Content Domain Expertise in the Learning Community

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Introduction

As knowledge-centered educational learning environments become increasingly popular among proponents of sustained educational inquiry and reform [Collins, Greeno, & Resnick, 1994; CTGV, 1992; Magnusson & Palincsar, 1995; Scardamalia & Bereiter, 1994; Schauble, Glaser, Duschl, Schulze, & John, 1995], issues of the existing content domain knowledge of the classroom teacher arise. What depth can the average teacher be expected to have in any one specific domain when their training has been specifically aimed at making the teacher a generalist in a number of academic areas? Recently, a McDonnell Foundation implementation project entitled *Schools For Thought* [Lamon, Secules, Petrosino, Hackett, Bransford, and Goldman; in press] has been developed which incorporates a number of content domain experts in the field of science, literature, and mathematics to actively participate as a resource for both classroom teachers and students as curriculum and classroom activities are developed and utilized. As this bridge is forged between experts in the field (content experts) and experts in the classroom (teachers), the "real world" is being brought into traditional educational settings with exciting results. This paper will focus on the roles that have evolved concerning content experts in classrooms dedicated to a "learning community" model either in person (assisting teachers at weekly meetings, helping with assessment, presenting "benchmark" lessons in class) or on-line electronically (corresponding with the classroom community via electronic mail or "seeding" questions on local area networks).

The Content Expert's Participation in the Learning Community

As the transition is made from the theoretical justifications for the development of a community of learners to the actualization of such a vision [Glaser, 1994], a number of issues arise concerning the role of members of the wider community, particulary that of outside experts. The conceptualization of a community of learners is predicated upon the underlying premise that learning occurs as people actively take part in shared endeavors with others [Brown, Collins, & Duguid; 1989]. This contrasts with the traditional models of learning in which learning either occurs through transmission of knowledge from experts (teachers, learned others) or acquired by novices through unguided activity [Rogoff, 1994]. The challenge for the content expert is in deciding in what manner they will choose to participate in this new community. Will they be an elaborate teacher's aid or the repository for knowledge? Will they become a confidant of the students or a potential tutor? This paper will report on a more complex picture of the content expert and the role(s) they will play as traditional classrooms evolve into technologically advanced learning environment. By articulating the various roles employed at our Nashville site, information may be provided which will be of potential benefit to others in their own professional practice as the experimental phase of the *Schools For Thought* model matures and the role of the content expert in the community of practice evolves accordingly [Figure 1].

Workshops

In our *Schools For Thought* implementation we have taken the role of educating the classroom teachers as a serious and necessary aspect for any chance of sustained reform to be realized. As part of our in service training, we have provided a number of workshops in St. Louis and in Nashville. In our experiences with the implementation of the *Adventures of Jasper Woodbury* series [CTGV, 1992], we have found that teacher education is extremely valuable and often underlooked when theoretical programs are implemented in the classrooms. The challenges facing the *Schools For Thought* teachers as they attempt to integrate current cognitive and educational psychology within their classrooms and into their own practice is obvious. Attempting to explain such pedagogical practices as "anchored instruction" [CTGV, 1992], "reciprocal teaching" [Palincsar & Brown, 1984], and Computer-Supported Intentional Learning Environment (CSILE) [Scardamalia & Bereiter, 1994) while distinguishing epistemological stances such as "constructivism" and "situated cognition" into a framework that is coherent and can assist the practitioners in their practice is certainly a challenge for everyone concerned.

As part of the workshops, the content expert worked with the teachers in the initial development of "hands-on" science projects, introduced the components of two units, and attempted to bridge the gap between research and practice. In addition, he presented possible ways that he may be utilized throughout the year by the teachers and essentially made individual "contracts" with each participating teacher. One teacher explained that they would need help with the physics but they "felt pretty confident in biology," another asked for a presence in the classroom while another wanted to explore what could be done via e-mail.

These workshops provided a common ground to meet in a relaxed setting during the summer preceding the implementation. In a very real sense, the seeds of the community were planted during these workshops. To be sure, the expert explained how he would "seed" the CSILE notes and allow the students thinking to become public. But the most important aspect established during these workshops was the development of trust between the expert and the classroom teacher.

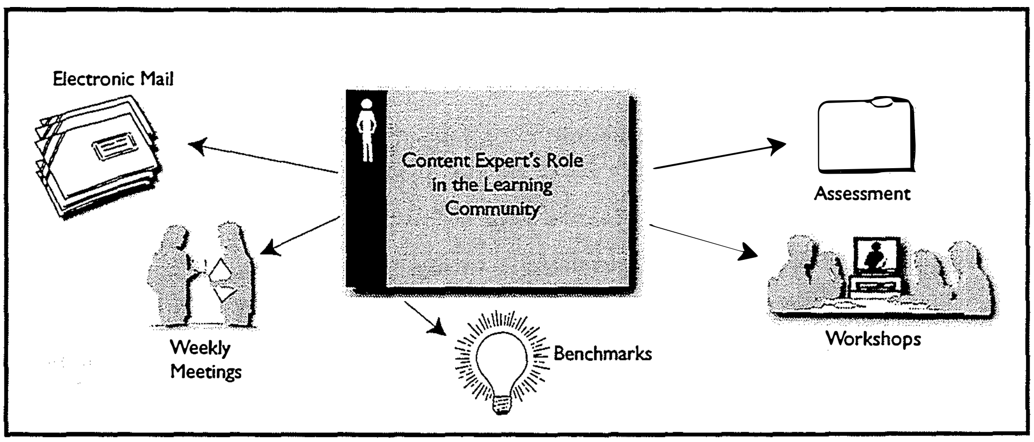


Figure 1: The Responsibilities of the Content Expert in the Learning Community

Weekly Meetings

Each team of teachers met at the Learning Technology Center on the campus of Vanderbilt University for a three hour period once a week. A regular component of these three hour meetings is a discussion with the content expert as to how each unit is progressing, discussions on what is working and not working in the classroom, as well as the need for possible benchmark lessons. With multiple sites come multiple needs and while each class undertakes the same project, each classroom obviously progresses at its own pace. A benchmark for "isolated environments" may arise in one class while another class may call for a benchmark in "inertia" or "the reasons for seasons on earth." This places considerable time constraints on the content expert but if each classroom is to become a legitimate learning community, the time expended is well worth the effort.

Assessment

Before each unit a diagnostic test is administered to each student in the classroom [Minstrell, 1989]. The purpose of this test is to inform the teachers of the qualitative understanding of their students and the possible misconceptions that may exist. This diagnostic is given at the beginning of each unit and attempts to identify some of the common preconceptions that children bring into the classroom from their everyday experiences. The results are then analyzed by the content expert and reported to the teachers at one of the weekly meetings. It is there where the content expert and the teachers discuss together the possible instructional interventions that may take advantage of the knowledge gained from these assessments.

For instance, it was found upon the pre diagnostic test that 91% (41 of 45 students) of the students felt that the space shuttle would be the ideal instrument to travel to Mars (in fact, the Space Shuttle does not have enough thrust to reach the speed needed to break away from Earth's gravitational pull), 53% (24 of 45 students) felt that gravity on earth was determined by the distance the earth is from the sun (acceleration due to gravity is determined by the mass of the planet and the distance the object is from the center of that planet) and only 7% (3 of 45 students) of the students felt that gravity helped muscles stay healthy (a serious health issue that the students would become aware of as they learned how muscles worked). These initial findings helped us to better understand some of the preconceptions that students were bringing into the class. As the Mission to Mars unit got underway, initial benchmark lessons where already being planned by the teachers to address the preconceptions brought to light by the content expert's diagnostic test. The teachers began to see the value in pre-assessing the children and the utility that such an approach can have in providing meaningful instruction to the class. By year's end, the content expert was working with the teachers at constructing their own tests for future units.

Benchmarks

Rather than discuss the nature of benchmark lessons [see Minstrell, 1989; Brown & Campione, 1994; Lamon et. al., in press], for the purposes of this paper, I will attempt to show how a benchmark was conceived and eventually implemented.

As spring arrived, the students became quite interested in the causal mechanisms that warranted the designation of the "first day of spring." The students wanted to know how can we know the exact time of day of spring's arrival. In addition and perhaps more importantly, the groups began to debate whether the planet Mars had seasons. This was clearly a wonderful time for a benchmark lesson since it was obvious that the class as a whole had reached an impasse in terms of an adequate explanation for the seasons on Earth. In fairness to the students, the full scientific explanation for the change in seasons is a concept that many adults have great difficulty in explaining as well.

For this unit it was decided to first "seed" the CSILE database with a general question that would stimulate conversation and allow the students to articulate their initial conceptions of the causal mechanisms involved with the seasonal variations on Earth (see figure 2.0). It was further planned that after the seeding took place, a Benchmark would be presented and then followed by a "revision" cycle on CSILE in which the children would attempt to modify their original explanations. After the revision, a second Benchmark would be presented using manipulative to visually show the 1) seasonal variation of the amount of sunlight, 2) the angle of light rays emanating from the sun hitting a given part of the globe and 3) the tilt of the Earth on its axis. A final activity was the creation of a transfer task which would make use of the students developing sense of analogical reasoning. Since the Earth and Mars share practically the same axis tilt from its perpendicular plane (23.45 and 25.17 respectively) the reasons for seasonal fluctuations for the two planets are quite analogous. Given the simple directions on CSILE to "hypothesize if and why there are seasons on Mars" the students were given the simple fact that the angle of tilt from perpendicular on Mars is @25 degrees. Students then completed the transfer task and data was analyzed for inclusion in a future study on the use of analogy in science teaching.

Reasons for the Seasons

P: In North America, it is warm during the summer months and cool during the winter monts. Why is this? What is your theory?

1 MT: The earth has a tilted axis. When it turns around the sun, the sun warms the area of the earth more that is tilted towards it because it shines almost at a straght angle on it and the is summer. And when the earth goes around the sun its tilt changes and the seasons change. When the northern hemisphere has summer the southern has winter. (iF)

2 MT: My theory is that Earth was just ment to change wheather temperatures. I don't think their is a right answer to that. (EB)

3 MT: My theory is when the Earth rotates it changes temperatures on each side therefore it changes seasons.

4 MT: My theory is that the world rotates around the sun different in the months. Like the Earth rotatoes closer to the in those months. (MD)

5 MT: I'm not totally sure of why this happens, but the Earth takes one year to rotate around the sun. During the summer months when it is warmer, the Earth is closer to the sun than it is during the winter months when it is cooler. (AF)

6 MT: I think that the weather changes because the Earth is further away from the Sun than usual. (SB)

30 MT: I don't know why but my guess is when it rotates it gets closer to the sun and the seasons change (SJ)

31 MT: I think that it is warm in the summar because the suns rays hit the earth more directly during those months. In the winter the earth is at a point on its axis where it is farther away from the sun then in the summar. The changing of the weather is an extrodenary thing. (KH)

32 MT: I think it is hot in the summer because the sun comes closer to the sun., and the rays hits the earth and the it just gets hot. Its cold in the winter because we are not close to the sunor we have the moister from places that had bad weather. (ES)

33 MT: The reason why is when the sun shines toward the Northern Hemisphere they have sunshine which is the summer season while the Southern Hemisphere has winter, but when the Earth's axis tilts and turns to the Southern Hemisphere the sun shines toward the Southern Hemsphere and it will have summer seasons and the Northern Hemisphere will have winter. That is why the seasons change. (LW)

34 MT: I think that the reason why is because, the earth is tilted so when North America hits a certain spot it changes seasons. (TF)

CSILE is a wonderful way to find out the preconceptions students have about many types of scientific phenomena. In addition, with new graphic capabilities, **CSILE** allows the students to show their mental representations of complex systems, scale, or naturally-occuring events (such as seasons). We will give a very short overview of how the *Reasons for Seasons* unit progressed using **CSILE**.

First, a "seed question" is posed to the students. In this example, the question was *"In North America, it is warm during the summer months and cool during the winter months. Why is this? What is your theory?"* Please note that the format used in the example roughly resembles what the computer screen would look like as the exchange of ideas takes place.

Figure 2: CSILE Posts from Season's Benchmark

Electronic Mail

One of the initial visins of the use of content area experts in the *Schools For Thought* model was to be utilized as essentially "virtual" or on-line experts. Students would send experts e-mail messages and the next day (or even sooner) answers would be waiting as the student logged into their computers [Figure 2]. Such a vision is not far from realized in our model. Students have access to the Internet, have been able to FTP sites from around the globe and have been brought to the Learning Technology Center by the content area expert to down load JPEG and GIFF pictures of the planet Mars along with accessing SpaceLink (an online service provided by NASA). All this makes for a very exciting use of the available technology at our Nashville site.

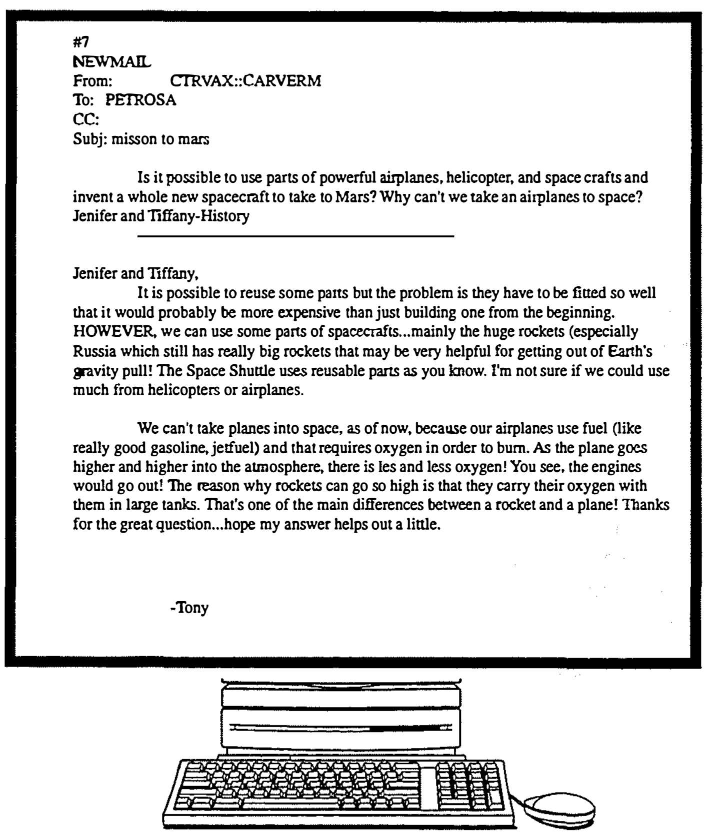
But in answering students questions over e-mail [Figure 3] some very interesting issues arise. How directive should the answers be to questions that students pose. After a couple of messages from the students, I quickly found myself switching roles from that of "expert" to that of "tutor." It would have been very easy to send the students immediate answers to their relatively easy questions. But if that was the only purpose of being available electronically, it seemed like a limited use of a great resource. In the same sense, the students needed to know that I was available and would not always be answering their questions with more questions. In other words, it was becoming clear that there were motivational and affective dimensions to my e-mail responses as well as instructional and cognitive dimensions. In their detailed account of expert human tutoring, Lepper, Woolverton, Mumme and Gurtner [1993] explain:

> In both general interviews about their philosophies of tutoring and in specific commentaries regarding their own actions in actual tutoring sessions, our best tutors appear to devote at least as much time and attention to issues of motivation and affect as they do to issues of information and cognition. (p.77).

Certainly if we desire the role of the content expert to assist in the development of the community's progress from domain to disciplinary understanding, the nature of the correspondences via e-mail is an area where particular attention should be paid since in all probability, it will be the easiest and most cost effective way of allowing content expertise into the *Schools For Thought* classrooms.

Conclusion

As was stated previously, the process of creating a true research community is a very difficult task. It has necessitated teachers rethinking their roles and students being placed in exciting yet untraditional settings. What is needed in the daily implementation of such a reform movement is the vision of progress of the community from that of domain knowledge to that of disciplinary knowledge. To such end, the role of the content expert will become more pivotal as sites move away from university involvement and become more dependent of the affordances of each local and global community.



In this response, we wanted to encourage the "reusable" aspects of the students' question. Certainly, reusability has been used with success on the Space Shuttle. The key aspect to this question, however, was the more complex idea of using airplanes in space. Having the students understand the necessity of the rocket needing to carry its own oxygen, as opposed to the plane using oxygen which is available in the atmosphere, was a key point that needed to be brought to the students' attention, especially as they began preparation for their Rocket Benchmark. For things to burn, they need oxygen. Since there is a decreasing amount of oxygen in the upper atmosphere, jet planes can only obtain certain altitudes. The use of wings by the Shuttle is a confusing sight for the students. The wings serve no purpose while in orbit. It is only upon re-entry when the Shuttle enters the atmosphere and becomes essentially a glider that the wings serve their entended purpose.

Figure 3: Content Expert as Virtual Resourse via Electronic Mail

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