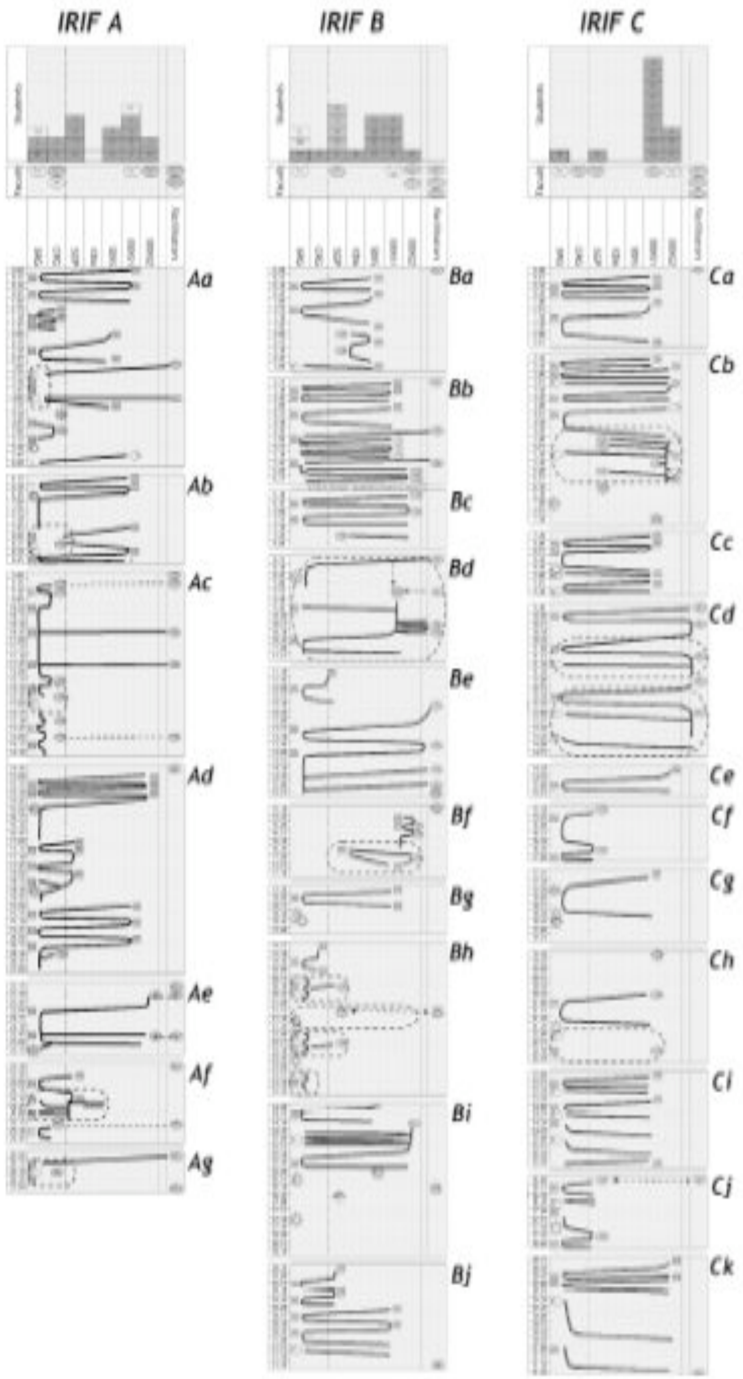

Figure 1: The GROD (Graphical Record of Discourse) is a new tool and process for discourse analysis that enables the tracking and analysis of discourse turns in communities of practice over time (vertical axis) and as a function of some attribute of the discourse community (horizontal axis). Here are shown the purely graphical portions of GROD's for three meetings of a community of practice (the "IRIF") consisting of cross-disciplinary doctoral graduate students in science and engineering. A portion of panel A is shown in Figure 2 with annotation and coding. See text and also Reference 5 for further information.

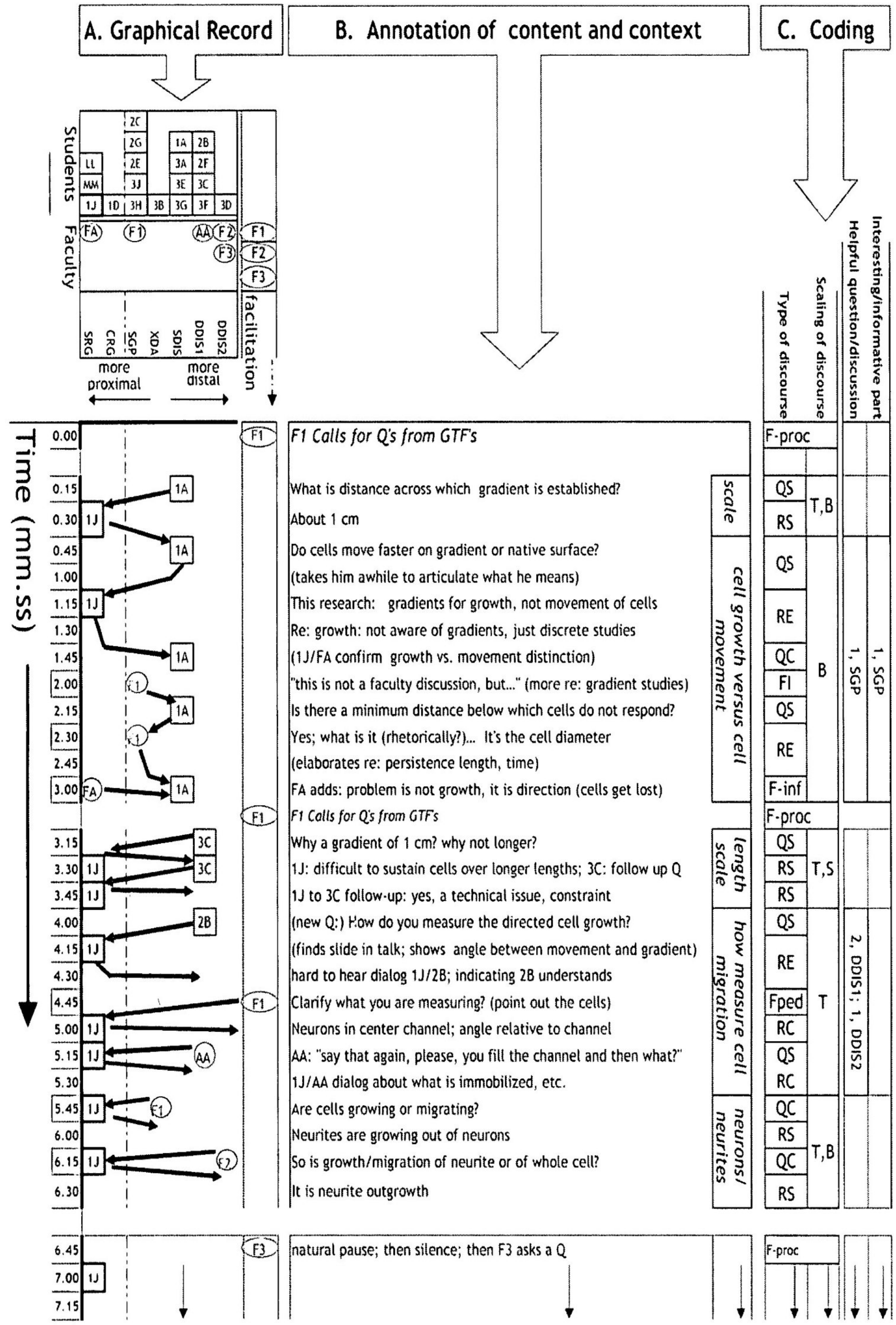

Figure 2: Expanded portion of a GROD (Graphical Record of Discourse) showing details of graphical representation and coding of participants (A), annotation of discourse content and context (B), and coding of discourse and triangulation with other data sources such as questionnaires (C). This is the first part of "IRIF B" from Figure 1. See text and also Reference #5 for further details.

programs in same discipline in the middle, and then to graduate programs in different, distal disciplines on the right. By placing a coded symbol for each student and faculty member in the appropriate bin, one constructs a histogram that represents the composition of the group as a function of disciplinary/sub-disciplinary proximity. This is illustrated in the boxes at the top of each GROD in Figure 1 and in the upper left corner of Figure 2.

Because we are additionally interested in studying pedagogical interventions and facilitations, we constructed an additional bin to the far right for contributions of this nature from the research team of IGERT faculty and educational collaborators and the presenter's primary thesis advisor. These individuals often are double listed both as facilitators and also in the appropriate disciplinary bin, the latter being for when their contributions reflect purely their scientific (as opposed to pedagogical) interest in the topic being discussed.

Comparison of the three participant-classifying boxes at the top of Figure 1 illustrates a particularly useful feature of the GROD: The shapes of the resulting histograms reflect the composition of the group with respect to the variable being studied. Talks a and b in Figure 1 were by biomedical engineers, who comprise over 35% of the IGERT population, whereas talk c was presented by a chemist, one of only 12% of the population that are physical scientists. The shapes of the histograms - roughly bimodal in a and b and clearly skewed to the right in c - clearly reflect this difference.

With the histogram of participants forming the first portion of the horizontal axis, the next step is vertical construction of a time axis. We have found that 10 to 15 second increments provide sufficient resolution in the present study. During the first in a series of iterative viewings of the video [8], the researcher scans the video to look for and mark on the vertical axis the major segments of the IRIF. Transitions between segments are denoted by such events as (i) beginning of presenter's talk (ii) end of talk/beginning of discussion, (ii) natural pauses/silences/transitions between questions (iii) lengthy explications or digressions ("monologues") by one participant (iv) obvious shifts in context/subject being discussed and (v) intentional facilitations (e.g. "Let's take this rather detailed discussion off line and shift gears and ask if there are questions from our guests from Prof. xx's group"). Segments are clearly marked by inserting a blank space in the time axis and annotating the type of transition.

This somewhat cursory documentation is roughly similar to the "content log" in Interaction Analysis[9] and analogous but less descriptive than the "describing the video data" step in the Powell[8] methodology. Delineating the number and duration of thematically and/or procedurally distinct segments initiates the process of creating a descriptive graphical representation of discourse turns. Time markers for segments also serve as guides to locate relevant sections for subsequent iterative viewing, annotation, full transcription, and deeper analysis[8], during which the segmentation may become revised and fine-tuned.

The final step in creating the graphical backbone of the GROD (Figure 1; Figure 2, column A) is to view the video in stop/start fashion and plot the discourse flow. When an attendee speaks, his/her ID code and symbol is placed at the appropriate intersection of time and column (bin) and lines and arrows are added that connect participants in dialogue and indicate the direction and time course of the interaction. For discussions among small groups with rapid interchanges and nearly simultaneous utterances, the discourse segment is simply enclosed in dotted lines. Comments (such as procedural facilitations) directed at the group at large are indicated with a starburst surrounding the speaker's symbol.

Using the GROD to characterize discourse turns: Even without proceeding to study and to code the discourse content (to be discussed in next section) the completed GRODs themselves yield an information-rich and wave-like pattern that can be read, interpreted at a high level, and compared with others, as depicted for three GRODs in Figure 1. Like waves, these GROD patterns are characterized by their (i) frequency and (ii) amplitude: *(Letters in parentheses refer to examples in Figure 1.)*

- Low frequency indicates a lengthy discourse turn, such as open-end questions or extended responses. *(Ba, Cd, Cg)*
- High frequency indicates brief interchanges, usually simple questions with short responses. *(Bb, Cb)*
- Low amplitude indicates discourse exchange within same/similar categories of participants (in our case, thematically/disciplinarily proximal research backgrounds, the same type of discourse as can occur in regular group meetings) *(Ac, Bh)*
- High amplitude indicates exchange between members of categorically different groups (in our case the cross-disciplinary exchange that the IRIF is designed to foster). *(Ad, Bb, most of C)*
- Waves displaced above the baseline indicate discourse in which the speaker/leader and his/her most similar colleagues are not involved, a clear marker for a digression or side conversation (in our case an exchange among experts from another discipline or an explanation to distal attendees). *(Bf, part of Cb)*

Using the GROD methodology to support analysis of discourse content: The graphical record thus generated provides the skeleton on which to flesh out the content and context of discourse. Key words, phrases, and occasionally brief verbatim utterances are recorded in a field adjacent to the wave pattern, as shown in Panel B in Figure 2. The horizontal annotation captures content, and the vertical boxes provide further description about themes or subjects of the discourse. Together, these cues enable researchers to describe and classify the discourse further. Discourse content and its context are then analyzed and coded using grounded theory.[7] This is discussed in the next section with other results.

For the final component of a GROD, we insert columns on the far right for triangulation of data from questionnaires with the video data analyses. For example, the questionnaire administered after each IRIF asks if anyone asked a question or made a comment that was particularly critical to understanding and what part of the talk was most interesting and illuminating. Thus, the far-right column in Figure 2 provides a place to tally how many and which participants identified a specific portion of the discourse as meeting one of those particular criteria in their questionnaire responses.

We note that, in our analytic methodology, two independent researchers scan video data, construct and code the GROD, and then discuss and resolve any disparities. Initially only members of the immediate research team (the co-authors) were among those to generate GRODs.

Since our previous publication,[5] we have had the viability of our GROD methodology validated by a new researcher. This outcome is discussed immediately below.

Results and Discussion

Methodological outcomes: One significant result that has emerged since our earlier report[5] is that the construction of a GROD from a videotaped record is teachable and replicable. Through a research practicum course, a master's student in mathematics education with no prior ties to our IGERT research was able to construct GRODs for multiple IRIFs with only minor assistance from two of the authors. The student was provided with a template with the structural formatting for the vertical time axis and unpopulated bins across the histogram portion of the horizontal axis (i.e., essentially an Excel file of an emptied GROD). Because participants make a brief self-introduction at the beginning of each IRIF, the novice researcher could identify each participant and required assistance only with placing them in their respective categorical bins for the histogram. There were no disparities with her work.

As our archive of IRIFs has continued to increase, another finding is that the GROD can be an extremely helpful tool for managing the growing body of videotaped records and the rich data sets they generate, thereby enabling the researcher to readily identify and catalog particular discourse records that one wants to study for a particular purpose. First, simply by scanning the histogram header, one can easily locate talks with a particular type of audience composition. For example, right skewed histograms indicate "audience distal" IRIFs, in which most of the audience was far removed from the speaker's disciplinary background and research. We are currently studying a collection of such IRIFs to determine if there are particular discourse patterns, facilitations, and learning and dissemination challenges that occur with this type of cross-disciplinary setting. Second, whether or not one has first selected from the archive for audience distribution, one can screen a large set of IRIFs to zero in on discourse segments that need full transcription and study to address a particular research question. This is done by looking for specific GROD frequency/amplitude patterns (Part A in Figure 2) in combination with content/context coding (Part B in Figure 2). For example, we have become interested in how disciplinary orientation and background influences one's approach to the graphical and statistical treatment of data. Toward this end, we are looking retrospectively for discourse segments that (i) have high amplitude and moderate to low frequency (i.e. presumably cross disciplinary and explicative discussions) and (ii) have content/context annotations indicating that they deal with data and statistics.

Finally, we emphasize that the GROD tool and methodology is generalizable to studying other group characteristics and to using varying numbers of categories. For example, one might wish to look at participation and turns as a function of the length of time that individuals have been affiliated with the IGERT program, in which case one might construct 5 bins (for Cohorts 1-5), and assign students and their advisors accordingly. Non-IGERT attendees could be binned separately or symbolically coded differently and assigned to bins with IGERT students who entered the graduate program in the same calendar year (e.g. Cohort 5= second year students, Cohort 4 = third year students, etc.). Likewise, the GROD can be extended beyond the IRIF model to help study other activity systems, for example in graduate courses focused on case studies and group presentations/discussions.

Qualitative analysis: characterization of discourse types by two independent attributes: The major finding that has emerged is that discourse in our IRIFs needs to be coded for two distinct and independent attributes, which we call "discourse type" and "scaling tendency." Per the tenets of grounded theory[7] this insight emerged from iterative viewing of the data itself, without imposing any significant judgments or conditions a priori.

Discourse types describe the purposes or functions of speech events that occur within the IRIFs. We identified 11 distinct types of discourse, described in detail previously.[5] The salient point is that they encompass a range of discourse functions - i.e., questions, answers, explications and facilitations - and that there are clear parallels to the classifications identified in other studies of communities of practice – i.e., elaboration, interpretation, explanation and argumentation in the work of Palincsar[10] and contextualization, explanation, instruction, critique, and elicitation among the speech events identified by Donath et al.[3].

Scaling tendency refers to the context in which the discourse occurs and where it fits in the landscape of activities that comprise the experience of doing research. We have identified three scales of discourse. The most finely grained is tactics (T) , which focuses on details of the specific research. The mid-level is strategy (S), which focuses on both the experimental design and interpretation of results, which may address issues like assumptions, simplifications, and trade-offs of design, as well as how well results support the hypotheses of the research. The third and largest scale is big-picture/background (B), which focuses on understanding the context and/or motivation for the research, connections/coherence among the strategies, tactics and motivation of the research, and potential long-term outcomes.

Our research revealed that discourse type and scaling tendency are entirely different and independent qualities of speech and that both are needed to characterize the discourse. Any discourse type can occur with any scaling tendency. Consider for example, two short and simple questions: (1) "Can you use regular AFM, or do you have to use tapping mode?" is tactical (T), whereas (2) "Is the goal of this work to promote cell growth, cell migration, or both" is big picture/background (B).

In our on-going research, we have become increasingly interested in investigating why some short-answer questions seem to elicit simple answers that do not immediately sustain discourse (in any scaling tendency) and indeed seemingly result in a "dead end" and shift to a new discourse segment, yet frequently become the "seed" for future sustained periods of strategic (S) or Big-Picture(B) discourse within the same IRIF involving a range of participants and a range of discourse types including facilitations. This is discussed further below as "factors that promote effective cross-disciplinary exchange."

Participation patterns and discourse content as a function of disciplinary proximity: First, scaling tendency and, to some extent, discourse type, both show some patterns of correlation with disciplinary proximity. To a first approximation, proximal students tended to offer (i) closed-end and largely tactical questions for areas in which they were interested in more details and (ii) open ended inquiries and responses about basic elements of experimental design and data interpretation. In contrast, more distally related students also asked simple closed-end questions about tactics but at a more fundamental level than their proximal colleagues (seeking basic, rather than detailed experimental details) and, in some instances, apparently posing them as "safe" questions to test the waters of discourse. Additionally, distal students also tended to ask provocative open-ended questions about the background/motivation for the work and how it related to experimental design/specific experiments performed.

Factors that promote effective cross-disciplinary exchanges: We have not detected a preponderance of any common factors (type of discourse, scaling tendency, type of person (faculty/student, distal/proximal)) in the lead-up to truly integrative and cross-cutting discourse segments (high amplitudes, several participants, range of frequencies). In a number of such instances, however, by examining the dialogue content of the entire IRIF, we have observed what we characterize as an "induction period." By this we mean that the cross-cutting discourse began when someone re-phrased or referred to a seemingly simply closed-ended question posed earlier in the IRIF. The former can be seen, in retrospect, as the "seed" for the more open and sustained discussion. While these interchanges were sometimes catalyzed via skilled interventions of faculty facilitators, they also occurred solely from student input, beginning with comments along the lines of "So I guess I am thinking of what (so and so) asked earlier…I mean, what about (such and such)? Why does that matter?" We have posited that such interchanges validate our design hypothesis that the IRIF environment needs to be highly student centric (not dominated by faculty attendees or frequency of their questions) but not student exclusive (some guidance from pedagogically and scientifically astute facilitators).

Demonstrable outcomes: In retrospective questionnaires and focus groups administered both by us and later by the independent educational evaluator, students and faculty have identified a number of benefits of IRIF participation that they feel are not available elsewhere. Students consistently report that they highly value the knowledge of what specific expertise, instruments, materials, and protocols are possessed by other IRIF participants and their colleagues and mentors. In some instances, students have reported already making use of these connections for specific purposes – e.g. to obtain samples, use an instrument or software package, etc. that they would not have known about otherwise. More frequently cited, however, is the benefit of knowing to whom to turn should the occasion arise. Students also cite being able to extrapolate to their own context some of the specific strategies and methods (such as statistical tests and data treatment formats for publications) from the work that others have presented at IRIFs.

Given our theoretical framework of learning communities[2] and activity systems,[3] we find it particularly significant and encouraging that many students (and a few faculty) have self-identified accounts of "modeling" "internalization" and "transformation." For example, students report that they benefit from observing not only the excellence but also the areas that need improvement in their peers' presentations, and that this has helped them to make note of what to do and not to do in their own subsequent presentations (not just IRIFs but also group meetings, conferences, etc.).

Additionally, the mere process of engaging in extended discourse, with its give and take, has been instructive for all students – and particularly so for those whose research groups are very small, and/or do not meet frequently, and/or have different norms and cultures for meetings. One student reported that the IRIF experience emboldened her to speak up in her own group meetings, which had been quite stilted and perfunctory. Now, her group members are beginning to model her example, and meetings are more interactive and productive. Somewhat conversely, a research center director (attending as a transient guest) observed how much more collegial and wide-ranging were the interchanges at the IRIF in contrast to the focused and highly analytic and critical focus of his group's meetings. He posited that his group should perhaps sometimes try the more expansive and brainstorming approach of the IRIFs.

Comparison of IRIF participants and their non-IRIF peers: An obvious question that has arisen since we first envisioned our experimental forum is whether IRIF participants can be compared with a "control" group of students to examine the impact of IRIFs on communication skills, research scholarship and productivity, and the like. As desirable as this may be, the construction and conducting of a large and longitudinal study to address this question is not our primary research focus and is also well beyond the extent of our resources. We also recognized from the outset that any findings would be subject to the same caveats about causality that arise in any study where one must deal with a host of possible contributory factors. Beyond the issues of whether one could realistically construct a control group matched for age, race, gender, socioeconomics, undergraduate major, similarity of thesis research, etc., there would be more fundamental questions about other potentially confounding and even harder to account for factors such as "predisposition". An extreme but illustrative example of this problem is the difficulty of validating what appear to be geographic "cancer clusters." In the IRIF context, the main issue is whether IGERT students constitute a self-selected group that differ in some attribute of initiative, curiosity, inherent "interdisciplinarity," etc.

Although concluding that a long-term control-group study was not feasible at this time because of these factors, we did request our external program evaluator to investigate perceived outcomes of IGERT programmatic activities during the major mid-program assessment of our IGERT program as a whole (complete report available at http://www.igert.rutgers.edu/assessment.php). Two findings are particularly relevant.

First, in a written instrument, IGERT faculty were asked to compare their IGERT student(s) and a typical/composite third year non-IGERT student in their group on a range of research attributes. The 17 (53%) responding faculty stated that there is more variability across fellows than within a program, but they did rate IGERT on Biointerfaces students more strongly overall (4.0 versus 3.2 on a five point scale where five is excellent, Wilcoxon signed ranks, $z=3.39$, $p=.001$). Though not tested statistically because of intercolinearity, there were some items with a one point or more difference between IGERT on Biointerfaces and typical fellows, suggesting areas that should be further explored. These items included: clearly communicating with others about their research; balancing reading, thinking, writing, and experimental work; independence; knowledge level outside of discipline; demonstrating integration of knowledge (i.e., insights or understanding not obtainable from knowing only one discipline); able to identify and use possible sources of knowledge to advance research; using ideas from research outside of the responding faculty's lab; using ideas from research outside of the responding faculty's field. There were also items with little difference between the two groups providing some reassurance that the rating differences were not simply a Hawthorne effect. Typical doctoral students and those receiving an IGERT fellowship were similarly rated in knowledge level within the discipline and in lab/experimental skills. It is noteworthy that the attributes with a one point or more differential relate to communication and extra-disciplinary acumen, areas targeted in the design and implementation of the IRIFs.

Second, both written and focus group/interview feedback from both Trainees and faculty revealed that the IRIFs and the IGERT interdisciplinary core courses were consistently the two most highly rated programmatic activities. With respect to IRIFs, focus groups conducted by the external evaluator revealed that "when fellows talk about community, they talk about a shared language and interactions, but they primarily talk about IRIFs and networking with other IGERT on Biointerfaces students. For some students, the IRIFs and the science community were interchangeable concepts".

Summary: Ours is a research endeavor with two distinct but related foci: We are developing and studying a discourse based community of practice (the IRIF) to address the particular learning and dissemination of challenges of doctoral graduate students in STEM fields. We also are developing a research tool and methodology (GROD) to enable more effective analyses of the rich data sets that such learning communities generate.

The IRIF provides a model for convening a semi-structured discourse-based community of practice in which graduate students can develop their skills for disseminating their own research while learning from the research presentations made by others. For researchers interested in studying how such learning transpires, the IRIF or some adaptation of it may provide a useful context for research not only among graduate students but also for undergraduates and other levels as well.

The GROD may also offer advantages to other education researchers as a methodological tool for discourse analysis, because variables other than disciplinary background - e.g. level of expertise, time in program, first language, etc. - could be plotted along the attribute axis. Thus, the methodology could be generalized and adapted for use in tracing the flow of ideas in a classroom setting or interactions in a group discussion.

Both the IRIF model and the GROD methodology may be particularly relevant for those working in increasingly cross-disciplinary environments, such as those that IGERT programs and other educational initiatives are designed to promote.

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