Genre Knowledge as Distributed Cognition in the ALESS Writing Classroom: A Preliminary Discussion

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In his monograph on naval research on an American naval ship, Hutchins (1995) describes numerous systems that produce navigational plottings, a common practice before the advent and widespread use of GPS systems. An avid navigator himself, he describes the intellectual excitement that the navigator feels as they must reconcile landfall on an unfamiliar coast and charts:

> If I am making a landfall on a high island or a mountainous coast, as I approach the land, I first see just the tops of mountains, then I see the lower slopes, then the hills, and finally the features on the shoreline itself. Now where am I? Turning to my chart…I can see across the water on the left is that headland…and perhaps that high peak off in the haze, inland, is this peak shown on the chart (Hutchins 1995, 13).

This process of reconciling the naval chart and the world is an example of what he calls "distributed cognition", the study of the ways in which cognitive processes occur in tandem with social interaction and with assistance from representational media. As the navigator looks at the world and plots the position on the chart, he is conducting several cognitive processes. For example, he transforms spatial information into numbers and aligns his visual field with the spatial representation on the map. The devices streamline spatial reckoning. Hutchins' approach is a particular perspective on situated cognition, the study of cognitive process in interaction (Lave 1988). Distributed cognition places special emphasis on the structuring of the physical world; namely, the spatial layouts and physical artifacts used to assist cognitive processes. For Hutchins, this kind of cognitive process

is not an outlier, in fact, it is the normal way that humans process information in their natural social environments. These environments are structured to achieve solutions to problems that could not be achieved—or achieved much more slowly—as individuals.

In recent years, many scholars have applied situated cognition theory to academic instruction (Wenger 2011, O'Donnell and Tobbell 2007), arguing that learning environments constitute communities of practice[1] (Lave and Wenger 1991). The distributed cognition approach places more emphasis on the cognitive consequences of the material environment. This approach has been applied to educational contexts (Salomon 1997, Pea 1993), and contrasts with educational theory that emphasizes internalization. Internalization refers to the process whereby information—cultural values, knowledge schemas, etc.—is transmitted into the mind of the individual. It is well recognized that internalization involves reconstruction (Shore 1996), clearly represented in Vygotsky's work on learning (Wertsch 1985). Students actively construct internal models of external ideas, objects, and processes. But this is only part of the learning process. The learning-as-internalization model has been criticized as too individual centric (Cole and Engestrom 1997). Students, like all individuals, are "cognitive bricoleurs", users of different representations and processes (both internal and external) to achieve certain ends (Hutchins 1995: 172). External materials, or cognitive artifacts, have important cognitive consequences in the writing classroom.

This paper is an initial attempt to understand use of the material environment in an academic writing context, the ALESS Program. The ALESS Program teaches writing skills for future research and publication to first-year students of the sciences at the University of Tokyo. From the perspective of genre studies, we suggest ways that visual and linguistic materials organize cognitive processes aimed at the production of experiment reports. This paper is intended as a prospective outline for continuing research, the goal of which is to understand the writing classroom as a socially organized system of cognitive labor; a system that distributes knowledge across materials and personnel. As an example, we will discuss task-based instruction in genre education and show how this approach emphasizes the role of materials in facilitating genre production.

Genre and Task-based Instruction

The genre approach to academic writing emphasizes the structural features of academic papers as well as content. The interest in helping students gain knowledge of the features of discipline-specific writing has led researchers to try to formalize such features. Of import to this task is *genre*, defined in some contexts as "typified rhetorical actions in recurrent situations" (Miller 1994 cited in Russell *et. al.* 2009). They grant "orienting frameworks, interpretive procedures, and sets of expectations that are not part of discourse structure, but of the way actors relate to and use languages" (Hanks 1987: 670 *cited in* Hodges 2011: 19). Hanks (1990), drawing from Halliday (1973), sees genre as indexically linked to social, political, and economic forces beyond the immediate interactive moment. In the context of academic writing, authors seek to minimize what Bauman and Briggs (1992) term the "intertextual gap": the distance between a particular text and the applicable genre types. The more narrow the gap, the easier it is to interpret the text (Hodges 2011). Genre is central to academic writing instruction; indeed, we may conceive (although we risk an oversimplification) that writing instruction *is* genre instruction. Suggesting that genre is the basis for learning all manner of expertise, Bazerman (2012) suggests that professors in content courses see the process of concept formation as underpinned by genre knowledge. Genre is a means for linking complex sets of information to one another, making the concepts easier to retrieve.

Genre instruction is one of the teaching methods implemented in general English composition as well as English as Specific Purposes (ESP) teaching. Cheng, drawing on Swales (1990), defines genre as "structured communicative events engaged in by specific discourse communities whose members share broad communicative purposes" (Cheng, 2007: 288). The underlying belief in genre teaching is that writing is a social action that is "performed through interactions of purpose, audience, and linguistic choice" (Yasuda, 2011: 112). Academic writing does not occur in a vacuum, but it involves communicative interactions between the writer and readers who share a common discourse community. Each discourse community has a distinctive register that the author needs to be familiar with to effectively transmit

her/his thoughts (Cheng, 2007; de Oliveira & Lan, 2014; Yasuda, 2011). In genre teaching, instructors, accordingly, attempt to fill students in with a set of terms, jargons, and rhetorical traditions specific to the discipline to produce writing with appropriate language and structure.

Genre teaching is bolstered by the notion that ideas, theories, and findings are formed and transmitted with the style of language specific to the discipline. In order to write an acceptable paper in the particular field, it is required for authors to have good knowledge of the disciplinary register, structure, rules and conventions, which are likely to be very different from the language used in the other aspects of students' everyday/academic life (de Oliveira & Lan, 2014; Huang, 2014; Yasuda, 2011). For instance, in scientific writing, the author should know appropriate linguistic features, including technical terms and the definitions. S/he also should follow the standard format of a scientific paper to communicate the findings, that is, 1) Introduction, 2) Methods, 3) Results, 4) Analysis, and 5) Discussion (IMRAD) to have the paper accepted in the academic community.

Wardle (2009) insists on the necessity of learning genres in college first-year composition courses in the United States. She critiques the current course design of first-year composition as too general and the writing students are engaged in is not relevant to the kinds of writing required in the disciplines that students would pursue. First-year composition courses generally expect students to produce various types of writing, such as autobiography, profile of a person, argumentative essay, interview, travel narrative, and review papers. Since the instruction rarely emphasizes the purposes and audience of writing, students fail to consider the social functions of writing. Instead, they regard writing as an isolated activity performed for the sake of writing. Furthermore, most of the students do not perceive the connection between writing activities in first-year composition courses and disciplinary writing. Although the course is meant to prepare first-year students for their future academic life, the skills students have learned in first-year composition course are not transferable to more advanced, professional levels of writing. Wardle, hence, claims that the syllabi of first-year composition courses should be reconstructed to familiarize students with

genre knowledge to help them be more effective writers in their future career. It should be noted, though, that features of genres are not static, but rather continuously renewed "responding to (…) rhetorical situations" as new knowledge and styles evolve (Wardle, 2009: 768). Students should be, accordingly, equipped with analytical skills to adjust their genre knowledge to incessantly emergent rhetorical conventions.

The genre-based approach is specifically developed to help students become aware of the rules, vocabulary, and structure through explicit instructions on genre knowledge. Genre-awareness comprises two aspects; genre-analysis and genre-acquisition. Genre-analysis includes deciphering and understanding of the "recurring generic features and disciplinary and rhetorical contexts of the targeted genres" (Cheng, 2011). On the other hand, genre-acquisition means to have students compose a piece of writing using appropriate genre knowledge in the given discipline. Cheng (2007) and Yasuda (2011) point out that while numerous studies on genre-analysis have been published, teaching practices and outcomes in genre-acquisition have rarely investigated in ESP scholarship. It indicates that the accumulated knowledge through genre-analysis of various academic fields has not been sufficiently transferred into pedagogical practices.

Some studies, however, suggest genre-acquisition teaching promotes student recognition of writing as a form of communicative interaction, which entails the increase of awareness of the audience and the social contexts. Genre acquisition pedagogy generally involves interactions between model texts and writing activities. By analyzing the linguistic features and styles of model texts, students gain genre understanding. The newly acquired knowledge is, then, applied into their writing when students produce their own writing using specific vocabulary and rhetorical tradition of the discourse community. Drawing on Martin and Rose (2005), de Oliveire and Lan (2014) describe a teaching-learning circle in genre-based pedagogy, which consists of three phases: deconstruction, joint construction, and independent construction. At first, students deconstruct model texts in the target genre with the guidance of teacher to understand the content, linguistic features and structure specific to the genre. It is followed by guided joint construction activities, in which stu-

dents compose texts in reference to linguistic features and structure they have learned through the previous deconstruction activities. After the joint writing practice, students independently write their own texts transferring genre knowledge into their own composition. The sequential teaching facilitates students' awareness and familiarizes them with the disciplinary contexts and specific register. It scaffolds students' learning to be an independent writer with appropriate rhetorical skills.

Mustafa (1995) describes how genre teaching enhanced college students' awareness of the rhetorical structure of scientific writing in Jordan University of Science and Technology, where students were expected to write their term papers in their second language, such as English. There was an English writing course focused on rhetorical conventions, in which instructions highlighted discipline specific structure and basic part of scientific writing—including the thesis statement, the table of contents, the introduction, the body part, the conclusion, the references, as well as how to cite and refer to related previous literature. Mustafa administered a survey to see the difference in the level of genre-awareness between those who had taken the genre-focused writing course and those who had not, and analyzed the correlation between the students' awareness of genre and the marks they received on their term papers. In addition, interviews were conducted with professors who taught and marked the students' papers in order to understand how professors perceived the usefulness of genre awareness to write a good term paper. The study revealed that not only were students who had taken the writing course with explicit instructions on genre more aware of discipline specific rhetorical structure, but they also received relatively higher grades for their term papers as opposed to those who had not taken the course. On the other hand, it was found that professors who taught respective subjects did not necessarily gave explicit instructions on structures of scientific papers in their courses. The underlying assumption is that students would already have understood basic conventions of scientific writing without explicit instructions. Indeed, professors did not regard teaching rhetorical structure as part of science education. The results suggest that science professors' lack of understanding would create the obstacle to students' genre acquisition.

Yasuda (2011) reports on a study conducted in college EFL courses at a private scientific university in Japan. In the classes, students learned how to write e-mail messages in English. The instructor chose e-mail as the teaching material because it would help enhance students' awareness of readers and purposeful writing, since e-mail messages, in general, were goal-oriented with clear purposes and rhetorical conventions to fill the goals. When the learners produced messages to imagined audience, they chose appropriate styles and applied their knowledge of proper formats and language to the composition. Yasuda's results showed that a focused explicit instruction on genre helped students increase their awareness of genres as well as improve their writing skills in various aspects, such as cohesion and organization, grammar, fluency, and language sophistication. Through the fifteen-week course, students' gained skills to achieve their goals by fulfilling tasks with appropriate use of language.

Huang (2014) studied a twelve-week graduate level academic writing course at a university in Taiwan, which focused on genre acquisition of academic writing. The purpose of the course was to prepare L2 graduate students to write English research-based articles to publish on international academic journals. At the beginning of the course, students read model texts published on academic journals and analyzed linguistic features and moves in the article. Students then produced their own research paper using the genre-specific knowledge as "resources instead of rules" (Huang, 2014: 178). The results demonstrated that explicit genre instructions helped students build rhetorical knowledge and process knowledge, such as structure, language, and an understanding of citations and referencing styles. Among various activities, the instructor highlighted the rhetorical purposes and functions of each section of scientific papers to enable students to organize and reorganize their writing more purposefully. In the most successful case, one of the students had attained more genre appropriate, convincing abstract with suitable rhetorical features after the guided revisions which encouraged readers to read the rest of the paper. The paper was eventually accepted by an international academic journal.

Although genre teaching is generally regarded the useful

pedagogy for advanced L2 learners with high language proficiency level as well as advanced knowledge in the subject-matter, the teaching methods have been introduced in various subject areas with diverse age groups of students. De Oliveira and Lan (2014) observed that the similar pedagogy was also effective with younger L2 learners in elementary school science class. In an upper elementary science classroom, a science teacher adopted genre teaching to a second language speaker student. The teacher noticed that the student originally from Korea was struggling to write a report on his experiment, while he did not have difficulties in oral communication with his peers as well as writing personal stories. The teacher identified a lack of scientific register as part of the difficulty. The teacher had the student interact with a model text to understand how to record the experimental procedure, pointing out crucial linguistic features in science writing, such as materials and tools used in the experiment. The focused instruction helped students write a scientific report with clarity and precise descriptions of the experimental procedures. This study clearly showed that if the language and materials used in class are tuned in accordance with the cognitive and linguistic level of the students, the concept of genre teaching would generate a fruitful outcome with younger students to improve their writing.

As described in the cases introduced above, genre teaching is inherently task-based (Yasuda, 20011), as the courses are devoted to various types of activities, such as interactions with model texts, analyses of genres, and transferring knowledge into writing. Task-based learning derives from Dewey's (1938) philosophy of experience and education. While criticizing knowledge based traditional education designed around adult standards that are often not relevant to children's experiences, Dewey insists on experience-based education which would allow students to relate subject matters with their previous experiences. By contextualizing knowledge through experience-based education, children would be able to connect and apply acquired knowledge to solve problems, which, he claims, would enable students to contribute to their community in the future.

In line with Dewey's experience-based education, task-based L2 teaching is organized centered around students' experiences that facilitate holistic learning "with the goal of enabling

L2 users to succeed in attaining needed lifetime performance objectives" (Robinson, 2005: 1). In task-based language teaching, the syllabus is designed in accordance with the varieties and complexity of the tasks as opposed to conventional language courses arranged based on linguistic content (Robinson, 2001; 2005). In genre teaching, a variety of pedagogic tasks are designed to have students be aware of and acquire genre knowledge through close reading of model texts to analyze and understand genre specific vocabulary and rhetorical features. Then students apply genre knowledge to their writing activities to produce texts more appropriate to the target genre.

To summarize, the genre approach involves the: (1) explicit analysis of particular types (for linguistic features), (2) general awareness (comparing the different genres) using specific registers, (3) genre acquisition, in which students actually produce texts. There is a fundamental problem faced by writing instructors in both L1 and L2 languages; that is, genre acquisition, or the transference of genre knowledge into new genre-specific papers is often challenging. Students often fail to implement genre features in their own writing (Wang, 2017).

This problem may be a result of a relative dearth of research into the cognitive micro-processes students use to create new texts. We advocate for a close analysis of the distribution of cognitive practices between the author and the material environment, much like the interaction between a navigator and the cognitive artifacts that exist around her. Below, we will conceptualize the ALESS classroom through the lens of distributed cognition theory and understand it as a *functional system*, an approach that will clarify the cognitive consequences of the material environment on genre instruction.

The ALESS Classroom as a Distributed System

The IMRaD scientific paper—standing for Introduction, Method, Results, and Discussion—is taught in the ALESS classroom. This is a genre composed of multiple sub-genres. It acts as a pre-existing template into which the scientist must place her experimental findings, link those findings to previous research, and understand how they may (or may not) contribute to wider social, political, and economic problems (among many other tasks). In

short, the goal of academic writing, within the ALESS program at least, is teaching students how to transform information from the experimental activity into the IMRaD template. They gain knowledge of the communicative skills required for engagement with the scientific community. In this way, we can see genre, as a form of concept formation, as integral to an understanding of distributed systems (Hutchins 2012). The final IMRaD product is not the sole result of an individual cognitive effort but a process of constant representational change and feedback.

The concept of a functional system is central to ethnographers and cognitive scientists who use the distributed cognition concept to understand cultural behaviors. Understanding whole societies as functionally oriented is, arguably, an idealized fiction of ethnographic research (Leach 1962), but communities of practice are functionally oriented towards a goal. As mentioned in the introduction, navigation is a useful example for understanding how thought processes are distributed across environments and individuals. Navigation in many cultural traditions is highly reliant on navigational charts. In the interaction between the chart and the plotter, we can see one goal-oriented system at work. The map is a spatial analogue, and navigational maps support certain kinds of computational acts, giving the plotter a "bird's eye view, that, depending on the scale of the chart, could be duplicated with respect to the real space only from an aircraft or a satellite" (Hutchins 1995, 62). The material artifact gives the user a different view of spatial relationships in the world. The plotter uses the scaled representations in the map to triangulate positions. The interaction constitutes a computation, or changing representations of one form of information into another form, which is a process cognitive scientists have traditionally attributed to the individual mind. Another example is the use of the alidade, which is a viewfinder with a two compass scales integrated with the lens. This laminates numerical compass values onto the geographical features, allowing the viewer to call out positions to the navigational chart uses (Hutchins 1995: 31). The articulation of the visual field and the chart is achieved with minimal internal cognitive processes; instead, it relies on the tools that do much of the cognitive work for the sailors. They then verbally coordinate their actions to correctly plot the ship. The material and social organization of the bridge is a functional

system. Navigation is achieved through social collaboration, and not solely through problem solving within the mind of an individual.

Hutchins argues that navigation shows how cognitive processes we often attribute to individuals are really the properties of groups and environments. Navigation maps, or other tools carry knowledge, as they show evidence of prior reasoning processes (Pea 1993). They are cognitive artifacts. Cognitive artifacts—material or embodied representations that contain information—play a central role in scientific research. Giere (2004) argues that scientists, within their disciplinary communities of practice, work within a distributed system that takes advantage of various types of cognitive artifacts. Scientists have different types of knowledge, and they must coordinate their different levels of expertise. Ethnographic studies of interaction show, for example, how modeling practices occur through the co-construction of gesture in laboratory settings (Becvar, Hollan, and Hutchins 2005). This also applies to writing in the scientific context. Research reports are often written by a team of scholars and represent multiple voices, which it shares with academic writing as a whole (Hyland 2003). The process of academic writing exists within a system designed to give feedback and make writing accord to certain genre rules (Cronin 2004). Scientific research is distributed across minds, texts, and materials[2]. Below, we discuss how the distributed cognition model might be applied to the ALESS Program at the University of Tokyo.

The ALESS Program attempts to replicate the experience of research and writing for undergraduate students. The Program employs seventeen full-time instructors. Each of these instructors develops their own course work centered on common goals of writing a scientific paper and giving a final presentation. Instructor backgrounds vary from the natural to the social sciences and humanities. The students in the class conduct experiments as individuals or in groups. The experiment becomes the basis for a scientific report based on the Introduction Method Results and Discussion (IMRaD) format. Much of the instruction time in the ALESS classroom is spent teaching students about this genre and its constituent parts. This instruction is distributed in several key ways: (1) the use of varied expertise at different institutions on campus (2) feedback within the classroom and

(3) material which retains previous knowledge and guides students to certain cognitive tasks. All of these are practices circumvent questions of genre knowledge in favor of socialization into a community of practice. By way of explanation, we will focus on the third category and offer an extended example. But initially we will explain the first two.

The Distribution of Expertise

All communities of practice have participants with different levels of knowledge. A parent-child interaction, or the navigation of a naval vessel, has a distributed system of knowledge that often correlates to status within the system. The University of Tokyo has a scientific laboratory dedicated to the ALESS program, which is staffed with teaching assistants from the natural sciences. While the instructor focuses on writing, teaching assistants guide students through practices from the relevant disciplines. The science tutors do not normally give instruction on scientific content (e.g. clarifying the biological process of decay). In their discourse analysis of tutorial sessions in the ALESS Lab, Yamamura, *et. al.* (2016) shows how tutors guide students towards practices of quantification and reproducibility, which are fundamental for conducting successful experimental research. Expertise is thus a distributed phenomenon, shared between the writing instructor and the science tutor.

Multi-level feedback (egalitarian, hierarchical, and temporal)

Functional systems require robust feedback mechanisms for avoiding error and improving performance. During the writing class, student work is subjected to a series of feedback activities. In peer-review sessions, students read one another's work and comment upon it. The students learn how to create effective reviews of one another's work, and these review sessions may occur numerous times throughout a semester. These feedback sessions are egalitarian in that students have the same social status within the classroom. This may lead students to comment upon non-face threatening problems, such as small grammatical and spelling errors. Instructors give ample instruction on how to

give a peer-review, focusing mainly on more significant structural problems such as missing a vital component of the Introduction. Student work is also subjected to two levels of hierarchical feedback. In addition to the ALESS Lab, the ALESS (and ALESA) program has a dedicated writing center, the Komaba Writing Studio, staffed by bi-lingual graduate students. These tutors guide students towards perfecting the IMRaD genre, giving students another opportunity for evaluation and advice from experts beyond the instructor. The other main hierarchical feedback mechanism is that between instructor and student. The instructors gives the student written or oral feedback on the papers once or several times throughout a semester. These feedback sessions take advantage of both distributed knowledge about writing (ALESS Lab tutors, KWS tutors, other students, and the professor) and knowledge distributed through time. As the class advances, so does the student's portfolio of writing, which can serve both as an externalized memory resource for all participants, and a gauge of increasing genre fluency. The knowledge that the students, professor, and tutors have—about a particular student's writing—changes over the course of the semester.

Cognitive Artifacts and Genre Production

Student papers are material artifacts encoded with their previous knowledge. They can serve both as a representation of genre knowledge and act as an external memory bank for the instructor, to help them remain up-to-date on student progress[3]. Another form of socially distributed memory occurs between professors. In the ALESS program, professors share their class resources with one another. This results in a robust exchange of syllabi, worksheets, and other materials between novice and more experienced teachers. All materials are changed by individual instructors to suit their pedagogical styles. These materials, much like a map, contain knowledge previously developed for the program. And also like a gyro-compass, navigational map, and alidade that augment perception in navigational settings, materials can distribute knowledge into the world and supplement perception. Below, we will use examples from pedagogy about scientific abstracts to explain the distribution of

knowledge into the material world.

Scientific abstracts are a genre that act as "a concise representation of a document's contents to enable the reader to determine its relevance to a specific information" (Johnson, 1995 *cited in* Orasan 2001: 1). In the ALESS program, the abstract reflects the IMRaD format. Professors use different approaches to abstract instruction. Some introduce the abstract initially to assist with background paper research. Others describe the abstract in depth later in the semester. The following example (figure 1) is introduced early in the semester as a means to teach students about the IMRaD format. Instruction varies, but generally the students are asked to identify the component parts of an IMRaD paper within this abstract taken from Nittono *et. al.* (2012).

Abstract

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Kawaii (a Japanese word meaning "cute") things are popular because they produce positive feelings. However, their effect on behavior remains unclear. In this study, experiments were conducted to examine the effects of viewing cute images on subsequent task performance. In the first experiment, university students performed a fine motor dexterity task before and after viewing images of baby or adult animals. Performance increased after viewing cute images (puppies and kittens; 43.9±10.3% improvement) more than after viewing images that were less cute (dogs and cats; 11.9±5.5% improvement). Results show that participants performed tasks requiring focused attention more carefully after viewing cute images. This could be the result of a narrowed attentional focus induced by the cuteness-triggered positive emotion. For future applications, cute objects may be used as an emotion elicitor to induce careful behavioral tendencies in specific situations, such as driving and office work.

> **This "abstract" is divided into four sections, just like the paper: Introduction, Method, Results and Discussion.**
>
> **Read the abstract and try to divide into four sections. Draw a line separating the sections.**

Figure 1

Teaching the genre of scientific abstracts is not reducible to the transfer of generic features from the teacher to the student. At every moment, instruction is mediated by the material environment. Before the students see this Power Point slide, they read the paragraph themselves, trying to identify the component parts. They underline the introduction, methods, results, and

discussion sections. This first step may rely on their own (internal) knowledge of the IMRaD format. More likely, however, the students compare the paragraph to their own written notes on the details of the format. Identifying the features of the genre becomes a deductive process of applying general principles to a specific example, which relies on visual and linguistic knowledge to identify the features. Once figure 1 is shown, the students then see the visual divisions of the IMRaD genre, and compare this to their own work. The task of evaluation relies on the visual field. At the end of the exercise, there will be variant amounts of understanding within the classroom. But drawing a strict division between the manipulation of their material environment—underlining, continuously unfolding writing—and the internal mind is largely impossible during genre instruction. This reflects how learning occurs in the ALESS classroom setting.

After genre instruction, instructors task the students with genre production. In the next example, we see how genre production can be created not as an externalization of genre knowledge, but a process of articulation of previous drafts written by the student, handouts, and summarization practices. Figure 2 is a worksheet that gives the students five themes to search for in their drafts. Initially the professor instructs the students on the required sub-sections of the abstract. But the worksheet reduces the need for students to memorize the sub-sections. By underlining sentences and arranging them in the order described in the worksheet, they can create an example of the genre without full genre knowledge. Highlighting aspects of the material environment—written language or otherwise—is a means for oriented viewers or listeners to features of a visual or auditory stimulus. Goodwin (1994) argues that the practice of highlighting is fundamental to the development of expertise in professional fields (e.g. a doctor identifying features on an x-ray with a pointing device or pen).

Abstract Guidelines

The abstract is a summary of the format and content of the paper. It will describe the: purpose, research questions, methods, results, and applications of the data.

First, read your entire paper, and <u>underline</u> the sentences that relate to the following topics.

Second, please write one to two sentences for each section below:

1. Problem that contextualizes the research

2. Research goal

3. Methods

4. Results

5. Applications of the results

Figure 2

At this point in the class, students have a draft of the IMRaD paper and, in theory, have completed all four sections. The abstract includes brief descriptions of these four sections. In the worksheet below, the students are told that writing abstracts is a skill that will help them condense information into smaller digestible paragraphs. With the sections that follow, they are asked to read their own paper, and underline the relevant sentences that apply to the sections. They then re-read the underlined sections and condense them into one or two sentences corresponding to the genre features (numbers 1–5). Number 1 relates to the first sentences of the paper, which identify an economic, social, medical, or environmental problem to which the research may be applied. The student, reading the paper, need

only underline the sentences in her opening paragraph that pertain to the contextualizing problem. They then re-phrase and/or summarize the sentences on the worksheet. Number 2 directs the student's attention to the goals of their experiment (e.g. "this experiment aims to understand the effect of X on Y"). The 4th and 5th numbers likewise correspond to sentences within the draft, and hence, they can summarize the sentences over on the worksheet.

In our experience, number 3 (methods) requires more significant summarization as it requires students to condense an entire section into a few sentences. The method section takes up several paragraphs of text. In a scientific abstract, however, the author must summarize these methods into two or three sentences. Most of the students have written about their methods using a kind of recipe analogy; for example, a student might write that "first the solution was created by mixing so many milliliters of X with so many milliliters of Y". Writing the abstract they are forced to change this step-by-step instruction into a summary. In this case, the student begins the process of summarizing the methods, relying on their own linguistic abilities as well as tools in the world (dictionaries, their own interaction with pen/paper or word processing program on a computer or tablet).

In interaction with the worksheet and the professor, students produce a genre example of the scientific abstract. This production does not necessarily rely on internalized genre knowledge. Students produce genre through the articulation of mental processes and external materials. This example highlights how a physical and linguistic artifact mediates the construction of (a portion of) an academic paper without the necessity of understanding the cognitive processes evident in the individual. Modeling of scientific genres, or any genre for that matter, does not require complete comprehension (Middleton 2016). The worksheet changes the task from genre comprehension to a more basic linguistic search within the student's previously written draft. After the students have completed the worksheet, they type the abstract for homework and bring it to class for peer review. The social interaction between student and artifact becomes an interaction between student and student. Eventually, the instructor offers verbal or written feedback on the abstract.

So what occurs is a nested system of social interactions designed to produce an end-product, *not necessarily to create an internalized model of the abstract genre.* We may see this as a problem, as it challenges notions of learning as internalization. But from another angle we can see it as a form of socialization into practices of cognitive and social organization that they will participate in, in the future, as research scientists in graduate school and beyond. The distributed cognition model describes the active integration of material, student, and professor in ways that reflect writing in the professional scientific world.

Each worksheet, Power Point presentation, note on the board, might require different kinds of cognitive engagement. Each representation gives different amount of information requiring maximal or minimal inferences from the students. The question of what is the most effective means is an ethnographic and empirical one. The interaction between students and artifacts as a form of social organization should be a central focus of pedagogical analysis. The navigator plotting her course is reliant on the social artifacts that she uses. Science writing professors should attend carefully to the cognitive consequences of material used in class, and evaluate their alignment with educational goals.

Conclusions

This paper does not aim to devise a *better* teaching strategy based upon the distributed cognition model; instead, it offers a theoretical outline and brief description of how artifacts might affect cognition in writing classes. Research on pedagogy in L2 acquisition and general education has integrated notions of communities of practice with education in myriad and productive ways. This paper explores one way in which instructors can understand the role of language and material representations in the classroom in relation to student instruction. We use the analogy of a navigator using preconstructed cognitive artifacts to plot distances to call for further analysis of student interaction with the material environment. This approach has several advantages.

The limitations of the internalization model have been evident in recent years with the growth in active approaches to

learning. One of the strengths of this distributed approach to academic writing is that it places emphasis not only on the internalization of knowledge, but socialization into a community of practice. Focus on the representational media (i.e. the written report) is one important component of this approach. This approach is appropriate for academic writing courses because the student is evaluated on the final report and are not given a test in which they recite memorized knowledge. In this way we can see academic writing instruction as a space for students to become familiar with scientific communities of writing.

Another advantage is that the distributed model emphasizes the changing representations (e.g. drafts) over the course of a semester. This approach may shed light on the importance of drafting, and feedback, for the success or failure of final papers. Students in our program have many classes to take. ALESS is one component of their first year experience. In each class period they must remember the specific goals of the course and their recent work within it. The drafts externalized memory devices for professors and students. Each week, they remind the student about the necessary genre features of the IMRaD format and remind the instructor of the specific strengths and weaknesses of the student's practice. Faulty drafts, or one's that are composed with less effort, hinder the feedback mechanisms between teacher and student. Just as the navigator would fail using old or inaccurate maps, drafts can handicap student performance and teacher assistance throughout the semester. Less than optimal student performance may the result of incremental interruptions to the professor-student feedback loop, which emphasizes the need for early intervention with struggling students.

This theoretical approach has limitations; for example, it may run the risk of emphasizing functionality over dysfunctionality. The feedback mechanisms between teacher and student often fail for various reasons. Students also have individual motivations that might collide with the goals of the system. This initial discussion also does not account for social structure beyond the classroom. Students often enter the classroom knowing one another well and cultural factors such as class and gender play a role in shaping interaction.

This research approach needs further theoretical development and empirical investigation, but by using the example of

genre, we hope to have further complicated notions of learning-as-internalization, and emphasize that students are opportunistic thinkers, taking advantage of combinations of internal and external information.

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Notes

1. Wenger (1998) describes the community of practice as group of individuals that share communicative repertoire, a common goal, and are mutually engaged in some fashion. A sports team—with a lexicon and register, common aim of winning the match, and coordinated activity—might be a prototypical example.
2. Scientific experiments themselves manifest the distributed cognition model. Researchers draw up the existing knowledge, their experimental plan and hypotheses using various cognitive artifacts. They also plot the data they have obtained on charts, which allows the researchers to visualize their findings. Experiments in ALESS are implemented to assist students' learning.
3. The ALESS Collection is an in-house selection of exemplary student papers. As such, the ALESS Collection is also an institutionalized memory bank shared with instructors and students across time. Students learn much from papers in previous issues of ALESS Collection regarding acceptable types of experiments and language features required in producing their term papers. The ALESS Collection also exemplifies the social aspects of writing by clearly presenting a discourse community that includes current students as audience.

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