Yore, L.D. (2001). Heightening reflection through dialogue: A case for electronic journaling and electronic concept mapping in science classes: A commentary on Germann, Young-soo, & Patton. *Contemporary Issues in Technology and Teacher Education* [Online serial], *1*(3) 337-345

Heightening Reflection through Dialogue: A Commentary on Germann, Young-soo, & Patton

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The following commentary is not meant to be judgmental. Rather, this commentary attempts to encourage, to be provocative, to supplement, and complement the article's contextual framework, and to promote the interactive potential of this new electronic journal by soliciting additional reactions and rebuttals. A somewhat different contextual framework is provided to allow alternative views and interpretations of the procedures, processes, and results.

Background

Germann, Young-soo, and Patton explored the use of electronic media and discourse in a secondary science methods class regarding the degree of personal reflections made and understandings constructed by the students. They established a rich, interactive, writing-intensive discourse community among preservice teachers and teacher educators that utilized oral discussions, electronic journaling, electronic concept mapping, and essay writing in an attempt to promote the construction of understanding and reflective conversations. The authors indirectly addressed two critical issues in science education reform: implementation of instructional innovations and the language dimension of science literacy.

Clearly, promoting instructional innovation is one of the teacher educator's most difficult tasks: convincing preservice teachers to teach using strategies and approaches they have not used as learners or that have not been authorized by the scientists who taught their science content courses nor by the cooperating teachers who demonstrate accepted professional practice in their clinical experiences. Innovations promoted by teacher educators must be infused into the preservice teachers' experiences and allowed to build support over multiple exposures. These experiences must provide substantive justification for the innovations, compelling evidence about the innovations' effectiveness, and familiarity with the innovations' procedures to encourage the preservice teachers to add the innovations to their instructional repertoire. This commentary tried to establish warrants in terms of the constructivist teaching approaches, nature of science, and writing to learn which to interpret their findings on and to justify the implementation of traditional and electronic writing tasks.

Constructivist Teaching

The current reforms in science education promote the use of constructivist teaching approaches rather than the traditional lecture-laboratory and teacher-centered approaches (American Association for the Advancement of Science, 1990, 1993; National Resource Council, 1996). The authors justly connected constructivist teaching with the work of Vygotsky and Wertsch, but several faces of constructivism have been described in the science education literature. Collectively, these faces have some common features (prior knowledge, individual construction of knowledge, integration of new ideas into established knowledge networks, assimilation, accommodation, etc.), while each face involves different assumptions about science, learning, teaching, and classroom dynamics.

The interactive-constructivist science teaching promoted in this commentary is a middle-of-the-road interpretation of constructivism. Interactive-constructivist teaching recognizes a specific worldview of thinking, the epistemological and ontological nature of science, the locus of mental activity in the learner, the sociocultural aspects of the classroom, the multiple purposes of language, and the realities of public education and schools. Interactive-constructivist science teaching assumes that contemporary science is based on a hybrid view of thinking that stresses the importance of interactions with the physical world and the sociocultural context in which interpretations of these experiences will reflect the lived experience and cultural beliefs of the knowers (Prawat & Floden, 1994).

The interactive-constructivist approach also assumes an ontological and epistemological view of science that stresses a naive realist, evaluativist position in which multiple interpretations are judged against the available data and canonical theories, unlike the postmodern, relativist position in which all claims are equally valid. The structure of knowledge clearly illustrates the evidence from nature and scientific warrants used to justify the coherent, but tentative, claims about reality within the limitation of knowing (Hofer & Pintrich, 1997). The locus of mental activity and construction of understanding involves both a private and public component, unlike social constructivism which maintains that understanding is made at the group level. The interactive-constructivist approach assumes that discourse reveals the variety of alternative interpretations, and the negotiations need not reach consensus. Evidence from nature supports or rejects the interpretations not consensus. The learners and the teacher share the locus of control for the learning agenda. This does not mean that the basic constructivist assumptions about prior knowledge, learner-set goals, and scaffolding are not important, but that professional wisdom, the accountability of public education, and the priorities of schools must mediate decisions about what to learn in science.

Nature of Science

Germann, Young-soo, and Patton wisely used the nature of science as the conceptual focus for their study, which provided a rich, controversial arena for interactions and argumentation. Science uses unique patterns of argumentation that attempt to establish clear connections among claims, warrants, and evidence (Holland, Holyoak, Nisbett & Thagard, 1986; Kuhn, 1993). The specific nature of science from a philosophical perspective has been contested in recent years, with cultural relativists refusing to accept science's traditional claims to durable standards of truth, objectivity, and reputable method. However, Lederman (2001) cautioned that some people misrepresent the magnitude and focus of the disagreement about the nature of science to be much greater than it actually is and that there is reasonable agreement about the general tentative, procedural, and declarative aspects of science.

Science literacy promoted in the current science education reforms involves the abilities and habits of mind to construct science understandings, the big ideas of science, and the communications to inform and persuade others about these big ideas. One of the crucial big ideas is an understanding of the evaluativist view of science that recognizes that multiple interpretations of an experience or data set are likely, but these interpretations must be submitted to public judgment using the available evidence extracted from nature and the canonical knowledge claims accepted by the scientific community. The nature of science is viewed as inquiry and as a speculative, temporary, and rational body of knowledge. A scientifically literate person is one who (Hurd, 1998):

1. Distinguishes experts from the uninformed, theory from dogma, data from myth and folklore, science from pseudo-science, evidence from propaganda, facts from fiction, sense from nonsense, and knowledge from opinion;
2. Recognizes the cumulative, tentative, and skeptical nature of science, the limitations of scientific inquiry and causal explanations, the need for sufficient evidence and established knowledge to support or reject claims, and the relationships among science, technology, society, and environment; and
3. Knows how to analyze and process data, that some science-related problems in a social and personal context have more than one accepted answer, and that social and personal problems are multidisciplinary.

Science distinguishes itself from other ways of knowing and from other bodies of knowledge through the use of empirical standards, logical arguments, plausible reasoning, and skepticism to generate the best temporal explanations possible about the natural world. Explanations about the natural world based on myths, personal beliefs, religious values, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but they are not science (NRC, 1996).

Writing to Learn

Bereiter and Scardamalia (1987) provided a model of writing that defined writing as an act of communication and knowledge building rather than just knowledge telling. There are three processes that writers' use: intentional cognition, managing the process, and the social nature of writing (Galbraith & Rijlaarsdam, 1999). Intentional cognition refers to the communicative goal of the writer. A novice writer's goal is knowledge telling, whereas an expert's goal is knowledge building. Knowledge telling involves representing recollections from long-term memory in printed symbols essentially unaltered, while knowledge building involves an act of learning where there is a dynamic between the content being addressed and the rhetorical requirements of the writing task. This dynamic leads to a constant evaluation and transformation of an individual's knowledge. Keys (1999), stated "The output from each space serves as input for the other, so that questions concerning language and syntax choice reshape the meaning of the content, while efforts to express the content direct the ongoing composition" (p. 120). This recursive attention on matching the content to the rhetorical goals of writing and written discourse to the requirements of good science helps develop an understanding. Clearly, the writer's goal, the writing task, the genre, and the external (scaffolding) and internal structure (metacognition) influence the effects of the writing on understanding (Yore, 2000).

Managing the writing process involves three metacognitive actions: planning, translating, and revising. Zimmerman and Risemberg (1997, p. 74) stated,

> Planning involves three cognitive subcomponents: generating information that might be included in the composition, setting goals for the composition, and organizing the information that is retrieved from memory. Translating is the process of converting ideas into textual output, and reviewing involves two subcomponents: evaluating and revising text as it is translated.

Novice writers tend to try and deal with planning, translating, and revising all at once; whereas experts tend to focus on each function separately.

The social nature of writing moves beyond the writer to focus on the interactions of writer and reader, which is an extension of the speaker-listener relationship in oral discussions, and involves the greater uncertainties and limitations of the unseen audience. Crossing between different communities requires the author to be aware of the needs of the audiences and the discourse conventions and traditions of the communities and to match the goals of the writing to these features. Feedback from the target audience in terms of editorial comments and suggestions, alternative interpretations, and additional considerations contribute to the authors' understanding and clarity. This feedback provides structure and supportive scaffolding on which to rethink ideas and to develop revisions. It is this extensive grappling with the demands of an authentic communication problem that allows the writer to master the good science writing and conventions and expectations of the science community.

Inquiry and written language are essential parts of science. It is unlikely that contemporary science would have developed as it has in a strictly oral culture or discourse community. The attention to detail and the connectedness of claims, evidence, and warrants required by science are nearly impossible in oral discourse. Chaopricha (1997) stated, "Any claim to the priority of discovery requires suitable, trustworthy, and persuasive methods for communicating the work that constitutes the claim to priority. Verbal or informal communication is not sufficient. The production of a written scientific research paper is needed as a record in case of dispute" (p. 12).

The permanence of print symbols and the form-function (genre) relationships of scientific text promote reflections on and connections among ideas. The real-time and speed of oral conversation do not maximize the opportunities for reflection. The short wait-time between question and response in traditional classrooms and between two people speaking in a social constructivist classroom promotes impulsive not reflective conversations. The problem-solution, cause-effect, and explanation forms of scientific text (genre) require connected discourse in which two or more ideas are related to form propositions and knowledge claims. Scientists use established text in their written text (intertexuality) to justify their procedures and claims. Citation of well regarded scientists' work is the most common technique of scholarly bricklaying used to demonstrate how the current methods and knowledge claims connect to established research procedures and canonical knowledge (Chaopricha, 1997).

Comments

Writing-intensive courses and the related graduation requirements provide evidence that university policymakers believe too little attention is being paid to thinking on paper and to promoting private reflection. Germann, Young-soo, and Patton addressed this concern by infusing traditional essay writing, innovative electronic journaling, and concept mapping into their secondary science methods course. The University of Hawaii was one of the first post-secondary institutions to adopt writing-intensive course requirements for AA, BA, and BS degrees in 1987 (Chinn & Hilgers, 2000). All students must complete five writing-intensive courses in their major area. Writing-intensive courses require that

1. Writing be used to promote learning,
2. Student and professor interact during the writing process,
3. Writing plays a major role in course grades,
4. Students produce a minimum of 4,000 words or 16 pages of text, and
5. Class enrollment be limited to 20 students.

Chinn and Helgers found that professors primarily focused writing on demonstrating mastery of content knowledge and discourse practices of the scientific community, and success was greater and more widespread when the professor adopted a collaboration stance rather than an expert critic stance. Germann, Young-soo, and Patton demonstrated the potential of incorporating information technologies into the writing process and in so doing increased the explicit collaboration among students and faculty, facilitated the editing and revising processes, and introduced greater and quicker reader responses.

The audience feedback likely provided the scaffolding (structure) for the journal writing task that supported increased potential for understanding and reflections not found in all journaling studies, but commonly found in concept mapping studies. Germann, Young-soo, and Patton hypothesized,

> ...that the two learning tools, concept mapping and journaling (genre), tend to stimulate complementary but different kinds of thinking: journaling tends to stimulate more inquiry and discovery learning, while concept mapping tends to stimulate more clarification, justification, and reasoned thinking of "already-discovered" concepts (outcome). The electronic medium, by heightening the social interaction possible, tends to blur these distinctions. That is, by facilitating greater access to each other's writing, the electronic medium fosters greater dialogue, which in turn helps students to suspend premature closure and to re-think or re-explore certain concepts. This suggests that the medium ...is possibly as significant as the learning tool....The electronic medium may provide a space in which some members of the learning community can participate in activities slightly beyond their competence, something called the "zone of proximal development."

This is the central point made by the genrists in which they stressed the form-function-outcome relationship in writing to learn science (Yore, 2000). It is unlikely that journaling of the 'Dear Diary' or the 'free write' variety would promote the higher-level cognition and reflection desired, but might promote personal connections between the writer and the ideas.

Germann, Young-soo, and Patton later implied that there was a potential learner by learning tool interaction, that the methods course experience was an integrated experience involving activities, reading, writing, discussing in and out of class time, and that electronic journaling and electronic concept mapping did not produce noticeable or different amounts of reflective conversions. They stated,

> Other students simply resisted change and were made somewhat uncomfortable by the sustained uncertainty and flux that characterized the electronic journaling. These students, too, needed to be nudged into more reflective practices. Furthermore, students who preferred concept mapping tended to resist the *in*efficiency of the journaling and the relative efficiency of the concept mapping. These students need to realize that, while efficiency is to be valued, reductionism or simple-mindedness is not. Much critical thinking *is* inefficient. These students can benefit from being taught upfront that different conventions are valued in different modes of writing: the productive rambling valued in the electronic journaling will not be as highly valued as a tight, logical, cohesive presentation in the concept maps. The different modes of thinking and their accompanying forms of expression serve different purposes.

It was difficult to assess whether the length of the study in which students faced the dual struggle of learning the technology and using the technology to learn would produce the changes in the higher-level cognition and reflective conversations desired or whether the quantification techniques used were sensitive enough to detect such changes.

Based on the background on writing to learn provided in this commentary, it was assumed that the structural requirements of concept mapping would produce changes in conceptual understanding. Assimilation of new ideas (conceptual growth) manifests itself as additional propositions in the concept map without major structural changes. Accommodation of new ideas (concept change) manifests itself as structural reorganization, introduction of cross-links, and additional propositions in the concept map. Each of these revisions to an existing knowledge network represents reflections. It is unlikely that relying strictly on the traditional scoring procedures of counting propositions and levels of hierarchy on a single concept map for each student will capture the quantity and quality of the reflections occurring (Shymansky et al., 1997).

The authors justly questioned whether traditional paper and pen unstructured journal entries would promote the desired changes in understanding and reflection. Their electronic version of journaling converted the private free-write entries into a public discourse space in which audience feedback appears to have promoted rethinking, revision, and collaboration. The audience feedback provided the scaffolding for further inquiry and discovery by necessitating additional reading and oral discussions. The content and quality of the audience response appear to be the key to whether increased understanding and reflection occurred.

The authors attempted to count and categorize the reflective judgments (Appendix B), to code the level of authority and evidence (Appendix D), and to identify behaviors and questions conducive to reflection (Appendix F) in the journal entries; but it is unclear if the hierarchy established for reflective judgments, authority, and evidence were supported by the research literature (other than the Kitchener & King article) or if behaviors and questions established by grounded analysis of the students' comments were generalizeable.

Future studies require a more compelling framework that closely illustrates the nature of science needed for critical thinking and reflective judgments. It seems inconsistent that the levels of reflective judgment about science would be based on an absolutist view of knowledge. It difficult to justify the hyperfine differentiation among opinion, expertise, theoretical warrants and evidence, and hierarchy proposed by the authors, but it does have appeal in terms of promoting the nature of science and the evaluativist epistemology. The different intentions and questions outlined might produce different quantity and quality of reflection. Student comments about Web-based courses frequently refer to type of questions that instructors ask, when interacting in an electronic conference dictates the quality of learning that occurs. Students believe that the quality of questions is higher in face-to-face settings.

The authors do not make maximum use of the culminating essay as an information source in this preliminary study. An early study of elementary preservice teachers' essay writing using cooperative jigsaw groups illustrated that conceptual comments promoted greater thinking and changes in understanding than did editorial comments about style, grammar, spelling, and other language features (Yore, 1996). It is unclear whether the authors provided progressive feedback on essay outlines, drafts, and final editions. If they did, the level of feedback would likely approximate that of the electronic journals but at much greater investment of teacher labor. This introduces another dimension to this study and to the implementation of innovations, labor investment, and time efficiency. Electronic journaling shared the responsibility for providing feedback among all participates in the class, not just the professor as do traditional essays.

Concluding Remarks

Germann, Young-soo, and Patton illustrated the type of partnerships, collaborations, and consortia of expertise needed to reform science teacher education. The science education community has neglected the language dimension of science literacy and language as a learning tool for nearly 40 years. Naturalistic studies like this one will produce more acute research questions, insightful hypotheses, and verified data documentation procedures and will start to re-open these closed doors and capitalize on the massive amount of literacy research in other academic communities. These authors must be praised for understanding the limitations of their research design and ascribing the appropriate level of skepticism to their assertions and for being willing to share their preliminary results for public comment.

Feel free to send me your reactions and comments (lyore@uvic.ca) or discuss them with me at the next AETS or NARST meeting. Do not wait too long, for at my age I may not remember what I said.

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