Group work in science learning - international scenarios and implications for teaching and learning in Hong Kong

Teresa T S WONG

Curriculum Developer of HKSAW Team

The Centre for Research and International Collaboration

Hong Kong Institute of Education

Email: tswong@ied.edu.hk

Received 12 December, 2001

Contents

Abstract

Group work, which is also known as collaborative or cooperative learning, is one of the best researched of all teaching strategies. Research results have shown that students who have opportunities to work collaboratively learn faster and more efficiently, have greater retention, and feel more positive about the learning experience (Johnson, Johnson & Smith, 1991). Although these teaching/learning strategies have undergone nearly fifty years of research and scores of studies, the extent of their recognition and application varies tremendously in various parts of the world.

During a 3-week International On-line Collaboration Discussion Seminar, (an event arranged by the Schools Around the World program held by the Council for Basic Education, Washington), teachers and national/regional facilitators from six participating nations/ regions shared their ideas and knowledge based on their experiences in implementing group work, particularly in the subject of science. Three major topics were explored within the seminar: defining group work, assessment of group work, and professional development for supporting implementation of group work.

This paper provides insights for group work in science education by drawing references from the shared ideas in the international seminar, in order to provide its implication in the future direction for science teaching in Hong Kong consistent with the current reform. As stated in the Hong Kong Government curriculum development document, a design for a student-focused curriculum is called upon for meeting the best interest of students and developing their different intelligence (Curriculum Development Council, 2000). Group work consists of various teaching and learning strategies with a sound record of research history and experimental results worldwide; therefore, it can provide resources for meeting these objectives. This on-line seminar provides a global educational community for teachers in Hong Kong (General Studies teachers at primary schools and science teachers at secondary schools), first allowing them to realize their

own stage of group work implementation compared to other countries, then forming a basis for strengthening or modifying their current teaching models.

Background

From October 15, 2001 to November 4, 2001, the Schools Around the World (SAW) Project conducted an International On-line Collaboration Discussion Seminar for all SAW participants. SAW is a professional development project designed by the Council for Basic Education (CBE), an educational interest group based in Washington that advocates high academic performance for all students. It includes nine participating nations/regions which are the United States, the Czech Republic, France, Germany, Portugal, Australia, Japan, the United Kingdom and the Hong Kong SAR. The program grew out of the need to understand what constitutes "world class" standards and work by giving science and mathematics teachers* in each of the participating nations/regions the opportunity to examine and reflect upon their teaching practice through the analysis of student work.

During this 3-week on-line seminar, SAW teachers and facilitators from six out of the nine participating nations/regions, including the United States, the Czech Republic, France, Germany, Portugal and the Hong Kong SAR, had the opportunity to exchange their professional knowledge and teaching experiences on group work practice, as well as to disseminate good science teaching and learning strategies in this area. The facilitators were scholars and educational researchers from the participating nations/regions. They served to stimulate and coordinate the discussion sessions among the SAW teachers, and then disclosed the amalgamated response to the on-line forum. Facilitators were necessary because many teachers from non-English speaking countries felt uncomfortable of expressing their ideas in English in an open forum. Since all participants are educational practitioners, they have done the sharing based on the context of their own science teaching. The

author, who was one of the facilitators of Hong Kong, summarized the content from the on-line discussion with theory support whenever appropriate. It is a hope that teachers may enrich their own professional development by making reference to these worldwide experiences, in order to support their own teaching practices in group-work learning.

Defining "Group Work" For the Seminar

Cooperative learning, collaborative learning, collective learning, learning communities, team learning, study groups, work groups ... are a few of the many terms related to group work used in education. Among these terms, cooperative learning and collaborative learning are the most commonly used and well-defined strategies in classroom teaching. Although both cooperative learning and collaborative learning imply individuals working in groups, Panitz (1999) has clarified that collaborative learning is a **personal philosophy**, not just a classroom technique. It suggests a way of dealing with people which respects and highlights individual group members' abilities and contributions. There is a sharing of authority and acceptance of responsibility among group members for the group actions. Cooperative learning on the other hand, is a **set of processes** which help people interact together in order to accomplish a specific goal or develop a content specific end product. Cooperative learning is closely controlled by the teacher and therefore more directive than a collaborative system of governance.

Although cooperative and collaborative learning can be separately defined, they are in fact not mutually exclusive but co-exist in most group work learning environments. However, since most teachers involved in the on-line seminar are practicing educators in science instead of researchers themselves, a lot of them have not distinguished these terms when referring to their own teaching. In this paper, unless in some specifically given examples, all activities designed for a group setting are referred as "group

work".

Regional Perspectives On the Meaning of Group Work

The participants from the six nations/regions have discussed about the meaning of group work around three aspects: emphasizing on individual participation and development of interpersonal and thinking skills in group work, organizing students to take up specific roles in groups to maximize individual resourcefulness, considering of personal growth in students' ability and enhancement of interdependence in groups. These are the teaching aspects that Hong Kong teachers may overlook or not be aware, but are worth their careful consideration.

A member from the United States Collaboration Team stated that: "group work is a fact of life in the corporate work force. It is a way for students to learn essential interpersonal life-skills and to develop the ability to work collaboratively - a skill greatly in demand in the workplace. The success of the group depends on the successful work of every individual." As the modern society has already transformed from an industrial society to a knowledge-based society, interpersonal life-skills have become the most important asset in the human labour force. While keeping abreast of this global trend, the United States as one of the major pioneers in the evolution of the technological world, has long realized this important asset in its students' whole-person development. Although Hong Kong teachers from primary and secondary schools often assign project work involving group work, they may not consider interpersonal and other high-order thinking skills as the learning outcomes when they design the activities.

The German Collaboration Team suggested that group work is different from the conventional kind of teaching: "It is every kind of working and learning with other persons that is not related to an institutionalized student-teacher-relationship. Group work has nothing to do with the following: one person is talking in front of the class and everyone else in the

classroom is forced to listen." The hands-on investigative nature of science and active participation are needed to be encouraged in science learning. While developing diverse way of learning is one of the key movements in Hong Kong's education, group work provides an excellent setting for meeting such incentive as well as fulfilling the intended "student-focused" curriculum.

The Czech Collaboration Team differentiated between the meanings of group work and cooperative work. They stated that group work often means merely assembling the students into groups, but cooperative work means more - it includes having specific roles or specific different tasks in the group, and sharing the goals and the assessment. One of the typical problems for teaching is that in reality, the design of learning may not allow for engaging all students at the same time. Even though Hong Kong students are used to doing project work, they are not usually assigned to take different roles within the project. Some science teachers may request their students to complete a form to indicate their individual contribution at the end of the project, but teachers seldom adopt the cooperative learning model (to be illustrated in the later section) and assign different roles to suit students' individual ability on strength development.

The Portuguese Collaboration Team stated that group work must involve sharing responsibility among the group members. It should involve the cooperation of several persons that have a common goal and common tasks to be realized in order to obtain a common outcome. The team listed the following characteristics for group work:

- It is an activity done by more than two people to attain a common goal;
- There are tasks to be shared;
- Socialization is promoted;
- They have the opportunity to share ideas and opinions;
- Information has to be collected, selected and organized;
- All the members of the group have to be responsible;

- All the tasks have to be very well coordinated.

The Hong Kong Collaboration Team shared a similar point of view for group work with Portugal in the light of they also believed that, in order for group work to be effective in enhancing student learning, it must consist of "meaningful learning activities" with "specific teachers' requirements" for students to follow.

The French Collaboration Team agreed that an efficient grouping for science (and mathematics) group work should be limited to 4-5 people. In this way, teachers can make sure that everyone has a specific task and will be active all the time. Each task should demand specific skills so that the objectives of the group can only be reached with the effective work of each member and persistent communication within the group. In order to achieve holistic development for every individual student, it is necessary to provide opportunities in rotating tasks (this can be within a particular science group work session, or for a long-term science project). Since teachers are not available for every individual student at the same time during group work, efficient group work requires strong and very well thought-out planning for each function of the group, to allow groups to establish full autonomy in completing the required tasks. They also pointed out that each science group work session must lead to an outcome, where students are aware of the objectives, the completion procedures and the time allowed.

The group size recommended by the French team is in agreement with the ideal team formation as specified by several cooperative learning experts (Johnson, Johnson, & Holubec, 1987; Kagan, 1992). These researchers have further suggested that team formation is most effective when four students work together in a specific academic mix: the combination of one high achiever, two average achievers, and one low achiever maximizes peer teaching and fosters the individual learning of each team member. The team should be balanced by gender and by race to promote equity. For local schools in Hong Kong, the race component may be replaced by mixing new

immigrants with local students.

Implementation Considerations for Group Work

Although participating teachers have drawn from their experiences as science teachers, the basic principles pertinent to group work implementation identified by these teachers can well be applied for teaching other subjects. However, whether or not group work is deemed appropriate for all teaching occasions is a questionable issue. All forms of group work need to be designed to fulfill their own sets of requirements, in order to become meaningful methods for both teaching and learning.

To structure lessons so that students do in fact work cooperatively with each other, Johnson, Johnson and Holubec (1994) believe that teachers must understand the five key elements (to be discussed in the following section) that make cooperation work. Mastering the key elements of cooperation allows the teacher to:

1. Take the existing lessons, curriculums, and courses and structure them cooperatively.
2. Tailor cooperative learning lessons to the teacher's unique instructional needs, circumstances, curriculums, subject areas and students.
3. Diagnose the problems some students may have in working together and intervene to increase the learning groups' effectiveness.

The first two objectives above come from the notion that the primary success factor for group work is the amount of initial effort that teachers put into its design and organization. These are of particular important for science education because of the necessary inclusion of experimental setups. As stated by the Czech Collaboration Team, successful teachers of group work should know how to set tasks unambiguously, how to steer the initiative of the students and how to assess students' tasks, but at the same

time, take into consideration the different situations and individual backgrounds on which each child builds his or her own learning. Here is a compiled list of teachers' tasks for the successful implementation of group work suggested by the team teachers:

- Teachers assign some work beforehand (formative assessment) to check students' previous knowledge and skills and to prepare them for the group work to be assigned.
- Teachers provide clear instructions during the assignment introduction, such as explaining the work schedule, role description for each group member, task specifications, uses of tools/experimental apparatus, the importance of interpersonal skills and division of labour.
- Teachers provide students with enough resources for group work as well as for reinforcing their research skills.
- Teachers provide sufficient time for students to complete the specified tasks.

Hong Kong teachers have identified some regional constraints for implementing group work. For example, resources available and the classroom physical environment may influence both the methods and applications of cooperative learning. Most Hong Kong classes and school climates have been primarily individualistic or competitive due to the fact that most people from the general public regard increasing individual power to compete in public examinations as the most important achievement in education. Therefore, teachers have to devote more time to convince students to engage and develop a cooperative climate for learning.

In addition, Hong Kong has a set of very intensive curriculum expectations for its local students within the educational system. Many teachers feel that they need to "compete" for more teaching time in order to cover all the curricular materials. It is also believed that the prescribed teaching contents in the current teaching syllabuses do not leave much learning space for developing students' creativity and critical thinking (Curriculum

Development Council, 2000). A well-designed group work should provide opportunity to foster these two important generic skills. However, the fixed time-tabling in terms of number of periods/weeks or cycles for most school do not suit the purpose of experimentation of an extend group work activity, especially if teachers are interested in implementing experimental extensive and investigative activity and doing cross-curricular collaboration. In reality, successful implementation of group work activity not only require time for teachers to follow-up student progress, but teachers themselves also require more time to develop implementation skills and confidence. To promote positive learning atmosphere for conducting different teaching strategies such as group work, the Hong Kong educational reform has introduced certain constructive motivations, such as creating more flexibility in time-tabling and trimming overlapping or out-dated curriculum content to provide teachers with room of trying different teaching approaches. Kagan (1994), one of the main leaders in the group work movement, has suggested a step-by-step approach for teachers who would like to attempt the group work strategy. First of all, he suggested that teachers should attempt to do this in a very limited way at the beginning. After they have mastered the art of managing a classroom of teams and feel competent in one structure, they may be ready to include other techniques - eventually discovering the amount and style of grouping which best fits their own personal style. As they endeavour to attain group work strategies, the excitement, involvement and gains of their students will lead them to try more.

The third objective of Johnson, Johnson and Holubec as stated above, is that cooperation work should be mastered with the aim of allowing teachers to diagnose the problems some students may have in working together, and intervene to increase the learning groups' effectiveness. Following along this direction, the German Collaboration Team believed that group work is successful if there is no loss of learning. Teachers have to install classroom rules for group work, have to watch all the groups carefully in case the students get out of control or require assistance.

Student Skill and Attitude Development Through Group Work

The investigative nature of science provides a unique setting for group work, particularly cooperative learning, to build its framework (Sherman, 1994). This nature of science is an aspect often neglected by science teachers in their normal teaching. It has a profound significance for building science literacy for students and therefore, its implication to the implementation of group work practice and assessment will be addressed. Group work has been proven to provide opportunity for developing important process skills and attitude in science learning and they will be discussed in the following.

Cooperative classrooms can effectively foster discussion, which is so essential for understanding in science, as well as in other subjects. Hands-on science activities are wonderful vehicles for the use and practice of the process skills. The combining of cooperative learning with science is seen as a natural union for many experienced science teachers who have worked extensively with small groups. When cooperative learning is properly implemented, it provides a vehicle for student teams to share materials and equipment, as well as ideas.

The process of science involves a number of skills that are important in scientific research. These process skills fit well into the cooperative framework. However, not every process skill is used in every lesson or activity, but every science learning task needs to focus on one or more of the skills. Teachers who employ a cooperative learning strategy should try to identify the science process skills that will be addressed in the lesson and build these into students' learning. The following is a list of science process skills suggested by Sherman (1994):

- formulate research questions
- identify and observe variables

- formulate hypotheses
- make observations
- use classification
- conduct experimentation
- use measurement
- strive for good communication
- use models to make predictions
- search for patterns or regularities when interpreting the data collected
- draw conclusions
- make inferences

Besides the improvement in thinking skills and the use of science process skills when students experience science through cooperative learning, Kyle (1984), Lazarowitz & Karsenty (1990) have observed that attitudes toward science are enhanced when students engage in hands-on science.

In order to successfully implement cooperative learning, Johnson, Johnson & Holubec (1994) have stated the following five key elements for cooperative learning:

- Positive interdependence
- Individual accountability
- Interpersonal skills
- Face-to-face promotive interaction
- Processing

Although not all teachers are specifically taught about the above process skills or key elements before they actually start their teaching career, the suggestions in the on-line seminar showed that teachers of some countries are well aware of their existence and importance. The advantages of group work/cooperative and collaborative learning are generally divided into two areas-- the improvement in attitude and skill abilities, which are reflected in

their comments that follow:

The United States Collaboration Team believed that accountability of students and interdependence are the two major components that make group work effective. Teachers are responsible for making it clear to students that they will expect them to be accountable for all of their work, regardless of its possibility for success. Often students think that they can disappear when working in groups, or one student may take over the work while the others sit back. Structuring the lesson to make all students equally accountable "forces" all of the students to demonstrate their skills. Regarding promoting interdependence in group work, students need to know that they cannot work independently to achieve the required result. Their product must be more than the "sum of their parts". In working together, students often come up with better ideas than they would independently.

Several teachers from the Czech Collaboration Team have noticed that cooperative learning is a vehicle for nurturing various interpersonal skills in students. They observed that students who have done group work display their growth in tolerance, their ability to listen to others and respect each others' views; improvement in self-reliability, independence in dealing with others and their ability in making decisions; and in becoming considerate and helpful towards others. They also noted that better communication, logical thinking and presentational skills are the trainable outcomes for group work. They concluded that group work is an effective way for providing opportunities for children with learning or behavioural difficulties to benefit in developing their interpersonal skills.

Face-to-face promotive interaction is another key cooperative learning element verified by French teachers. Although group work introduces a higher possibility of conflicts arising, the French Collaboration Team said that group work not only creates situations for students to develop skills of argumentation and tolerance; it can also promote opportunities for

confronting different ideas, training ways of thinking that require the daring of individuals to express one's point of view, the capacity of listening and understanding others, the ability of making oneself understandable by others, and lastly, the capacity of being involved actively in discussions and accepting criticism.

Some Czech teachers have stated that it is mainly the best talented students who have difficulties in cooperating in group work. Other Czech teachers challenged this by saying that cooperative learning can actually be of better benefit for students with better learning skills or knowledge. When they each assume a new and different role during group work, they must interact with others who have different abilities, and therefore must be able to learn how to help, lead, organize, and become a resource person. Due to the fact that students need to rely on each other to complete all tasks, as well as that any task can be perceived at different difficulty levels for different students, a heterogeneous classroom environment for group work promotes positive interaction among students.

With regard to the processing element, cooperative learning should provide opportunities for both the teacher and students to reflect on how well the groups are functioning or how to function even better. A Hong Kong SAW teacher has expressed this opinion: " I think teachers should encourage students to share experiences after completing the activity. I believe students enjoy the process of the activity as well as the final sharing session. Unfortunately, many teachers just pay attention to the activity itself, but do not spend enough time for the sharing session." Despite the constraints stated in the above section for Hong Kong in implementing group work, the responses from Hong Kong teachers regarding assessment method show that, they have gradually become aware that group work should be treated as a process, but not as an independent activity for the students. Many Hong Kong teachers are familiar with the concepts of peer and self-evaluations. They have used these assessment instruments to assess the following during

students' learning:

- The proportion of each student work in the assignment,
- Cooperation amongst team members,
- Individual effort toward group's success.

Some Hong Kong teachers suggested some interesting alternative assessment strategies. For example, teachers can videotape group learning process and develop evaluation form to assess the videotaped group work. The suggested assessment criteria are group interaction, students' response and involvement, individual student's questioning skills, answering skills, problem-solving skills, communication skills and presentational skills.

Three Main Types of Cooperative Learning in Science

Cooperative learning is the most commonly used group work teaching strategy by all science teachers. Johnson & Johnson, two well-known pioneers in modern methods of cooperative learning have identified the three main types of cooperative learning: cooperative base groups, informal cooperative learning groups and formal cooperative learning groups (Johnson, Johnson, 1994). Definitions for these three types of cooperative learning are stated below coupled with illustrations with examples chosen from the seminar. Other science teachers may use these as their guidelines for forming cooperative learning groups in their classes.

I. Cooperative Base Groups

Cooperative base groups are long-term, heterogeneous cooperative learning groups (lasting for at least one semester or year) with a stable membership, whose primary responsibility is to give each member the support, encouragement, and assistance he or she needs to progress academically and develop cognitively and socially in healthy ways. The following example, which is a French nationwide compulsory project applicable to different subjects including science, illustrates the use of this type of setting for

cooperative learning.

Recently, French high schools have included compulsory group work projects in their curriculum. TPE (Travaux Personnels Encadres - translated into Supervised Personal Work) is a compulsory project assignment for all Grade Eleven students in France. Each student needs to spend a semester on a research project worked out in groups. The final products of the project consist of a group component and an individual student component. This research project also includes an oral report. Each student is assessed for his/her collaboration effort among the group as well as his/her personal production. In the twelfth grade of the French curriculum, this research project becomes optional but can be included as part of the Baccalaureat (Final Examination for High School). Although it is not specified in the seminar whether or not the project is related to science, but the project organization may well be suited for all science subjects such as conducting science investigation and scientific research study.

II. Informal Cooperative Learning Groups

An informal cooperative learning group is one in which students work together in temporary, ad hoc groups that last for only one discussion or class period to achieve joint learning goals. Informal cooperative learning groups are used to focus student attention on the material to be learned, create an expectation set and mood conducive to learning, ensure students cognitively process the material being taught, and provide closure to an instructional session. The one-period long group work activity designed for conducting any laboratory work in small groups (usually of 3-4 students) is an example of an informal cooperative learning group.

Group work is appropriate for laboratory work in science lessons because it is not always possible to provide material for individual manipulation.

III. Formal Cooperative Learning Groups

The formal cooperative learning group is the most widely used method as almost all teaching examples provided in the on-line seminar were classified under this method. A formal cooperative learning group is when students work together for one or several class sessions to achieve shared learning goals and jointly complete specific tasks and assignments. These groups provide the foundation for all other cooperative learning procedures. They are structured through pre-instructional decisions, setting the task and the cooperative structure, monitoring the groups while they work, intervening to improve task-work and teamwork, evaluating student learning, and processing group functioning.

In order to ensure that all students have individual accountability (one of the Johnson & Johnson five basic elements of cooperative teams) and are actively involved in the groups, it is typical for teachers to assign a specific task/role for each group member. Teachers may assign roles to students according to their strengths and abilities, or teachers may allow students to choose their roles once they have gained a certain level of comfort and independence. Some typical tasks for formal cooperative learning in science are principal investigator, material manager, recorder, spokesperson, timekeeper, gatekeeper, checker, encourager/praiser (Sherman, 1994). Teachers in the seminar suggested that, when forming small formal cooperative learning groups for students conducting experimental activity, the roles may include organizer, record writer, assistant, observer. The goals of the teacher are to maximize interdependence and active learning among students.

Although assigning roles to group members can facilitate group work, French teachers have noted that as more mature students become accustomed to doing group work, it is less necessary for teachers to define and fix the different functions/roles within the group. Students become capable of organizing themselves as they gain experience.

Implications of Group Work Practice in Science Teaching in Hong Kong & Conclusion for the On-line Seminar

By examining the sharing of global experiences of group work practice in science education, group work has been illustrated to be one of the effective solutions for solving the various issues of concerns and existing tensions in the Hong Kong education. Group work can improve learning by creating environment for meeting students' individual differences (e.g. students of mixed learning abilities, the academically low achievers and the gifted), cultivating whole-person development (through building up of students' various generic, high-order thinking skills and science process skills), using alternative modes for learning and teaching (such as group discussion and various forms of assessment). In order to promote "learning to learn" and to establish a successful climate for group work learning, Hong Kong teachers need to develop their competence to infuse generic skills during the various stages of group work implementation. A bank of exemplary teaching/learning/assessment materials along with the curriculum planning exemplars needed to be collected and introduced to local teachers. Local and international curriculum development experts may serve to advise on the development strategies and review the developmental progress whenever appropriate. In terms of science education, the application of group work in real life, particularly in the context of the professional science and technology world, should be examined and emphasized to simulate similar kind of culture in students' educational experience.

Seminar like this one will help to disseminate evidence-based findings from actual educational practitioners for the reference of other schools. Administrative support and teachers themselves are encouraged to bring up teachers' collaborative effort. At the curriculum planning level, identifying and removing existing curricular and educational system constraints (such as the ones discussed in the previous sections) that would hinder the effective implementation of group work, would be the first step in promoting movements in this type of learning. Nevertheless, an incremental

and interactive approach (based on the establishment of cumulative knowledge and experiences) is thus advocated, rather than a radical approach to nurture group work in learning.

This International On-line Collaboration Discussion Seminar has provided a channel for exchanging ideas and questions, which offered some insight from their useful experiences and evidence-based learning and teaching related to group-work for the references of other teachers. This seminar has proven to be an effective, stimulating and successful way for teachers worldwide to communicate collaboratively. It is hoped that more seminars of this nature can be held in the near future to strengthen teachers' professionalism and provide further opportunity for sharing ideas in science education.

References

Curriculum Development Council (2000). *Learning To Learn - The Way Forward in Curriculum Development*. Hong Kong SAR: Hong Kong Government Printing: Author.

Johnson, D. W. and Johnson, R. T. (1994). Learning Together. *In Handbook of Cooperative Learning Methods* (Ed. Sharan, S.). pp. 51-64

Johnson, D., Johnson, R. and Holubec, E. (1987). *Structuring Cooperative Learning: Lesson Plans for Teachers*. Edina, MN: Interaction Book Company.

Johnson, D., Johnson, R. and Holubec, E. (1994). *Cooperative Learning in the Classroom*. Virginia: Association for Supervision and Curriculum Development. pp. 9-11

Johnson, D. W., Johnson, R. T. and Smith, K. A. (1991). Cooperative Learning: Increasing College Faculty Instructional Productivity. *ASHE-FRIC Higher Education Report No.4*. Washington, D.C.: School of Education and Human Development, George Washington University.

Kagan, S. (1992). *Cooperative Learning*. San Juan Capistrano, CA: Resources for Teachers.

Kagan, S. (1994). *Cooperative Learning*. San Clemente: Kagan Cooperative Learning.

Kyle, W. (1984). Curriculum Development Projects of the 1960s. In *Research Within Reach*. (Eds. Holdzkom, D. and Lutz, P.). Charleston, WV: Appalachia Educational Laboratory.

Lazarowitz, R. and Karsenty, G. (1990). Cooperative Learning and Students' Academic Achievement, Process Skills, Learning Environment, and Self Esteem in Tenth Grade Biology Classrooms. In *Cooperative Learning: Theory and Research (Ed. Sharan, S.)*. New York: Praeger. pp. 123-149.

Panitz, T. (1999). Collaborative Versus Cooperative Learning: A comparison of the Two Concepts Which Will Help Us Understand the Underlying Nature of Interactive Learning. pp. 3-5. *Microfiche: Office of Educational Research & Improvement, U.S. Department of Education*.

Sherman, S. J. (1994). Cooperative Learning and Science. *In Handbook of Cooperative Learning Methods (Ed. Sharan, S.)*. pp. 226-244.