CHAPTER 5: COOPERATIVE LEARNING: A BASIC INSTRUCTIONAL METHODOLOGY FOR GLOBAL SCIENCE LITERACY

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1. INTRODUCTION

The development and implementation of GSL curricula in countries around the world could potentially have a positive impact on citizens' worldviews and understanding of other cultures. Citizens exposed to such curricula should be able to engage more effectively in a world approaching globalization through politics and commerce. Importantly for the desired outcomes of GSL, those who have internalized the curricula should see Earth's environment as one without borders. They should see the need for working together for the common goal of a sustaining and sustainable environment.

One of the most important issues in world affairs is how to establish cooperation in an atmosphere in which competition has been the norm for centuries. When the world was not competing for land area with which to expand its empires, it was competing for the wealth of the lands. When individuals were deprived of competition, as in communist regimes, the quality of their performance was prone to decline, for the measure of excellence ceased to be based on comparative quality. As advertisers compete for buyers, and as organizations compete for members, there are expressions of one entity's benefits compared to the other. When many are competing, there must be "play-offs" to see who is ultimately the best.

Education has unfortunately been no different. Science educators, politicians, the mass media and parents around the world have taken great interest in the tests comparing students' science and mathematics achievement in different countries. No matter that the educational systems in those countries are very diverse, and individual goals may be culture-bound; higher scores are interpreted by most as signaling "better" science. Should we compete for science literacy, or cooperate to achieve it?

In classrooms, we have competed against an arbitrary scale determined by a person assumed to know "the answers" to questions. If all students excelled, the questions must not have been difficult enough. A teacher who assigns a large number of high grades is assumed not to be teaching on a high enough level. Low grades are a sign of rigorous instruction, through which the ignorant are raised (not quite) to the level of their master. All are provided with the information; those who can remember it for the examination are the winners. Thus, one student is at the head of the class, because s/he competes best. How, then, is a student to be taught the value of cooperative learning, when the measures of excellence are the traditional competitive ones?

2. VALUES OF GROUP LEARNING/COLLABORATION FOR LEARNING SCIENCE

Imagine how different the world would be if people were taught from the first days of life that the sharing they do on the playground would also serve them well in creating a peaceful world and an educational system fostering human development in its most positive patterns! In the essay, "All I really need to know, I learned in Kindergarten" (Fulghum, 1993), we are reminded of the importance of dealing with others in a simple, forthright manner, and of the benefits that come from this behavior. Some of Fulghum's bits of wisdom with application to world cooperation are: Share everything. Play fair. Don't hit people. Clean up your own mess. Say you're sorry when you hurt somebody. My personal favorite is "When you go out into the world, watch out for traffic, hold hands, and stick together." If we work together and use our collective wisdom, we can survive potentially harmful situations.

We can also apply some of these maxims to the learning of science. We can't all know it all, so why not share information, build each other's competencies, and grow together? If we trust each other to do our best and share our talents, we not only gain allies instead of enemies; we also build up a collective body of knowledge and experience larger than our own. We have a bigger bag of tricks when it comes to figuring out the answers to complex questions, and we have a nurturing environment that will not let us quit when there is a chance for success.

In environmental education, the emphasis is usually not on competition but on accomplishment through cooperation and collective action. We teach about the Earth as a system, with interacting components that are always affecting each other (Fortner, 1991). We cannot study individual disciplines without seeing how they are connected to other disciplines. Since 1988, the Earth Systems Education program at The Ohio State University and in many other areas has been developing curriculum materials and cooperative instructional methods for the multi-disciplinary sciences of global change and other environmental issues (Fortner, 1996). The combination of curriculum development and teacher education provides schools with high profile examples of the ways humans have affected the Earth system and how they must cooperate to restore and maintain a sustainable environment for the future.

Thus, it is natural that Global Science Literacy relies on cooperative learning as a prominent feature of instruction. Slavin (1983) defined cooperative learning as referring to "instructional methods in which students of all performance levels work together in small groups toward a group goal. The essential feature of cooperative learning is that the success of one student helps other students to be successful." While the concept of cooperation in teams is not new, research is building to justify its use in instruction through cognitive and social gains, and the methodology of cooperation is consistent with goals of science in society.

In a special issue of Theory Into Practice (TIP), the College of Education at The Ohio State University has focused on "Building Community Through Cooperative Learning," and that is exactly why global science literacy depends on the collaborative process. In the issue, the co-directors of the Cooperative Learning
Center at the University of Minnesota, David W. Johnson and Roger T. Johnson (1999), discuss what is and what is not cooperative learning:

*Cooperation* is working together to accomplish shared goals and *cooperative learning* is the instructional use of small groups so that students work together to maximize their own and each other's learning. Within cooperative learning groups, students are given two responsibilities: To learn the assigned material and make sure that all other members of their group do likewise.

Assessment of student outcomes from such lessons takes into account their non-competitive nature. Thus, individual achievement is measured by portfolios, concept maps, and other alternatives to testing, and group achievement is observable as a communicated product that synthesizes the group's activities, research, or thinking about a topic. Research in many situations has shown that cooperative learning usually produces similar or greater gains in knowledge in comparison to traditional methods (e.g., Allen and VanSickle, 1984; Humphreys et al., 1982; Okebukola, 1985; Slavin and Karweit, 1985). It is important to note that social gains are included in the assessment of cooperative learning outcomes in most of the recent research (e.g. Slavin and Fashola, 1998; Stevens and Slavin, 1995). It is those aspects that are most exciting to those who look toward schools as providing teachable moments for more than just college entrance examinations.

3. TYPES OF COOPERATIVE LEARNING

Not all groups assembled in a classroom are cooperative. As Johnson and Johnson (1999) describe: There are *pseudo learning groups* in which students assigned to a group have no interest in or incentive for learning together, and believe they will still be ranked as highest to lowest. As a result of grouping the sum is less than the potential of the individual members; group activity hinders the learning process. *Traditional classroom learning groups* accept that they must work together, but group growth is not an internal goal. Some students let others do most of the work, and the workers are frustrated and feel exploited. In such cases the conscientious students would be better achievers if they worked alone, and some students do not work at all yet get marks for completion.

In a true cooperative learning group,

students work together to accomplish shared goals. Students seek outcomes that are beneficial to all. Students discuss material with each other, help one another understand it, and encourage each other to work hard. The result is that the group is more than a sum of its parts, and all students perform higher academically than if they worked alone” (Johnson and Johnson, 1999).

Three general types of true cooperative learning have been described by Johnson, Johnson and Holubek (1998):

- Formal (for teaching specific content);
- Informal (to insure active cognitive processing of information during a lecture or demonstration; and
- Cooperative base groups (to provide long-term support and assistance for academic progress).
Cooperative learning strategies place the responsibility for learning more squarely on the shoulders of students than do the lecture-discussion strategies that dominate college classrooms. This does not imply that the responsibility of the instructional leader is diminished. On the contrary, the design of cooperative learning experiences is more difficult than lecture preparation, as it requires a high degree of advance organization, anticipation of student response, and concurrent development of meaningful applications of the subject matter, for use in assessment.

Cooperative learning has been used in many settings for many different purposes. While the beginnings of cooperative learning probably extend back to the division of labor among pre-hominids, more recent applications in education often cite the work of Johnson and Johnson (1975/1994) for the basis of the ideas. There are many strategies for implementation of cooperative groups, and the books by Johnson and Johnson detail the components and strengths of those. Our experiences in Earth systems education have tested various cooperative learning methods and settings. The form of cooperative learning I use most often is the "jigsaw" (Johnson and Johnson, 1975/1994). This has worked well in our teacher education programs (e.g. Mayer, Fortner and Hoyt, 1995), where teachers have a stake in learning about and using the technique. Briefly, the class is divided into groups of six students or fewer, based on some characteristic that gives them something in common as a basis for discussion. These are the Base Groups. To reinforce their common characteristics, they select a group name. This identity will shape their activities within the jigsaw, as they will be encouraged to apply new learning in the context of their Base Group's needs.

The new learning comes with the activities of Expert Groups. Members of the Base Groups, after preliminary discussions that establish a common background, are divided into working teams that include one or two members of each Base Group. This new group becomes an Expert Group on one component of the subject matter. Activities of Expert Groups are structured by the teacher to assure that certain objectives are met and each group member contributes to the learning experience. Upon completion of those activities, the Experts reassemble into their original Base groups to teach their peers what they have learned. Each student's responsibility to both groups is clear, a combination of learning and peer teaching for a common specified goal.

Base Groups include students with common characteristic as a basis for applying information (major, career goal, etc).

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Expert Groups contain at least one member of each Base Group.

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Experts return to Base Groups to share information for common needs.
Figure 1. Organization of students in a jigsaw cooperative learning experience.
Each number represents one student in a class of 36

4. EXAMPLES OF GROUP PROCESS WITH EFFECTIVE RESULTS

In the work of Earth Systems Education, we have used cooperative learning in a number of ways. Described here are examples of how jigsaw techniques have been used at three levels of learning to help develop global science literacy.

4.1. Undergraduates learning about their professional literature

While undergraduate students are learning the basics of their sciences and how those information components are combined into lessons, I have them examine the literature of the field with their own professional needs in mind (Fortner, 1999). The genres of science literature are many, but as college students, I invite their attention to the primary science reporting, secondary features based on those writings, television treatment of science, and popular writings for practitioners (educators, in this case). The jigsaw process is most effective for such an activity. The purposes of this group process are several:

- Expanding the amount of science materials to be introduced in a short time.
- Providing people with perspectives similar to their own (rather than from the instructor’s viewpoint).
- Introducing new professionals to literature they may want to have in their own professional libraries.

The procedure followed is summarized below. This information has been previously reported in the Journal of College Science Teaching (Fortner, 1999) and contains Johnson and Johnson’s (1999) structural steps for formal cooperative learning: Pre-instructional decisions, Explanation; Monitoring; and Assessment.

An initial brainstorming session with the full class is used to focus attention on how [the profession] uses its literature. Discussion includes the primary literature of science, interpretive literature for various target groups who need the science information (such as teachers, recreationists, researchers, etc), information produced by special interest groups, environmental news as part of other news coverage, and the like. We attempt to cover as many sources and recipients of environmental information as the students can envision.

In the meantime I collect from colleagues, home, and students at least 5-6 samples of publications that represent each category of literature. Each category will be used in a separate jigsaw, so the categories will need to include as many different publications as there are Expert Groups. For example, a category of “Science Background” might include publications best used by an informed audience. In other words, to get the most from this category of science literature, a reader would have to know some science first. Based on availability such a set of literature could encompass Science, Bioscience,