Information Literacy, distributed cognition, and virtual teaming in a linked writing/general education chemistry assignment

Introduction

Information literacy is an umbrella concept encompassing library instruction, computer literacy, critical thinking, communication, ethics, and lifelong learning. How might information literacy contribute to teamwork? Information Literacy enables learners to "master content and extend their investigations, become more self-directed, and assume greater control over their own learning"[1]. In a teamwork situation, can individual skills with information gathering and synthesis contribute to the work of the group? We know from communication and composition journals that a teamwork assignment provides students with an audience and purpose for written interaction.

Jean Lave, social anthropologist and professor of learning-as-social-practice has developed (with computer scientist and theorist of learning systems) Etienne Wegner, a model of learning that has been influential among educators adopting inquiry-based learning and student-centered techniques. In Lave and Wegner's community-based concept, a learner moves from novice to full practitioner through his or her involvement in peripheral practice, where becoming a legitimate participant in a community of practice involves learning how to talk and how to use the tools, including communication tools. Lave and Wegner assert that learning results from the structure of practice, rather than exclusively from the structure of pedagogy[2]. The novice progresses through various stages of structured "participation" in the community of practice, including learning the specialized tools and discourse of the community. Communities of practice are a "set of relations among persons, activities, and world, over time and in relation with other overlapping communities"[2].

In their study of engineering teams of students, graduate students, and faculty, Donath, Spray, Alford, et. al. applied a community-based model of learning, using the term "distributed cognition" to explain the integrated contributions of team members to the global problem-solving of a group[3]. Cognition is an activity distributed among persons and their environment[4] , including team members, and the group becomes a resource for learning. Language and such language structures as genres contribute to distributed cognition as well[3]. Writing has been described as a contributing element of distributed cognition[5]. Donath and partners identified seven categories of speech events that characterize active learning as "students construct an emerging community of practice"[3]. They conclude that awareness of knowledge-making speech events can help educators facilitate active group learning.

Would a combined assignment with general chemistry and technical writing students generate observable communication events related to distributed cognition? Collaborating faculty sought evidence (in written and oral communication) of:

- Student control, awareness, and demonstration of knowledge

- Information literacy: the performance of secondary research to retrieve, synthesize and explain high-quality information
- Negotiation and consensus building among team members

Collaborating faculty in this study found the concept of distributed cognition useful to describe their observations, after gathering and examining students' communication materials. Although our chemistry and technical writing courses were not discipline-specific in our college programs, (and could not capture students' constructions of "emerging communities of practice") we believe that distributed cognition describes virtual interactions leading to the goals of our project. These are: control, awareness and demonstration of learning, information literacy, and negotiation with team members. Our assignment helped students understand the application of a chemical process, chromatography, within their future communities of practice. We further claim that information literacy serves a key function in constructing the pool of shared language and genre resources for the team members to access as they address the problems posed by the assignment to build a presentation.

Collaborating faculty had participated in a peer review of teaching in 2001, where they found that their teaching philosophies emphasized the importance of active learning, teamwork, and Information Literacy. To enrich student experiences in chemistry and writing for students in business, aviation, and engineering technology programs, collaborating faculty developed a linked assignment that they offered over two years of instruction.

Method

The students involved in this study were enrolled in sections of a general education chemistry course and an upper-level technical writing course. Faculty designed a linked assignment consisting of two face-to-face meetings (if enough time was available in the semester), asynchronous virtual meetings, shared file functions, and a large-group presentation. The combined classes were under thirty students in number, most of whom majored in professional pilot, aviation maintenance, engineering technology or technology management programs.

Student teams of maximum five participants were composed of two chemistry students and two technical writing students whenever possible. The chemistry faculty identified students enrolled in technical writing who had previously taken the chemistry course, so one of these students were assigned to lead a group as a "knowledgeable peer," because of their experience with both courses. Because enrollment numbers fluctuate, flexibility in composing groups is required.

The assignment

The assignment was given as a pre-lab to the chemistry students; it was given as a secondary research (library digital database compendium) assignment to technical writing students. Ideally, students were to meet for a full 50-minute session to share the results

of their research into chromatography. Two subsequent 50-minute sessions provided time for teams to synthesize their information, plan and create their Power Point presentations. Given the time constraints of summer sessions, more recently the assignment has offered no face-to-face meetings, unless students arrange them on their own initiative. Communication was conducted via message board, email, and file-sharing. Individually and collectively, all students were to integrate discipline-specific secondary investigation with science literacy, information literacy, and virtual/face-to-face communication skills, which altogether, support life-long learning.

All students were to search for information about how a particular chromatography technique/tool is used in their major fields, to write a summary reflecting the subject (chromatography) and the discipline (chemistry). Faculty guided students toward effective project-management skills with handouts to encourage information management and time management. The chemistry instructor also requested that students articulate connections between chromatography, their disciplines and their daily lives. Technical writing students were to conduct research, write summaries, share files, manage the virtual meeting space, and participate as team members.

Faculty keyed their objectives to university student learning outcomes, and The Association of College and Research Libraries learning outcomes, and TAC of ABET criteria (Appendix A). All students were required to consult peer-reviewed journal information, rather than relying uncritically on their research tool of choice (The primacy of Google and its relatives as the research tool of first choice among undergraduate students has been extensively documented over the last two decades. The lack of instruction in Information Literacy, especially in the choices and responsibilities of contemporary information users is also well-documented). Our students were to:

- Provide an example of the application of chromatography in their community of practice (engineering technology, professional pilot, airframe and powerplant maintenance, or technology management).
- Compose a ten-to-twenty minute team PowerPoint presentation conveying this information to an audience of peers and the course faculty
- Document (through minutes or notes) the group process of creating the PowerPoint using virtual team software (technical writers)
- Perform the presentation

Information literacy instruction

Using materials prepared by a partnering librarian, the instructors presented details regarding the location and use of information resources, after which students would sign up for individual conferences with the librarian as needed. Technological proficiency in searching and navigating professional literature databases places these resources within undergraduates' comfort zones, increasing their motivation to revisit them as information needs arise. Students were prepared for their research of chromatography by chemistry faculty who had partnered with our instructional librarian to develop competency in database searching. Students were shown how to navigate the library's portal for general education chemistry students. Librarians have designed a link on the college library website, labeled "Chemistry Section" to ease navigation. Students were also shown the

logic of Boolean operators, and Advanced Google was demonstrated so students can limit their domain results to educational or government sites, or otherwise manipulate results through keyword phrases.

In addition, students were to document their search path, so they would better understand the architecture of the information gateway. They are guided by a prewriting worksheets with questions such as, "My initial search outcomes are/are not matching my expectations", "I need to narrow my search because . . .", "Changes that I am making (keywords or databases) . . ." "Initial session ending time . . . " Appointments with the partnering librarian and with the writing center are also recorded. (See Appendix B).

When students document their search path, the chemistry faculty has found that student time is more effectively utilized throughout the research process, because search strategy becomes more deliberate and less random. The observations made during the summer sessions led the chemistry faculty to collaborate further with the writing center to refine the search-process assignment, which now includes planning and more careful annotation of the process. The worksheet provides sequential support to students while highlighting the meta-cognitive heuristics so essential to strategic searching (Appendix B).

Role assignments

In real-time or virtual asynchronous communication, students share the results of their research and plan a ten-to-twenty minute Power Point presentation. During this process, they elect a "file manager" who organizes the virtual files, including the evolving PowerPoint. The teams also elect a communicator, who is responsible to contact faculty with issues and problems, while keeping the group coordinated and on task. Finally, they elect an editor, who is responsible for producing the final version of the PowerPoint, and organizing the work of team contributors. (A useful guide for helping teams self-evaluate their group performance can be found in Appendix C).

File Manager	Organizes all virtual files: minutes, notes, articles, summaries, individual Power Point contributions from team members.
Communicator	Contacts faculty with issues and problems, keeps group coordinated and on-task.
Editor	Develops and edits final version of the Power Point presentation.

Virtual teaming and technology

As articles are identified and retrieved, students write summaries of relevant information, then post the original and the summary to "group files," the virtual team file- sharing software. Students are assigned to read each others summaries in preparation for planning and building the presentation. The tools students used include personal computers, a standard presentation software, search browsers, virtual team software featured in the web course tools, and library subscription databases. The web course software automatically labels each uploaded version of the PowerPoint chronologically,

version 1, version 2, and so forth. This feature allows individual students to create a section of slides and upload them to the group, so that an editor or planner can compile a final version of the presentation. All files are tagged with the author's name, and date-stamped. The software, authored by Kansas State University, meets best practices for collaborative learning environments[6]. These include:

- support for shared construction of knowledge objects
- tools for negotiation
- public and private feedback features
- division of tasks
- joint online commentary

Faculty easily monitored group progress, and could intervene if no progress was observed in a group.

Observations

Faculty objectives	*Observation materials/events*
Control, demonstration, and awareness of knowledge gained	Written summaries, Power Point slide show and its oral presentation, evaluation forms post-presentation
Information literacy	Student records of search path, strategy, Pre-writing worksheet (Appendix B).
Negotiation, consensus building	Message board, email, video-taped face-to-face meeting, faculty observation

Evidence of competent file management and information sharing (or lack thereof) was obvious in the team presentation, where effective groups demonstrated a level of "control and awareness of their own learning". Typically, a group would describe what they learned about a routine aspect of their program through the inquiry process. (For example, the role of chromatography in grading fuel quality, for aviation maintenance students).

We found that the concept of distributed cognition provides a convenient way to describe the relationships among files, emails, face-to-face interactions, PowerPoint graphics, sequential, archived PowerPoint versions, the final oral presentation, and learning. Information literacy and the use of virtual original documents with student-written summaries provided important language and tool resources for distributed cognition, making available to all team members the potential for demonstration and awareness of learning.

Viewed in video tape and real-time face-to-face meeting interactions, students were challenged to make meaningful contributions of information, manage the information, cooperate with team members, and complete the assigned task. If one member of the team failed to contribute, the team goals were attainable. However, if an entire team failed to contribute to the team's knowledge overall, the results (oral presentation of the

Power Point) demonstrated the team's less effective displays of learning and synthesis of ideas.

Students retrieved quality information, which contributed to the collective knowledge gained. For example, they cited reliable chemistry resources rather than information returned by Google more appropriate for middle school chromatography experiments. Summaries written by technical writing students saved team members time (not everyone read each original article), thereby contributing to the expanding knowledge of the team. At the beginning of the assignment, neither chemistry students nor technical writers knew what chromatography was.

In many respects, virtual teaming contributed to distributed cognition, because files uploaded to the group could be accessed by individuals at their convenience any time. Individuals could also contribute files at any time and notify group members by email with one click that new information was available. (faculty did not utilize simultaneous chat features for this assignment). The communication demands of distributed cognition, where team members share a goal to solve a problem, contribute information, and share tools, were met competently.

Although technical writing students did not learn chemistry (and at times struggled with the terms such as spectrometry) they did learn about the application of chromatography to their field, and they served as document designers, writers, and leaders. All students learned to search effectively for information in science databases, and to glean relevant information to the purpose at hand. The often-documented tendency for students to short-cut the information search process was circumvented by teacher expectation for strong documentation, and teacher oversight of the group files. After a review of the materials leading to the culminating presentations, faculty agree that we observed these hallmarks of learning:

- control, demonstration and awareness of knowledge gained,
- contribution, synthesis and explanation of research or related ideas,
- negotiation and consensus building.

Finally, an unanticipated outcome of the linked-course group assignment was our observation of various forms of leadership that emerged throughout the team projects, usually over two course meetings. Although we have not investigated this aspect of the assignment, we found that leadership was fluid within groups. It was usually functional, meaning individuals served as leaders when situations arose, and the contribution was appropriate. Another form of leadership was participatory, meaning leadership decisions were shared among group members. In addition, leadership was contributed by females in the group in proportion to their representation; we observed no bias toward male leadership even though we are a predominantly male college.

Conclusion

The linked assignment was valuable to faculty because their collaborative initiative led to refinements of learning objectives and the pedagogical activities to achieve them (See Appendix B). Beneficial learning was observed while important objectives were attained

in student communication of learning, information literacy, science literacy and teamwork skills. Ancillary objectives such as computer literacy and leadership were also informally observed.

Student benefits have been documented by chemistry faculty over the course of several years; these include an increase in student awareness of the meaning of information literacy from 2004 to 2007 as shown in a faculty-administered survey. Dimensions of library instruction, computer literacy, critical thinking, communication, ethics, and lifelong learning were also surveyed, with all areas showing strong gains in student awareness. In addition, students' self-statements of time spent performing secondary research during the chromatography assignment has increased on average from 2.9 hours in 2004 to 8.7 hours in 2006. Faculty observe that over time, the quantity and quality of cited references has improved as well as the quality of the search process and path.

Cross-curricular endeavors such as these amplify teaching effectiveness and strengthen collegial communication. The collaborators learn from each other's reflections to make the assignment meaningful for themselves and their students.

Appendix A: Keying Faculty/Librarian objectives to university learning outcomes
Chemistry assignment: Chromatography

English Faculty Objectives and student activities	Chemistry faculty objectives and student activities	K-State University student learning outcomes supported	TAC of ABET criterion 2	Association of College and Research libraries standards and outcomes for higher education
(b) Contribute relevant, high-quality researched information to virtual teams; **(c)** plan, meet, communicate, design and **(a)** deliver team presentations using effective technical communication techniques	Integrate discipline specific pre-lab with science literacy, information literacy, and communication skills, to foster life-long learning.	*Knowledge (in this assignment, of content area chromatography*) Critical Thinking (relates to information retrieval synthesis, summary, writing, planning) Communication (during small group meetings, written summaries, group oral presentation).	*a. mastery of knowledge, techniques, skills, modern tools* g. effective communication	*2.2 d* *Construct a search strategy using appropriate commands* 3.1 a-c Read text, restate concepts in own words, quote appropriately
Students meet face-to-face and virtually with chemistry students. Integrate Information literacy and graphic skills; function as effective team members, perform presentation.	Students search for information about how a particular technique/tool is used in their major fields. Write a report on their learning process reflecting the subject (chromatography), the discipline (chemistry), information management, time management, and connection of what was learned with an application in their everyday life	Diversity (working effectively in teams) Academic and professional integrity (Using high-quality, professional-standard information without plagiarism)		

(a) = control, demonstration, awareness of learning
(b) = Information literacy: effective contribution of high-quality, relevant information
(c) = Negotiation and consensus building
italics = knowledge-related objective or learning outcome
underline = communication-related objective or learning outcome

Appendix B: Prewriting/Invention Worksheet

Plan: (before starting a search)

My field of study/major is:
Keywords to consider using are:
Search engines or databases that I usually use are: because:
I plan to use this database first, because:

Action/Process to find and evaluate information. (While performing a search)

First set of search tools used:
First set of keywords used:
Initial search outcomes are or not matching my expectation because:
I need to narrow or expand my search option, areas, etc. because:
Changes that I am making (keywords or databases):
I need to work more on: because:
Initial evaluation search sources and outcomes are reasonable because:

Additional Notes:

questions and ideas
lessons learned
suggestions to myself, peers, teacher and librarians

Summary:

Source
Talks about:
Follow-up additional work after reading this article
Initial session ending time with faculty/writing staff signature
Follow-up session starting date/time and ending time with faculty/writing staff signature
Work done at home: make note of staring and end time
Appointment with librarian: (date, time)
Appointment with Writing Center (date, time)

Appendix C: Group/Self Evaluation Form

Use this form to rate the following items according to how you feel about the group or its members: 1 (strongly disagree) to 5 (strongly agree). (L.A. Samovar and S.W. King, Communication and Discussion in Small Groups).

Group Name _____
Your Name _____

1. _____ The group is an effective problem-solving team.
2. _____ The goals of the group are clear-cut.
3. _____ The group should be achieving more than it is.
4. _____ Group online communication is effective.
5. _____ Communication was a priority for all group members, to keep all participants informed of group decisions.
6. _____ The group developed a way to make fair decisions.
7. _____ The work load for meeting, communicating, uploading material, and preparing the presentation was evenly distributed.
8. _____ We delegated work within the group based on _____
9. _____ Leadership emerged when needed.

Comments:

Self-evaluation continued:

Log individual activities, time spent
Log activities with group, time spent (if you met face-to-face)
The process of working online in a team made me aware of knowledge I did not have prior to this experience. That knowledge was (briefly explain):
I demonstrated (shared) my knowledge in the following ways:
(check any that apply)

	summary writing posted to group files		Message board
	notes posted to group files		Oral presentation
	Power Point slides posted to group files		

Other comments:

I used these skills to retrieve reliable information

	K-State databases:		Message board
	notes posted to group files		Oral presentation
	Power Point slides posted to group files		

Team skills

I observed interaction and/or negotiation during the planning and Power Point process in these examples:
Aspects of my participation that were successful
Aspects of my participation I would improve in the future

[1] Information Literacy competency standards for higher education. (2000). The Association of College and Research Libraries. Retrieved November 29, 2006 from http://www.ala.org/acrl/comstan.html.

[2] Lave, J. and Wenger, E. (1991). Situated Learning: Legitimate Peripheral Participation. Cambridge University Press.

[3] Donath, L, Spray, R.T., Alford, N., Elisabeth ,M. et. al. (2005). Characterizing discourse among undergraduate researchers in an inquiry-based community of practice. Journal of Engineering Education, 94 (4), 403-17.

[4] Imel. S. (2000). Contextual learning in adult education. Practice Application Brief N. 12. ERIC Clearinghouse on Adult, Career, and Vocational Education. Office of Educational Research and Improvement, Washington, D.C. Retrieved from http://www.ericacve.org/fulltext.asp

[5] Cronin, B. (2003). Bowling alone together: academic writing as distributed cognition. Journal of the American Society for Information Science and Technology, 55 (6), 557-560.

[6] Spector, J.M. (1999). Teachers as designers of collaborative distance learning. Society for Information Technology and Teacher Education International Conference, San Antonio Texas. ED 432 259.