COOPERATION AND THE USE OF TECHNOLOGY

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30.1 TECHNOLOGY IN THE CLASSROOM

We live in an historical period in which knowledge is the most critical resource for social and economic development and people need to be able to participate in a networked, information-based society. Whereas previously people engaged in manufacturing-based work where they generally competed with or worked independently of each other, now people engage in information- and technological-rich work where they work in teams. People need to be able to work collaboratively in designing, using, and maintaining the tools of technology. Technology and teamwork will continuously play a larger role in most people's lives. Children, adolescents, and young adults have no choice but to develop and increase their technological and teamwork literacy. There is no better place for them to begin than in school. Learning in cooperative groups while utilizing the tools of technology should occur at all grade levels and in all subject areas.

Because the nature of technology used by a society influences what the society is and becomes, individuals who do not become technologically literate will be left behind. Influences of a technology include the nature of the medium, the way the medium extends human senses, and the type of cognitive processing required by the medium. Harold Adam Innis (1964, 1972) proposed that media biased toward lasting a long time, such as stone hieroglyphics, lead to small, stable societies because stone was difficult to edit and rewrite and was too heavy to distribute over great distances. In contrast, media biased toward traveling easily across distances, such as papyrus, enabled the Romans to build and run a large empire. Marshall McLuhan (1964) believed that the way the media technology balances the senses creates its own form of thinking and communicating and eventually alters the balance of human senses. He believed that oral communication makes hearing dominant and thought may be linear (one thing follows another), rational (cause and effect), and abstract. Electronic technology tends to recreate the village on a global scale through instantaneous and simultaneous communication in which physical distance between people becomes irrelevant. On a more negative note, Neil Postman (1985) expressed fears that our ability to reason with rigor and self-discipline is being eroded as fewer people read systematically and more people watch and listen to electronic media. Their thinking may become more reactive and impressionistic.

Given the pervasive and powerful effects media that technologies can have on the nature of society and the thinking and communicating of its members, there can be little doubt that technology will increasingly be utilized in instructional situations. In the past, however, teachers and schools have been very slow in adopting new technologies and very quick in discontinuing their use (Cuban, 1986). There tends to be a cycle in which (a) the potential of a technology leads to fervent claims and promises by advocates, (b) its utility is demonstrated by academic research in a small set of classrooms rich with human and technical support, (c) teachers who have little or no resources adopt the technology and are frustrated by their failure to make it work, and (d) the use of the new technology gradually declines. With the invention of motion pictures, for example, Thomas Edison predicted that films of great teachers would replace live classroom teachers. When radio was invented the prediction was made that teachers would soon be obsolete because all over the country students could sit and listen to great minds lecture via the radio. Similar predictions were made when television and computers were first invented.

The failure of schools to adopt available instructional technologies and to maintain (let alone continuously improve) their use may be due at least in part to two barriers: (a) the individual assumption underlying most hardware and software development and (b) the failure to utilize cooperation learning as an inherent part of using instructional technologies. The purpose of
this chapter is to clarify the interdependence between instruc-
tional technologies and cooperation among students in using
the technologies. To understand how cooperative learning may
be used with technologies, the nature of cooperative learning
needs to be defined, the theoretical foundations on which it is
based need to be clarified, the research validating its use needs
to be reviewed, distinctions between cooperative learning and
other types of instructional groups need to be made, and the ba-
sic elements that make cooperation work must be defined. At
that point, the interrelationships between cooperative learning
and technology-supported instruction can be noted and their
complementary strengths delineated. The future of technology-
assisted cooperative learning can then be discussed.

30.2 THE INDIVIDUAL ASSUMPTION

Before the 1990s, most of the research on computer-supported
learning was based on the single-learner assumption. The
individual assumption is that instruction should be tailored
to each student's personal aptitude, learning style, personality
characteristics, motivation, and needs. Computers were viewed
as an important tool for individualizing learning experiences,
especially for computer-assisted instruction programs based on
programmed learning, but also for learning experiences derived
from constructivist principles (Crook, 1994). Many hardware
and software designers (as well as teachers) assumed that all
technology-supported instruction should be structured individ-
ually (one student to a computer) and computer programs
were written accordingly.

The ability of designers to adapt instruction sequences to
the cognitive and affective needs of each learner, however, is
limited by three factors.

1. Substantial variation exists in types of learning styles and per-
sontality traits, and although many of them are sometimes cor-
related with achievement, few have been shown to predict
achievement consistently.

2. Little agreement exists on how to translate differences in
learning styles and personal traits into instructional prescrip-
tions. The only design rule that is widely accepted is that
students should control the flow of information.

3. Creating algorithms to adapt instruction to individual needs
and designing and producing multiple versions of lessons are
both time-consuming and expensive.

Thus, the potential for individualized instruction may be lim-
ited due to the difficulties associated with identifying individual
differences and translating them into instructional prescrip-
tions. In addition, individualized instruction has several short-
comings:

1. Individual work isolates students and working alone for long
periods may lower personal motivation by increasing bore-
dom, frustration, anxiety, and the perception that learning is
 impersonal.

2. Individual instruction limits the resources available to them-
selves and the technology. The support and encouragement
of peers and the cognitive benefits associated with ex-
plaining to peers and developing shared mental models are lost.

3. Individualized instruction greatly increases development and
hardware costs. A workstation is required for each learner,
which entails considerable hardware expense. Considerable
development and software expenses are required, as the
lessons have to be designed to personalize instruction and
to adapt the instructional sequenced to individual process-
ning requirements.

The difficulties associated with identifying and accommodat-
ing individual needs severely limit designers' ability to individ-
ualize instruction. The shortcomings of individualized instruc-
tion call into question the wisdom of designing individualized
programs. Despite these problems, however, much of the in-
structional software has been designed, developed, and
marketed for individual use.

This omission of social interaction in computer-based learn-
ing experiences worried many educators in the 1980s (Baker,
1985; Cuban, 1986; Hawkins, Sheingold, Gearhart, & Berger,
1982; Isenberg, 1992). Given the limitations of the individual
assumption, and its shortcomings, technology may be more pro-
ductively used when it is used in combination with cooperation
learning. The spontaneous cooperation often reported around
technology, in addition, both casts doubt on the individual as-
sumption made by hardware and software designers and points
toward the use of cooperative learning in technology-supported
instruction (Dyer, 1994). To use cooperative learning, however,
educators must understand its nature.

30.3 THE NATURE OF COOPERATIVE LEARNING

There are advantages to embedding technology-supported in-
struction in cooperative learning. Cooperative learning may
be distinguished from traditional “direct transfer” models of
instruction in which the instructor is assumed to be the dis-
tributor of knowledge and skills. To understand technology-
supported cooperative learning, you must understand the na-
ture of cooperative learning, the theoretical foundations on
which it is based, the research validating its use, the distinctions
between cooperative learning and other types of instructional
groups, and the basic elements that make cooperation work
(Fig. 30.1).

30.3.1 Cooperative Learning

Cooperation is working together to accomplish shared goals.
Within cooperative activities individuals seek outcomes that are
beneficial to themselves and beneficial to all other group mem-
bers. Cooperative learning is the instructional use of small
groups so that students work together to maximize their own
and each other's learning. In cooperative learning situations
there is a positive interdependence among students' goal at-
tainments; students perceive that they can reach their learning
goals if and only if the other students in the learning group also
30. Cooperation and Technology

Social Interdependence

<table>
<thead>
<tr>
<th>Cooperative</th>
<th>Competitive</th>
<th>Individualistic</th>
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Research: Why Use Cooperative Learning

Effort To Achieve | Positive Relationships | Psychological Health

Five Basic Elements

Positive Interdependence | Individual Accountability | Promotive Interaction | Social Skills | Group Processing

Cooperative Learning

Formal Coop Learning | Informal Coop Learning | Coop Base Groups

Make Preinstructional Decisions | Conduct Introductory Focused Discussion | Opening Class Meeting To Check Homework, Ensure Members Understand Academic Material, Complete Routine Tasks Such As Attendance

Explain Task And Cooperative Structure | Conduct Intermittent Pair Discussions Every Ten Or Fifteen Minutes | Ending Class Meeting To Ensure Members Understand Academic Material, Homework Assignment

Monitor Learning Groups And Intervene To Improve Taskwork & Teamwork | Conduct Closure Focused Discussion | Members Help And Assist Each Other Learn In-Between Classes

Assess Student Learning And Process Group Effectiveness | Conduct Semester Or Year Long School Or Class Service Projects

Cooperative School

Teaching Teams | Site-Based Decision Making | Faculty Meetings

Constructive Conflict

Students | Faculty

Academic Controversy | Negotiating, Mediating Decision-Making Controversy | Negotiating, Mediating

Civic Values

Work For Mutual Benefit, Common Good | Equality Of All Members | Trusting, Caring Relationships | View Situations From All Perspectives | Unconditional Worth Of Self, Diverse Others


reach their goals (Deutsch, 1962; D. W. Johnson & R. Johnson, 1989).

Technology-supported cooperative learning exists when the instructional use of technology is combined with the use of cooperative learning groups. Cooperative learning is usually contrasted with competitive learning (students working to achieve goals that only a few can attain; students can succeed if and only if the other students in the class fail to obtain their goals) and individualistic learning (students working alone on goals independent from the goals of others) (Deutsch, 1962; D. W. Johnson & R. Johnson, 1989).

30.3.2 Collaborative Learning

Cooperative learning is sometimes differentiated from collaborative learning, which has its roots in the world of Sir James Britton (1990) and others in England in the 1970s. Quoting Vygotsky (1978), Britton notes that just as the individual mind is derived from society, a student’s learning is derived from the community of learners. Britton is quite critical of educators who wish to provide specific definitions of the teacher’s role. He recommends placing students in groups and letting them generate their own culture, community, and procedures for learning.
Britton believed in natural learning (learning something by making intuitive responses to whatever our efforts throw up) rather than training (the application of explanations, instructions, or recipes for action). The source of learning is interpersonal; learning is derived from dialogues and interactions with other students and sometimes the teacher. He viewed structure provided by teachers as manipulation that creates training, not learning, and therefore teachers should assign students to groups, provide no guidelines or instructions, and stay out of their way until the class is over. As an educational procedure, therefore, collaborative learning has historically been much less structured and more student directed than cooperative learning, with only vague directions given to teachers about its use. The vagueness in the role of the teacher and students results in a vagueness of definition of the nature of collaborative learning. Although there is a clear definition of cooperative learning, there is considerable ambiguity about the meaning of collaborative learning. The two terms (cooperative learning and collaborative learning) are, therefore, usually used as interchangeable and synonymous.

30.3.3 Types of Cooperative Learning

There are four types of cooperative learning that may be used in combination with instructional technology: formal cooperative learning, informal cooperative learning, cooperative base groups, and academic controversy.

Formal cooperative learning is students working together, for one class period to several weeks, to achieve shared learning goals and complete jointly specific tasks and assignments (such as decision making or problem solving, completing a curriculum unit, writing a report, conducting a survey or experiment, reading a chapter or reference book, learning vocabulary, or answering questions at the end of a chapter; D. W. Johnson, Johnson, & Holubec, 1998a, 1998b). Any course requirement or assignment may be reformulated to be cooperative. When it is needed, the teacher intervenes to assist students who are not learning, and therefore teachers should assign students to groups, provide no guidelines or instructions, and stay out of their way until the class is over. As an educational procedure, therefore, collaborative learning has historically been much less structured and more student directed than cooperative learning, with only vague directions given to teachers about its use. The vagueness in the role of the teacher and students results in a vagueness of definition of the nature of collaborative learning. Although there is a clear definition of cooperative learning, there is considerable ambiguity about the meaning of collaborative learning. The two terms (cooperative learning and collaborative learning) are, therefore, usually used as interchangeable and synonymous.

1. Make a number of preinstructional decisions. A teacher has to decide on the objectives of the lesson (both academic and social skills objectives), the size of groups, the method of assigning students to groups, the roles students will be assigned, the materials needed to conduct the lesson, and the way the room will be arranged.

2. Explain the task and the positive interdependence. A teacher clearly defines the assignment, teaches the required concepts and strategies, specifies the positive interdependence and individual accountability, gives the criteria for success, and explains the expected social skills to be engaged.

3. Monitor students’ learning and intervene within the groups to provide task assistance or to increase students’ interpersonal and group skills. A teacher systematically observes and collects data on each group as it works. When it is needed, the teacher intervenes to assist students in completing the task accurately and in working together effectively.

4. Evaluate students’ learning and help students process how well their groups functioned. Students’ learning is carefully assessed and their performances are evaluated. Members of the learning groups then process how effectively they have been working together.

Informal cooperative learning consists of having students work together to achieve a joint learning goal in temporary ad-hoc groups that last from a few minutes to one class period (D. W. Johnson et al., 1998b; D. W. Johnson, Johnson, & Smith, 1998). During a lecture, demonstration, or film they can be used to focus student attention on the material to be learned, set a mood conducive to learning, help set expectations as to what will be covered in a class session, ensure that students cognitively process the material being taught, and provide closure to an instructional session. Informal cooperative learning groups are often organized so that students engage in 3- to 5-min focused discussions before and after a lecture and 2- to 3-min turn-to-your-partner discussions interspersed every 15 min or so throughout a lecture.

Cooperative base groups are long-term, heterogeneous cooperative learning groups with stable membership (D. W. Johnson et al., 1998b; D. W. Johnson, Johnson, & Smith, 1998). The purposes of the base group are to give the support, help, encouragement, and assistance each member needs to make academic progress (attend class, complete all assignments, learn) and develop cognitively and socially in healthy ways. Base groups meet daily in elementary school and twice a week in secondary school (or whenever the class meets).

The fourth type of cooperative learning is academic controversy; which exists when one student’s ideas, information, conclusions, theories, and opinions are incompatible with those of another, and the two seek to reach an agreement (D. W. Johnson & R. Johnson, 1979, 1995). Teachers structure academic controversies by choosing an important intellectual issue, assigning students to groups of four, dividing the group into two pairs, and assigning one pair the pro position and the other pair the con position. Students then follow the five-step controversy procedure of (a) preparing the best case possible for their assigned position, (b) persuasively presenting the best case possible for their position to the opposing pair, (c) having an open discussion in which the two sides argue forcefully and persuasively for their position while subjecting the opposing position to critical analysis, (d) reversing perspectives, and (e) dropping all advocacy coming to a consensus as to their best reasoned judgment about the issue.

In all four types of cooperative learning, repetitive lessons can be scripted so they become classroom routines. Cooperative learning scripts are standard cooperative procedures for conducting generic, repetitive lessons and managing class routines. Cooperative learning requires repetitive, ad-hoc routines that occur repeatedly. Some examples are checking homework, preparing for and reviewing a test, drill-reviewing facts and events, reading textbooks and reference materials, writing reports and essays, giving presentations, learning vocabulary, learning concepts, doing projects such as surveys, and problem solving. All of these instructional activities may be done cooperatively and...
once planned and conducted several times, will become automatic activities in the classroom. They may also be used in combination to form an overall lesson.

Cooperative learning is being used throughout preschools, elementary and secondary schools, colleges, and adult education programs because of its blend of theory, research, and practice. It is being used throughout the world, that is, throughout North America and Europe and in Central and South America, Africa, the Middle East, Asia, and the Pacific Rim. Cooperative learning’s popularity is based on its theoretical basis, which has been validated by hundreds of research studies.

30.4 THEORETICAL FOUNDATIONS OF COOPERATIVE LEARNING

Whereas computers have been used as educational tools since the 1970s, integrating the design and deployment of computers with educational theory has been difficult and largely absent. Technology-supported instruction, for example, needs to be integrated into the theories underlying the use of cooperative learning. There are at least three general theoretical perspectives that have guided research on cooperative learning—cognitive-developmental, behavioral, and social interdependence. The cognitive developmental or constructivist perspective is based largely on the theories of Piaget and Vygotsky. The work of Piaget and related theorists is based on the premise that when individuals cooperate on the environment, sociocognitive conflict occurs that creates cognitive disequilibrium, which in turn stimulates perspective-taking ability and cognitive development. The work of Vygotsky and related theorists is based on the premise that knowledge is social, constructed from cooperative efforts to learn, understand, and solve problems. The behavioral learning theory perspective focuses on the impact of group reinforcers and rewards on learning. Skinner focused on group contingencies. Bandura focused on imitation, and Homans as well as Thibaut and Kelley focused on the balance of rewards and costs in social exchange among interdependent individuals. While the cognitive-developmental and behavioral theoretical orientations have their followings, the theory dealing with cooperation that has generated by far the most research is the social interdependence theory.

Social interdependence exists when individuals share common goals and each person’s success is affected by the actions of the others (Deutsch, 1962; D. W. Johnson & R. Johnson, 1989). It may be differentiated from social dependence (i.e., the outcomes of one person, are affected by the actions of a second person, but not vice versa) and social independence (i.e., individuals’ outcomes are unaffected by each other’s actions). There are two types of social interdependence: cooperative and competitive. The absence of social interdependence and dependence results in individualistic efforts.

Theorizing on social interdependence began in the early 1900s, when one of the founders of the Gestalt School of Psychology, Kurt Koffka, proposed that groups were dynamic wholes in which the interdependence among members could vary. One of his colleagues, Kurt Lewin, refined Koffka’s notions in the 1920s and 1930s while stating that (a) the essence of a group is the interdependence among members (created by common goals), which results in the group being a “dynamic whole,” so that a change in the state of any member or subgroup changes the state of any other member or subgroup, and (b) an intrinsic state of tension within group members motivates movement toward the accomplishment of the desired common goals. In the late 1940s, one of Lewin’s graduate students, Morton Deutsch (1949, 1962), extended Lewin’s reasoning about social interdependence and formulated a theory of cooperation and competition. Deutsch conceptualized three types of social interdependence—positive, negative, and none. Deutsch’s basic premise was that the type of interdependence structured in a situation determines how individuals interact with each other which in turn largely determines outcomes. Positive interdependence tends to result in promotive interaction, negative interdependence tends to result in oppositional or contrent interaction, and no interdependence results in an absence of interaction. Depending on whether individuals promote or obstruct each other’s goal accomplishments, there is substitutability, cathexis, and inducibility. The relationship between the type of social interdependence and the interaction pattern it elicits is assumed to be bidirectional. Each may cause the other. Deutsch’s theory has served as a major conceptual structure for the study of social interdependence since the late 1940s.

30.5 RESEARCH ON SOCIAL INTERDEPENDENCE

The research on social interdependence is notable for the sheer amount of work done, the long history of the work, the wide variety of dependent variables examined, the generalizability and external validity of the work, and the sophistication of the research reviews. A great deal of research on social interdependence has been conducted. In North America, the first study was published in 1898. Between that time and 1989, over 950 experimental and 100 correlational studies were conducted on social interdependence (see D. W. Johnson & R. Johnson, 1989, for a complete listing of these studies). Hundreds of other studies have used social interdependence as the dependent rather than the independent variable. In our own research program at the Cooperative Learning Center at the University of Minnesota since the late 1960s we have conducted over 90 studies to refine our understanding of how cooperation works. In terms of sheer quantity of research, social interdependence theory is one of the most examined aspects of human nature.

The research on social interdependence has been conducted in 11 historical decades. Research subjects have varied as to age, sex, economic class, ethnicity, nationality, and cultural background. A wide variety of research tasks, ways of structuring social interdependence, and measures of the dependent variables has been used. Many researchers with markedly different theoretical and practical orientations working in different
Two heads are better than one.
—Heywood

Positive interdependence creates promotive interaction. **Promotive interaction** occurs as individuals encourage and facilitate each other’s efforts to reach the group’s goals (such as maximizing each member’s learning). Group members promote each other’s success by (D. W. Johnson & R. Johnson, 1989):

1. Giving and receiving help and assistance. In cooperative groups, members both give and receive work-related help and support. Hoover (1992a) found a positive and significant correlation between achievement and helping behaviors.

2. Exchanging resources and information. Group members seek information and other resources from each other, comprehend information accurately and without bias, and make optimal use of the information provided (e.g., Cosden & English, 1987; Hawkins et al., 1982; Webb, Ender, & Lewis, 1986). There are a number of beneficial results from (a) orally explaining, elaborating, and summarizing information and (b) teaching one’s knowledge to others. Yueh and Alessi (1988) found that a combination of group and individual rewards resulted in increased peer teaching. Explaining and teaching increase the degree to which group members cognitively process and organize information, engage in higher-level reasoning, attain insights, and become personally committed to achieving. Listening critically to the explanations of groupmates provides the opportunity to utilize other’s resources.

3. Giving and receiving feedback on taskwork and teamwork behaviors. In cooperative groups, members monitor each other’s efforts, give immediate feedback on performance, and, when needed, give each other help and assistance. Carrier and Sales (1987) found that students working in pairs chose elaborative feedback more frequently than did those working alone.


5. Advocating increased efforts to achieve. Encouraging others to achieve increases one’s own commitment to do so.

6. Mutually influencing each other’s reasoning and behavior. Group members actively seek to influence and be influenced by each other. If a member has a better way to complete the task, groupmates usually quickly adopt it.

7. Engaging in the interpersonal and small group skills needed for effective teamwork.

8. Processing how effectively group members are working together and how the group’s effectiveness can be continuously improved.

Negative interdependence typically results in oppositional interaction. **Oppositional interaction** occurs as individuals discourage and obstruct each other’s efforts to achieve. Individuals focus both on increasing their own success and on preventing any one else from being more successful than they are. **No interaction** exists when individuals work independently without any interaction or interchange with each other. Individuals focus only on increasing their own success and ignore as irrelevant the efforts of others.

Each of these interaction patterns affects outcomes differently. The outcomes of social interdependence may be organized into three major areas.

30.5.1 Effort to Achieve. Between 1898 and 1989, researchers conducted over 375 experimental studies on social interdependence and achievement (D. W. Johnson & R. Johnson,
3. Higher-level reasoning (critical thinking) and metacognitive
tools. Cooperative efforts promote a greater use of higher-
level reasoning strategies and critical thinking than do com-
petitive and individualistic learning. When we examined only
high-quality studies and (b) studies using pure operationaliza-
tions of cooperative learning than for studies using mixed oper-
ationalizations.

Some cooperative procedures contained a mixture of coop-
ervative, competitive, and individualistic efforts, whereas oth-
ers contained pure cooperation. The original jigsaw procedure
(Aronson, 1978), for example, is a combination of resource in-
terdependence and an individualistic reward structure. Teams-
games–tournaments (DeVries & Edwards, 1974) and student-
teams–achievement–divisions (Slavin, 1986) are mixtures of
cooperation and intergroup competition. Team-assisted instruc-
tion (Slavin, Leavcy, & Maddon, 1982) is a mixture of individu-
alistic and cooperative learning. When the results of “pure” and
“mixed” operationalizations of cooperative learning were com-
pared, the pure operationalizations produced higher achieve-
ment.

Besides higher achievement and greater retention, co-
operation, compared with competitive or individualistic ef-
forts, tends to result in more (D. W. Johnson & R. Johnson,
1989).

1. Willingness to take on difficult tasks and persist, despite dif-
ficulties, in working toward goal accomplishment.
2. Long-term retention of what is learned.
3. Higher-level reasoning (critical thinking) and metacognitive
thought. Cooperative efforts promote a greater use of higher-
level reasoning strategies and critical thinking than do com-
petitive or individualistic efforts (effect sizes = 0.93 and 0.97,
respectively). Even on writing assignments, students working
cooperatively show more higher-level thought.
4. Creative thinking (process gain). In cooperative groups,
members more frequently generate new ideas, strategies, and
solutions that they would think of on their own.
5. Transfer of learning from one situation to another (group to
individual transfer). What individuals learn in a group today,
they are able to do alone tomorrow.
6. Positive attitudes toward the tasks being completed (job satis-
faction). Cooperative efforts result in more positive attitudes
among the superiors in the organizational structure. Thus, individuals
are able to do alone tomorrow.
7. Time on task. Cooperators spend more time on task than do
competitors (effect size = 0.76) or students working individu-
ally (effect size = 1.17).

Kurt Lewin often stated, “I always found myself unable to
think as a single person.” Most efforts to achieve are a personal
but social process that requires individuals to cooperate and to
construkt shared understandings and knowledge. Both compet-
tive and individualistic structures, by isolating individuals from
each other, tend to depress achievement.

30.5.2 Positive Interpersonal Relationships

Heartpower is the strength of your corporation.
—Vince Lombardi (famous coach of the Green Bay Packers)

Since 1940, over 180 studies have compared the impact of
cooperative, competitive, and individualistic efforts on inter-
personal attraction (D. W. Johnson & R. Johnson, 1989). Cooper-
eative efforts, compared with competitive and individualistic
experiences, promoted considerably more liking among indi-
viduals (see Table 30.1). The effect sizes were higher for (a)
high-quality studies and (b) studies using pure operationaliza-
tions of cooperative learning than for studies using mixed oper-
ationalizations. These positive feelings were found to extend to
superiors in the organizational structure. Thus, individuals tend
to care more about each other and to be more committed to each other's success and well-being when they work together cooperatively than when they compete to see who is best or work independently from each other.

A major extension of social interdependence theory is social judgment theory, which focuses on relationships among diverse individuals (D. W. Johnson & R. Johnson, 1989). Cooperators tend to like each other not only when they are homogeneous, but also when they differ in intellectual ability, handicapping conditions, ethnic membership, social class, culture, and gender. Individuals working cooperatively tend to value heterogeneity and diversity more than do individuals working competitively or individualistically. The positive impact of heterogeneity results from a process of acceptance that includes frequent and accurate communication, accurate perspective taking, mutual inducibility (openness to influence), multidimensional views of each other, feelings of psychological acceptance and self-esteem, psychological success, and expectations of rewarding and productive future interaction.

Besides liking each other, cooperators give and receive considerable social support, both personally and academically (D. W. Johnson & R. Johnson). Since the 1940s, over 106 studies comparing the relative impact of cooperative, competitive, and individualistic efforts on social support have been conducted. Social support may be aimed at enhancing another person's success (task-related social support) or at providing support on a more personal level (personal social support). Cooperative experience promoted greater task-oriented and personal social support than did competitive (effect size = 0.62) or individualistic (effect size = 0.70) experiences. Social support tends to promote achievement and productivity, physical health, psychological health, and successful coping with stress and adversity.

30.5.2.1 Psychological Health. Ashley Montagu was fond of saying, "With few exceptions, the solitary animal is, in any species, an abnormal creature." Karen Horney said, "The neurotic individual is someone who is inappropriately competitive and, therefore, unable to cooperate with others." Montagu and Horney recognized that the essence of psychological health is the ability to develop and maintain cooperative relationships. Psychological health may be defined, therefore, as the ability to develop, maintain, and appropriately modify interdependent relationships with others to succeed in achieving goals (D. W. Johnson & R. Johnson, 1989). To manage social interdependence, individuals must correctly perceive whether interdependence exists and whether it is positive or negative, be motivated accordingly, and act in ways consistent with normative expectations for appropriate behavior within the situation. The major variables related to psychological health studied by researchers interested in social interdependence are psychological adjustment, self-esteem, perspective-taking ability, social skills, and a variety of related attitudes and values.

A number of studies have been conducted on the relationship between social interdependence and psychological health (D. W. Johnson & R. Johnson, 1989). Working cooperatively with peers and valuing cooperation results in greater psychological health than does competing with peers or working independently. **Cooperativeness** is positively related to a number of indexes of psychological health, such as emotional maturity, well-adjusted social relations, strong personal identity, ability to cope with adversity, social competencies, and basic trust in and optimism about people. Personal ego-strength, self-confidence, independence, and autonomy are all promoted by being involved in cooperative efforts. **Individualistic attitude** tend to be related to a number of indexes of psychological pathologies such as emotional immaturity, social maladjustment, delinquency, self-alienation, and self-rejection. **Competitiveness** is related to a mixture of healthy and unhealthy characteristics. Cooperative experiences are not a luxury, they are an absolute necessity for healthy psychological development.

Interested researchers have examined the relationship between social interdependence and self-esteem. Since the 1950s there have been over 80 studies comparing the relative impact of cooperative, competitive, and individualistic experiences on self-esteem (D. W. Johnson & R. Johnson, 1989). Cooperative experiences promoted higher self-esteem than did competitive (effect size = 0.58) or individualistic (effect size = 0.44) experiences. Our research demonstrated that cooperative experiences tend to be related to beliefs that one is intrinsically worthwhile, others see one in positive ways, one's attributes compare favorably with those of one's peers, and one is a capable, competent, and successful person. In cooperative efforts, students (a) realize that they are accurately known, accepted, and liked by one's peers, (b) know that they have contributed to own, others, and group success, and (c) perceive themselves and others in a differentiated and realistic way that allows for multidimensional comparisons based on complementarity of own and others' abilities. Competitive experiences tend to be related to conditional self-esteem based on whether one wins or loses. Individualistic experiences tend to be related to basic self-rejection.

Cooperative experiences tend to increase perspective-taking ability (the ability to understand how a situation appears to other people) while competitive and individualistic experiences tend to promote egocentrism (being unaware of other perspectives other than your own [effect sizes of 0.61 and 0.44, respectively] D. W. Johnson & R. Johnson, 1989). Individuals who are part of a cooperative effort learn more social skills and become more socially competent than do persons competing or working individually. Finally, it is through cooperative efforts that many of the attitudes and values essential to psychological health (such as self-efficacy) and learned and adopted.

30.5.2.2 Everything Affects Everything Else. Deutsch's (1985) crude law of social relations states that the characteristic processes and effects elicited by a given type of social interdependence also tends to elicit that type of social interdependence. Thus, positive interdependence elicits promoting interaction and promotive interaction tends to elicit positive interdependence. Deutsch's law may also be applied to the three types of outcomes resulting from cooperative experiences. The more individuals work together to achieve, the more caring and committed their relationships tend to be; the more individuals care about each other the harder they will work to achieve mutual goals. The more individuals work together to achieve, the greater their psychological adjustment, self-esteem, and social
competence; the healthier psychologically individuals are, the better able to they are to work with others to achieve mutual goals. The better individuals’ psychological health, the more caring and committed their relationships tend to be; the more caring and committed their relationships, the more healthy psychologically they tend to be. Because each outcome can induce the others, you are likely to find them together. They are a package, with each outcome a door into all three. Together they induce positive interdependence and promotive interaction.

The research outcomes noted occur only when the efforts are truly cooperative. Not all groups are cooperative groups. To be cooperative, five basic elements must be present in a group.

30.6 THE BASIC ELEMENTS OF COOPERATION

30.6.1 Potential Group Performance

Not all groups are cooperative (D. W. Johnson & F. Johnson, 2003). Placing people in the same room, seating them together, telling them they are a group, does not mean they will cooperate effectively. Project groups, lab groups, committees, task forces, departments, and councils are groups, but they are not necessarily cooperative. Many groups are ineffective and some are even destructive. Almost everyone has been part of a group that has wasted time and produced poor work. Ineffective and destructive groups are characterized by a number of dynamics (D. W. Johnson & F. Johnson) such as social loafing, free riding, group immaturity, uncritical and quick acceptance of members’ dominant response, and group think. Such hindering factors are eliminated by carefully structuring the five essential elements of cooperation. Those elements are positive interdependence, individual and group accountability, promotive interaction, appropriate use of social skills, and group processing.

30.6.2 Positive Interdependence: We Instead of Me

All for one and one for all.

—Alexander Dumas

The heart of cooperation is positive interdependence (see D. W. Johnson & R. Johnson, 1989, 1992a, 1992b). Positive interdependence exists when one perceives that one is linked with others in a way so that one cannot succeed unless they do (and vice versa) and/or that one must coordinate one’s efforts with the efforts of others to complete a task (Deutsch, 1962; D. W. Johnson & R. Johnson, 1989). There are two major categories of interdependence: outcome interdependence and means interdependence (D. W. Johnson & R. Johnson). When persons are in a cooperative or competitive situation, they are oriented toward a desired outcome, end state, goal, or reward. If there is no outcome interdependence (goal and reward interdependence), there is no cooperation or competition. In addition, the means through which the mutual goals or rewards are to be accomplished specify the actions required on the part of group members. Means interdependence includes resource, role, and task interdependence (which are overlapping and not independent from each other).

The authors have conducted a series of studies investigating the nature of positive interdependence and the relative power of the different types of positive interdependence (Frank, 1984; Hwong, Caswell, Johnson, & Johnson, 1995; D. W. Johnson, Johnson, Johnson, & Garibaldi, 1990; Johnson, Johnson, Or- tiz, & Stanne, 1991; Lew, Mesch, Johnson, & Johnson, 1986a, 1986b; Mesch, Lew, Johnson, & Johnson, 1986; Mesch, Johnson, & Johnson, 1988). Our research indicates that positive interdependence provides the context within which promotive interaction takes place, group membership and interpersonal interaction among students do not produce higher achievement unless positive interdependence is clearly structured, the combination of goal and reward interdependence increases achievement over goal interdependence alone, and resource interdependence does not increase achievement unless goal interdependence is present also.

30.6.3 Individual Accountability/Personal Responsibility

What children can do today, they can do alone tomorrow.

—Vygotsky (1978)

Using cooperative groups requires structuring group and individual accountability. Group accountability exists when the overall performance of the group is assessed and the results are given back to all group members to compare against a standard of performance. Individual accountability exists when the performance of each individual member is assessed, the results given back to the individual and the group to compare against a standard of performance, and the member is held responsible by groupmates for contributing his or her fair share to the group’s success. On the basis of the feedback received, (a) efforts to learn and contribute to groupmates’ learning can be recognized and celebrated, (b) immediate remediation can take place by providing any needed assistance or encouragement, and (c) groups can reassign responsibilities to avoid any redundant efforts by members.

The purpose of cooperative groups is to make each member a stronger individual in his or her own right. Individual accountability is the key to ensuring that learning cooperatively in fact strengthens all group members. There is a pattern to classroom learning. First, students learn knowledge, skills, strategies, or procedures in a cooperative group. Second, students apply the knowledge or perform the skill, strategy, or procedure alone to demonstrate their personal mastery of the material. Students learn it together and then perform it alone. Archer-Kaith, Johnson, and Johnson (1994) found that individual feedback resulted in greater achievement and perceptions of cooperation, goal interdependence, and resource interdependence than did group feedback. Hooper, Ward, Hannafin, & Clark (1989) found that cooperative technology-supported instruction resulted in higher achievement when individual accountability was structured than when it was not.
30.6.4 Promotive Interaction

In an industrial organization it’s the group effort that counts. There’s really no room for stars in an industrial organization. You need talented people, but they can’t do it alone. They have to have help.

—John F. Donnelly (President, Donnelly Mirrors)

Promotive interaction exists when individuals encourage and facilitate each other’s efforts to complete tasks in order to reach the group’s goals. Through promoting each other’s success, group members build both an academic and a personal support system for each member. Promotive interaction is characterized by individuals providing each other with efficient and effective help and assistance; exchanging needed resources such as information and materials and processing information more efficiently and effectively, providing each other with feedback in order to improve subsequent performance, challenging each other’s conclusions and reasoning in order to promote higher-quality decision making and greater insight into the problems being considered, advocating the exertion of effort to achieve mutual goals, influencing each other’s efforts to achieve the group’s goals, acting in trusting and trustworthy ways, being motivated to strive for mutual benefit, and having a moderate level of arousal characterized by low anxiety and stress.

Traditionally, promotive interaction was viewed as being face-to-face. Technology, through the use of local and wide area networks and mediating tools such as e-mail, electronic bulletin boards, conferencing systems that can include live video, and specialized groupware, enables individuals to promote each other’s success all across the world, in ways that were never possible before. Such electronic communication is growing exponentially, but it does not always substitute for face-to-face interaction. Face-to-face communication has a richness that electronic communication may never match (Prusak & Cohen, 2001).

There is evidence that up to 95% of people’s intent is conveyed by facial expression and tone of voice, with the most important channel being facial expression (Druckman, Rozelle, & Baxter, 1982; Meherabian, 1971). Harold Geneen, the former head of ITT, believed that his response to requests was different when they included multiple ways for students to promote each other’s success, both electronically and face to face whenever possible.

30.6.5 Interpersonal and Small Group Skills

I will pay more for the ability to deal with people than any other ability under the sun.

—John D. Rockefeller

Using cooperative learning requires group members to master the small group and interpersonal skills they need to work effectively with each other and as a part of a group. The greater the members’ teamwork skills, the higher will be the quality and quantity of their learning. Cooperative learning is inherently more complex than competitive or individualistic learning because students have to engage simultaneously in taskwork and teamwork. To coordinate efforts to achieve mutual goals, students must (a) get to know and trust each other, (b) communicate accurately and unambiguously, (c) accept and support each other, and (c) resolve conflicts constructively (D. W. Johnson, 1991, 2003; D. W. Johnson & F. Johnson, 2003).

The more socially skilled students are, and the more attention teachers pay to teaching and rewarding the use of social skills, the higher the achievement that can be expected within cooperative learning groups. In their studies on the long-term implementation of cooperative learning, Marvin Lew and Debra Mesch (Lew et al., 1986a, 1986b; Mesch et al., 1986, 1988) investigated the impact of a reward contingency for using social skills as well as positive interdependence and a contingency for academic achievement on performance within cooperative learning groups. In the cooperative skills conditions students were trained weekly in four social skills and each member of a cooperative group was given two bonus points toward the quiz grade if all group members were observed by the teacher to demonstrate three of four cooperative skills. The results indicated that the combination of positive interdependence, an academic contingency for high performance by all group members, and a social skills contingency promoted the highest achievement. Archer-Kath et al. (1994) found that individual feedback was more effective in teaching students social skills than was group feedback. Putnam, Rynders, Johnson, and Johnson (1989) demonstrated that, when individuals were taught social skills, were observed by their superior, and were given individual feedback as to how frequently they engaged in the skills, their relationships became more positive.

30.6.6 Group Processing

Take care of each other. Share your energies with the group. No one must feel alone, cut off, for that is when you do not make it.

—Wilf Unsoeld (renowned mountain climber)

Group processing occurs when members discuss how well they are achieving their goals and maintaining effective working relationships among members. Cooperative groups need to describe what member actions are helpful and unhelpful and make decisions about what behaviors to continue or change. The purposes of group processing are to clarify and improve the effectiveness of members in contributing to the cooperative efforts to achieve the group’s goals by (a) enabling
groups to improve continuously the quality of member's work, (b) facilitating the learning of teamwork skills, (c) ensuring that members receive feedback on their participation, and (d) enabling groups to focus on group maintenance (D. W. Johnson, 2003; D. W. Johnson et al., 1998a). Groups that process how effectively members are working together tend to achieve higher than do groups that do not process or individuals working alone, the combination of teacher and student processing resulted in greater problem-solving success than did the other cooperative conditions, and the combination of group and individual feedback resulted in higher achievement (Archer-Kath et al., 1994; D. W. Johnson et al., 1990; Yager, Johnson, & Johnson, 1985).

Group processing leads to self-monitoring and self-efficacy. Discussing the observations of members' actions results in (a) a heightened self-awareness of the effective and ineffective actions taken during the group meetings, (b) public commitment to increase the frequency of effective actions and decrease the frequency of ineffective actions, and (c) an increased sense of having the ability to be more effective if appropriate effort is exerted (i.e., self-efficacy). Sarason and Potter (1985) examined the impact of individual self-monitoring of thoughts on self-efficacy and successful performance and found that having individuals focus their attention on self-efficacious thoughts is related to greater task persistence and less cognitive interference. They concluded that the more that people are aware of what they are experiencing, the more aware they will be of their own role in determining their success. The greater the sense of self and joint efficacy promoted by group processing, the more productive and effective group members and the group as a whole become.

Effective processing focuses group members on positive rather than negative behaviors. Sarason and Potter (1985) found that when individuals monitored their stressful experiences they were more likely to perceive a program as having been more stressful than did those who did not, when individuals monitored their positive experiences they were more likely to perceive the group experience as involving less psychological demands, were more attracted to the group and had greater motivation to remain members, and felt less strained during the experience and more prepared for future group experiences. When individuals are anxious about being successful and are then told that they have failed, their performance tends to decrease significantly, but when individuals anxious about being successful are told that they have succeeded, their performance tends to increase significantly (Turk & Sarason, 1985).

### 30.7 THE COOPERATIVE SCHOOL

The new electronic tools are radically changing the way people access and use information and, therefore, have profound implications for the educational process. Education, on the other hand, is stuck with organizational patterns and professional traditions that negate many of the advantages of the new technologies. For technology to be fully utilized in schools, the organizational structure of the school has to change, as well as the organizational structure of the classroom. To utilize the new technologies most effectively, schools need to change from a mass-manufacturing organizational structure to a team-based, high-performance organizational structure. This new organizational structure is created when cooperative learning is used the majority of the time in the classroom and cooperation is used to structure faculty and staff work in (a) collegial teaching teams, (b) school-based decision making, and (c) faculty meetings (D. W. Johnson & R. Johnson, 1994).

Just as the heart of the classroom is cooperative learning, the heart of the school is collegial teaching teams. Collegial teaching teams are small cooperative groups in which members work to improve continuously each other's (a) instructional expertise and success in general and (b) expertise in using cooperative learning in specific. Administrators may also be organized into collegial support groups to increase their administrative expertise and success.

School-based decision making may be structured through the use of two types of cooperative teams. A task force considers a school problem and proposes a solution to the faculty as a whole. The faculty is then divided into ad hoc decision-making groups and considers whether to accept or modify the proposal. The decisions made by the ad hoc groups are summarized, and the entire faculty then decides on the action to be taken to solve the problem.

Faculty meetings represent a microcosm of what administrators think the school should be. The clearest modeling of cooperative procedures in the school may be in faculty meetings and other meetings structured by the school administration. All four types of cooperative learning (formal, informal, base groups, and controversy) may be used in faculty meetings to increase their productivity, build faculty cohesion, and improve the faculty's social competence.

Technological innovation lags in schools. A key obstacle to the use of technology in schools is the limited support teachers have for integrating unfamiliar technologies into instruction. Just as students group together to learn cooperatively how to use new software or hardware, teachers need to group together to learn how to use the new technologies and then how to integrate them into the instruction. As long as each teacher works in isolation from his or her peers, the implementation of technology represents a personal decision on the part of each teacher, rather than an organizational change at the school and district levels. Many teachers are unfamiliar with the new technologies and feel unable to master them. To implement technology fully, the organizational structure of the school has to change from the old mass-manufacturing organizational structure to a team-based, high-performance organizational structure where teams of teachers can explore the new technologies, learn how to use them, and implement them together.

### 30.8 COOPERATIVE LEARNING AND TECHNOLOGY-SUPPORTED INSTRUCTION

To enhance learning, technology must promote cooperation among students and create a shared experience. Crook (1996) has widely analyzed how computers can facilitate collaborative learning in schools. He makes a distinction between:
1. Interacting around computers. The first perspective stresses the use of computers as tools to facilitate face-to-face communication between student pairs or in a small group. Crook (1996, pp. 189–193) states that technology may serve to support cooperation by providing students with points of shared reference. He states that the traditional classroom does not have enough available anchor points at which action and attention can be coordinated. The capabilities of computers can be used as mediating tools that help students to focus their attention on mutually shared objects.

2. Interacting through computers. This refers to the use of networks. Local area networks (LAN) and wide area networks (WAN) and the global version of the latter (Internet) provide education with a variety of mediating tools for cooperation (email, electronic bulletin boards, conferencing systems, and specialized groupware).

30.8.1 Interacting Around Computers

30.8.1.1 Single-User Programs Reapplied to Cooperative Learning. Many computer programs were developed to tailor learning situations to individual students. Field experiments, however, indicate several advantages of the importance of cooperation among students in using these programs (Crook, 1994; Hawkins et al., 1982). The technical extension of the tradition LOGO (Papert, 1980) to legoLOGO, where Lego bricks robots can be controlled by LOGO programs has been an especially promising tool for creating cooperation among students (e.g., Erat, 1995; Jarvela, 1996). Cooperative learning has been promoted by many different program types, such as databases, spreadsheets, math programs, programming languages, simulations, multimedia authoring tools, and so forth (Amigues & Agostinelli, 1992; Brush, 1997; Erat, 1995; Lehtinen & Repo. 1996).

30.8.1.2 Programs Developed To Promote Cooperation. For cooperation to take place, students must have a joint workspace. One of the promises of the computer is to allow students to create shared spaces. Instead of sharing a blackboard or a worktable, students can share a computer screen. Such groupware (aimed at supporting group rather than individual work) has expanded dramatically the past ten years. Numerous programs in a variety of subject areas have been developed to externalize the problem-solving process by displaying the student’s solution or learning paths on the screen, and they generally tend to be helpful for both individual reflection and cooperative problem solving (Lehtinen, Hamalainen, & Malkonen, 1998). The ways in which technology and cooperative learning have been integrated are so numerous that even a small fraction cannot be mentioned. Some of the more widely used methods of computer-supported cooperative learning (CSCL) are CSILE, the Belvedere System, and CoVis.

CSILE (Computer-Supported Intentional Learning Environment) was originally developed in the late 1980s (Scardamalia, Bereiter, McLearn, Swallow, & Woodruff, 1989) and uses a network to help students build, articulate, explore, and structure knowledge. The system contains tools for text and chart processing and a communal database for producing, searching, classifying, and linking knowledge. The Belvedere system was developed by Lesgold, Weiner, and Suthers (1995) and it focuses and prompts students’ cognitive activity by giving them a graphical language to express the steps of hypothesizing, data gathering, and weighing of information. CoVis (Learning Through Collaborative Visualization Project) focuses on cooperative project work in high-school science (Pea, Edelson, & Gomez, 1994), with advanced networking technologies, collaborative software, and visualization tools to enable students and others to work together in classrooms and across the country at the same time (synchronously) or at different times (asynchronously). These and many other groupware systems are providing new and powerful opportunities for cooperative learning.

30.8.2 Cooperation Through Computers

There has been a rapid expansion of computer network technology that allows students all over the world to create powerful shared spaces on the computer screen. The future of technology-supported cooperative learning may depend on the software and hardware that creates workspaces that network group members and groups throughout the world. Networking has had a strong influence on the tools and methods of technology-supported cooperative learning. In a network-based environment, students and teachers can interact through the computer free of the limitations of time and place. The speed at which asynchronous and distance communication may be completed opens new opportunities for cooperative learning. It makes more intensive cooperative possible with the out-of-school experts, brings students from different schools into contact with each other, and creates powerful tools for joint writing and knowledge sharing. There are, however, different levels at which the network environment supports cooperation. From a series of studies, Bonk and King (1995) concluded that networks can (a) change the way students and instructors interact, (b) enhance cooperative learning opportunities, (c) facilitate class discussion, and (d) move writing from solitary to more active, social learning. The network tools include the following.

1. Local Area Network-Based Client-Server Systems. There are many software programs based on local area networks and client-server architecture, such as CSILE, the Belvedere System, and CoVis.

2. E-Mail for Cooperative Learning. E-mail is used to deliver information to students, supervise students, and support national and international communication between cooperative learning groups and schools located far away from each other. With the help of mailing lists, groups of students can use e-mail to share joint documents and comment on each other’s work.

3. The Internet and World Wide Web and Cooperative Learning. Internet-based conferencing systems and e-mail systems are very similar. Computer conferencing has existed since the first computer networks but has only recently been
30. Cooperation and Technology

30.3. Outcomes of technology-supported cooperative learning

Implementing technology as part of cooperative learning. Web-based cooperative learning is time independent and location independent, thus allowing a combination of synchronous and asynchronous discussions. It is similar to e-mail lists but, in addition, has user-control, document structures, shared databases, and interaction styles that make it especially effective for cooperative work (Bates, 1995; Harasim et al., 1995; Malikowski, 1998). Creating and using shared databases is especially helpful for network-based cooperative-learning systems. On the World Wide Web, conferencing may require "threading" (the ability to sequentially read the messages that make up one discussion). Woolley (1995) listed about 150 internet conferencing systems. It is now possible to have live video of individuals and groups conferencing with each other.

Adding technology to a lesson inherently increases the lesson's complexity. When students participate in technology-supported instruction, they have the dual tasks of (a) learning how to use the technology (i.e., the hardware and software required by the lesson) and (b) mastering the information, skills, procedures, and processes being presented within the technology. When cooperative learning groups are used, students have the additional task of learning teamwork procedures and skills. Consequently, the initial use of technology-supported cooperative learning may take more time, but once students and teachers master the new systems, the results will be worth the effort. Technology-supported cooperative learning tends to be cost effective way of teaching students how to use technology. In addition, increasing academic achievement, giving learners control over their learning, creating positive attitudes toward technology-based instruction and cooperative learning, promoting cognitive development, and increasing social skills. Computers themselves promote cooperative interaction among learners. The composition of the group and the gender of the learners are factors that have been hypothesized to affect the success of technology-supported cooperative learning (see Fig. 30.3).

30.8.3 Achievement

30.8.3.1 Academic Achievement. Two large metaanalysis on the effectiveness of computer-assisted instruction concluded that the use of technology markedly improved learning outcomes (e.g., Fletcher-Finn & Gravatt, 1999; Khalili & Shashazani, 1994). These metaanalysis, however, did not differentiate among
teaching practices and the ways technology was implemented in classrooms. It is not possible, therefore, to draw any conclusions about the effectiveness of technology-supported cooperative learning from these metaanalyses.

We conducted several studies examining the use of cooperative, competitive, and individualistic learning activities at the computer. (D. W. Johnson, Johnson, & Stanne, 1989; D. W. Johnson et al., 1990; R. Johnson, Johnson, & Stanne, 1985, 1986; R. Johnson, Johnson, Stanne, Smizak, & Avon, 1987; Johnson, Johnson, Richards, 1986). The studies included eighth-grade students through college freshmen and lasted from 3 to 30 instructional hr. The tasks were a computerized navigational and map reading problem-solving task and word processing assignments. Computer-assisted cooperative learning, compared with competitive and individualistic efforts at the computer, promoted (a) a higher quantity of daily achievement, (b) a higher quality of daily achievement, (c) greater mastery of factual information, (d) greater ability to apply one’s factual knowledge in test questions requiring application of facts, (e) greater ability to use factual information to answer problem-solving questions, and (f) greater success in problem solving. Cooperation at the computer promoted greater motivation to persist on problem-solving tasks. Students in the cooperative condition were more successful in operating computer programs. In terms of oral participation, students in the cooperative condition, compared with students in the competitive and individualistic conditions, made fewer statements to the teacher and more to each other. Made more task-oriented statements and fewer social statements, and generally engaged in more positive, task-oriented interaction with each other (especially when the social skill responsibilities were specified and group processing was conducted). Finally, the studies provided evidence that females were perceived to be of higher status in the cooperative than in the competitive or individualistic conditions.

In addition to our work, there are a number of studies that have found that students using a combination of cooperative learning and computer-based instruction learn better than do students using computer-based instruction while working individually (Anderson, Mayes, & Kirby, 1995; Cockayne, 1991; Cox & Berger, 1985; Dalton, 1990a, 1990b; Dalton, Hannefin, & Hooper, 1987; Dees, 1991; Hooper, 1992b; Hooper, Tenny, & Williams, 1993; Hybecker et al., 1985; Inkpen, Booth, Klawe, & Upitis, 1995; Lin, Wu, & Liu, 1999; Love, 1969; McInerney, McInerney, & Marsh, 1979; Mevarech, 1983, 1987; Mevarech, Silber, & Fine, 1991; Mevarech, Stern, & Levita, Okey & Majer, 1970; Postthast, 1995; Replin, 1990; Repman, 1993; Rocklin et al., 1985; Sleetzer, 1990; Stephenson, 1992; Underwood, McCaffrey, 1990; Webb, 1984; Whitecloud, Scallon, Taylor, & O’Shea, 1995; Yeuh & Alessi, 1988). There are also a number of studies that found no statistically significant differences in achievement between subjects who worked in groups and subjects who worked alone (Carrier & Sates, 1987; Conden & English, 1987; Hooper & Hampafin, 1988; Trowbridge & Durnin, 1984). No study has reported significantly greater learning when students work alone. Many of these studies, however, are short-term experiments focused on a small number of students. Several experiments provide evidence that well-known CSDL programs like CSIE and Belvedere have proved to be helpful for higher-order social interaction and, subsequently, for better learning in terms of deep understanding (Scardamalia, Bereiter, & Lamon, 1994; Suthers, 1998). It is still lacking is evidence that the same results could be found in normal classrooms. There are CSDL projects like CoVis that are widely implemented (Pez, Edelson, & Gopmez, 1994), but there have been few well-controlled follow-up evaluations published.

Simon Hooper and his colleagues have conducted a series of studies on technology-supported cooperative learning involving fifth through eighth grade and college students (Dyer, 1993; Hooper, 1991; Hooper & Hannafin, 1988, 1991; Hooper et al., 1989, Huang, 1993; McDonald, 1993). They found that (a) cooperative group members achieved significantly higher than did students working under individualistic conditions, (b) cooperative learning groups in which individual accountability was care fully structured achieved higher than did cooperative learning groups in which no individual accountability was structured, (c) the achievement of low-ability students in heterogeneous cooperative groups was consistently higher than the achievement of low-ability students in homogeneous groups, (c) there was a positive and significant correlation between achievement and helping behaviors, and increases in achievement and cooperation were significantly related within heterogeneous groups, and (d) cooperative (compared with individualistic) learning resulted in greater willingness to learn the material, options selection, time on task, perceived interdependence, and supportiveness for partners. Carlson and Falk (1989) and Noell and Car nine (1989) found that students in cooperative groups perform higher than students working alone on learning tasks involving interactive videodiscs. Adams, Carlson, and Hamm (1999) suggest that cooperative learning can influence motivation, achievement, and when students use the medium of television.

Fletcher (1985), on the other hand, investigating cognitive facilitation, found on a computer task calling for solving equations in an earth space game that individuals who were told to verbalize their decisions did as well in problem-solving performance on the game as groups told to come to consensus (both of which had results superior to those of individuals working silently). King (1989) asked groups of fourth graders to reproduce a stimulus design using LOGO computer graphics after they had watched a videotape modeling of “think aloud problem solving.” The groups were instructed to think aloud as they performed their task. More successful groups asked more task-related questions, spent more time on strategy, and reached higher levels of strategy elaboration than did groups who were less successful on the task.

30.8.3.2 Learning How to Use Technology. Cooperative learning may reduce hardware and software problems that interfere with achievement when students work alone (Hativa, 1988). Students naturally form groups when learning how to use a new technology or software program (Becker, 1984). In his description of the implementation of the Apple Classrooms of Tomorrow, Dwyer (1994) notes that the cooperative, task-related interaction among students was spontaneous and more extensive than in traditional classrooms, with students interacting with one another while working at computers, spontaneously...
helping each other, showing curiosity about each other's activities, wanting to share what they had just learned to do, working together to build multimedia presentations about diverse topics, and combining their group's work into whole class, interdisciplinary projects.

When technology-supported lessons require new, complex procedures (such as learner-controlled lessons), cooperative learning tends to promote quicker and more thorough mastery of the procedures than competitive or individualistic learning. Trowbridge and Dunnin (1984) found that students working in groups of two or three seemed more likely to interpret program questions as the authors of the materials intended. Discussions of multiple interpretations tended to converge on the correct interpretation. Hooper (1992a) reported that students were frustrated and could not master the computer-assisted, learner-controlled lesson when they worked alone. Keeler and Anson (1995) used cooperative learning in a software application lab course and found that both students' performance and their retention were significantly improved. Dyer (1995) compared structured cooperative pairs, unstructured cooperative pairs, and individuals working alone to solve computer-assisted math problem solving lessons. Structured cooperative pairs communicated more frequently and used the computer more efficiently when they learned in cooperative groups. Students studying alone had greater difficulty reading and understanding lesson directions, used the help option more often, and spent more time interacting with the tutorial than did the unstructured cooperative pairs or the students in the individualistic condition. McDonald (1993) found that students in the learner-controlled/cooperative learning condition selected more options during the lesson and spent more time interacting with the tutorial than did the learner-controlled/individual learning condition. Hooper et al. (1993) found that cooperative learning established a mutually supportive learning environment among group members in which both cognitive difficulties and navigational disorientation were overcome in using the computer to complete a symbolic-reasoning task. Students studying alone had greater difficulty reading and understanding lesson directions, used the help option more often, and required more attempts to master embedded quizzes than did students in cooperative learning groups. In learning how to use computers, Webb (1984) and Webb et al. (1986) found that in cooperative groups, explaining how to do computer programming was not related to skill in doing so and receiving explanations influenced only the learning of basic commands (not the interpretation of programs or the ability to generate programs). Generally, this evidence indicates that students will learn how to use hardware and software more quickly and effectively when they learn in cooperative groups rather than alone. When teachers wish to introduce new technology and new software programs of some complexity, they will be well advised to use cooperative learning.

30.8.4 Cognitive and Social Development

30.8.4.1 Cognitive Development: Cooperation and Controversy. Social-cognitive theory posits that cognitive development is facilitated by (Bearison, 1982; D. W. Johnson & R. Johnson, 1979, 1995; Perret-Clermont, 1980) (a) individuals working cooperatively with peers on tasks that require coordination of actions or thoughts, (b) cooperators contradicting and challenging each other's intuitively derived concepts and points of view (i.e., engaging in academic controversy), thereby creating cognitive conflict within and among group members, and (c) the successful and equitable (members contributing approximately equally) resolution of those conflicts (learners have to go beyond mere disagreement to benefit from cognitive conflict, [Bearison, Magzament, & Filardi, 1986; Damon & Killen, 1982]). To create the conditions under which cognitive development takes place, students must work cooperatively, challenge each other's points of view, and resolve the resulting cognitive conflicts. Clements and Nastasi conducted a series of studies on the occurrence of cooperation and controversy in technology-supported instruction (Battista & Clements, 1986; Clements & Nastasi, 1985, 1988; Nastasi & Clements, 1992; Nastasi, Clements, & Battista, 1990). They have found that both LOGO and CAI/CBI-W computer environments promoted considerable cooperative work and conflict (both social and cognitive). The LOGO environment (compared to CAI/CBI-W computer and traditional classroom tasks environments) promoted (a) more peer interaction focused on learning and problem solving, (b) self-directed problem solving (i.e., learners solve problems they themselves have posed) in which there is mutual "ownership" of the problem, (c) more frequent occurrence and resolution of cognitive conflicts, (d) greater development of executive-level problem-solving skills (planning, monitoring, decision making), higher-level reasoning, and cognitive development. The development of higher-level cognitive processes seemed to be facilitated by the resolution of cognitive conflict that arises out of cooperating. They also found that the LOGO (compared with the CAI) computer environment resulted in more learner satisfaction and expressions of pleasure at the discovery of new information and their work, variables reflective of intrinsic and competence motivation.

More recently, Bell (2001) has developed a software program to create arguments to be used in discussions with other students (the SenseMaker argumentation tool). It is designed to support a rhetorical construction of arguments by individuals by connecting evidence dots with claim frames. The intent is to teach students the nature of scientific inquiry by coordinating emerging evidence with an existing set of theories. The use of SenseMaker to develop arguments to be used in an academic controversy could significantly advance students' level of reasoning and learning.

30.8.4.2 Learner Control. Combining cooperative learning and technology-supported instruction results in students having more control over their learning. Hooper and his associates (Hooper, 1992a; Hooper et al., 1993) note that three forms of lesson control are used in the design of technology-based instruction: learner, program, and adaptive control. Learner control involves delegating instructional decisions to learners so that they can determine what help they need, what difficulty level or content density of material they wish to study, in what sequence they wish to learn the material, and how much they want to learn. Learner-controlled environments include simulations, hypermedia, and online databases. Program or linear control prescribes an identical instructional sequence for all students regardless of interest or need. Adaptive control modifies
lesson features according to student aptitude (e.g., Snow, 1980), prior performance (e.g., Tobias, 1987), or ongoing lesson needs (e.g., Tennyson, Christensen, & Park, 1984). Linear or program control may impose an inappropriate lesson sequence on learners and thereby lower their motivation, and adaptive instruction may foster learner dependence (Hannafin & Bieber, 1989). As learner control increases so does (a) instructional effectiveness and efficiency (Reigeluth & Stein, 1985) and (b) learner independence, efficiency, mental effort, and motivation (Federico, 1980; Salomon, 1983, 1985; Steinberg, 1984).

Technology-supported cooperative learning tends to increase the effectiveness of learner control. When students work alone, in isolation from their peers, they tend not to control the learning situation productively, making ineffective instructional decisions and leaving instruction prematurely (Carrier, 1984; Hannafin, 1984; Milheim & Martin, 1991; Steinberg, 1977, 1989). Students working cooperatively tend to motivate each other to seek elaborative feedback to their responses to practice items during learning control and to seek a greater variety of feedback types more frequently than did those working alone (Carrier & Sales, 1987). Cooperative pairs spent longer times inspecting information on the computer screen as they discussed which level of feedback they needed and the answers to practice items. Students in the learner-controlled/cooperative learning condition selected more options during the lesson, and spent more time interacting with the tutorial, than did students in the learner-controlled/individual learning condition (McDonald, 1993). Hooper et al. (1993) found that students in the program-control conditions attempted more than four times as many examples and nearly twice as many practice questions as did those working alone (Carrier & Sales, 1987). Cooperative pairs spent longer times inspecting information on the computer screen as they discussed which level of feedback they needed and the answers to practice items. Students in the learner-controlled/cooperative learning condition selected more options during the lesson, and spent more time interacting with the tutorial, than did students in the learner-controlled/individual learning condition (McDonald, 1993). Hooper et al. (1993) found that students in the program-control conditions attempted more than four times as many examples and nearly twice as many practice questions as did those working alone (Carrier & Sales, 1987). Cooperative pairs spent longer times inspecting information on the computer screen as they discussed which level of feedback they needed and the answers to practice items. Students in the learner-controlled/cooperative learning condition selected more options during the lesson, and spent more time interacting with the tutorial, than did students in the learner-controlled/individual learning condition (McDonald, 1993). Hooper et al. (1993) found that students in the program-control conditions attempted more than four times as many examples and nearly twice as many practice questions as did those working alone (Carrier & Sales, 1987).

30.8.4.4 Increasing Social Competencies. If students are to work effectively in cooperative groups they must have the teamwork skills to do so. To examine the importance of social skills training on the productiveness of cooperative groups, it is possible to compare studies that have included cooperative skills training and those that have not. Numerous studies on technology-supported cooperative learning have demonstrated positive effects on the amount and quality of social interaction (e.g., Amigues & Agostinelli, 1992; Crook, 1994; Davis & Huttenlocher, 1995; Fishman & Gomez, 1997; McConnell, 1994; Rysavy & Sales, 1991). A number of studies have found that when teamwork procedures and skills are present, cooperative learning results in higher achievement in technology-supported instructional lessons than individualistic learning (Hooper & Hannafin, 1991; Hooper & Hannafin, 1988, 1991; R. Johnson et al., 1985, 1986; Susman, 1998). In studies where teamwork procedures and skills were not emphasized, reliable differences in achievement in cooperative and individualistic technology-assisted instruction tend not to be found (Mevarech et al., 1987; Hooper et al., 1989; Susman, 1998; Underwood & McCaffrey, 1990).

Software designers may be able to facilitate the development of the interpersonal and small group skills required for teamwork in several ways.

1. Before students engage in the actual instruction, they might first be required to complete a tutorial activity designed to introduce or refresh their understanding of cooperative skills. This could include a discussion of each member’s role and its value in determining the overall group success.

2. Teachers’ guides could suggest roles to assign to each group member to perform in the group (keyboarder, recorder, checker for understanding, encourager of participation).

3. Time for group processing to analyze and discuss how effectively they are working together and how they might work together more effectively in the future could be provided. Software could be designed to include pauses during which group members are directed to focus on their progress, discuss the records they are keeping, or reflect on improvements or changes they might make to increase performance.

4. The software could periodically remind students to monitor their own performance and to assist in optimizing group performance.

5. Yeuh and Alessi (1988) suggest that group reward is crucial to provide a group goal motivating everyone to work well together and individual accountability is needed to create a feeling of fairness among group members. Tangible prizes are recognition for individual successes and for group achievement offers motivation to succeed on both levels. One computer-generated reward would be a printout of collective characters, coupons, or certificates that are assigned points or a relative value or are valued based on the number accumulated. These items could be displayed by students where they would be acknowledged by the teacher and other classmates.

30.8.5 Attitudes

30.8.5.1 Attitudes Toward Technology-Based Instruction. Students are more likely to learn from and to use technology-based instruction in the future when their self-efficacy toward technology and attitudes about technology-based instruction are positive. Sutton (1991) found that students developed more positive attitudes toward the computer-based instructional lesson and learning with a computer when they worked in cooperative learning groups than when they worked individually (Hooper et al., 1993; Huang, 1993; McDonald, 1993). Students tend to enjoy using the computer to engage in cooperative activities.

30.8.5.2 Attitudes Toward Cooperative Learning. Mevarech et al. (1985) found that students who learned in pairs were more positive in their attitudes toward cooperative
learning than were students who worked individually with the computer. Evaluations obtained by Rocklin et al. (1985) from students involved in computer-based cooperative learning were more positive toward cooperative learning and how it affected them personally than were subjects who worked individually. Hooper et al. (1993) found that students working in cooperative pairs developed more positive attitudes toward cooperative learning than did students working alone, that is, students rated cooperative learning in a computer-assisted lesson almost a point higher on a 5-point scale than did students who worked alone. A number of studies found that students in the structured cooperative learning conditions developed more positive attitudes toward working cooperatively than did students in the unstructured cooperative learning or the individualistic learning condition (Dyer, 1993; Hooper et al., 1993; Huang, 1993; McDonald, 1993).

30.8.5.3 Preference for Using Technology Cooperatively. There is a natural partnership between technology and cooperation. The introduction of computers into classrooms tends to increase cooperative behavior and task-oriented verbal interaction (Chernick & White, 1981, 1983; Hawkins et al., 1982; Levin & Kareev, 1980; Rubin, 1983; Webb, 1984). Individuals prefer to work cooperatively at the computer (Hawkins et al., 1982; Levin & Kareev, 1980; Muller & Perlmuter, 1985). Students are more likely to seek each other out at the computer than they normally would for other schoolwork. Even when students play electronic games they prefer to have partners and associates. Working at a computer cooperatively with classmates seems to be more fun and enjoyable as well as more effective for most students.

30.8.6 Individual Differences

30.8.6.1 Group Composition. A factor hypothesized to affect the success of technology-supported cooperative learning is whether members of cooperative groups are homogeneous or heterogeneous. There is considerable disagreement as to which is the most effective composition. Advocates of heterogeneous grouping point out that (a) students are more likely to gain sophistication and preparation for life in a heterogeneous society by working cooperatively with classmates from diverse cultures, attitudes, and perspectives, (b) high-achieving students benefit from the cognitive restructuring that occurs when providing in-depth explanations to peers, and (c) less academically successful students benefit from the extra attention, alternative knowledge representations, and modeling that more academically successful students provide (D. W. Johnson & R. Johnson, 1989; Webb, 1989). Students in heterogeneous ability groups tend to learn more than students in homogeneous ability groups (Yager, Johnson, & Johnson, 1985; Yager, Johnson, Johnson, & Snider, 1986). Beane and Lemke (1971) found that high ability students benefited more from heterogeneous than homogeneous grouping. The academic discussion and peer interaction in heterogeneous (compared with homogeneous) groups promoted the discovery of more effective reasoning strategies (Johnson & Johnson, 1979; Berndt, Perry, & Miller, 1988).

Proponents of homogeneous ability grouping, however, state that heterogeneous ability grouping may fail to challenge high-ability students (Willis, 1990) and that less academically successful students benefit at the expense of their more successful partners (Milis & Durden, 1992; Robinson, 1990). Many of the most carefully conducted studies aimed at resolving this controversy have been focused on ability grouping in technologically-assisted instruction. In a week-long study on the learning of LOGO, Webb (1984) investigated whether the higher-ability students in cooperative groups of three would try to monopolize the computer. She found that (a) student ability did not relate to contact time with the computer and (b) student success in programming was predicted by different profiles of abilities and by group process variables such as verbal interaction. Yeuh and Alessi (1988) used group ability composition as one of their treatments for students utilizing the computer to learn three topics in algebra. They formed groups of medium-ability students and groups of mixed-ability students and found that group composition had no significant effect on achievement. Hooper and Hannafin (1988), in a study with 40 eighth-grade students, found that on a computer task low ability students working with high-ability partners achieved higher than did low ability students studying in homogeneous groups or alone, without lowering the achievement of high-ability students. In a subsequent study involving 125 sixth- and seventh-grade students, Hooper and Hannafin (1991) randomly assigned students to homogeneous or heterogeneous pairs, and pairs to cooperative or individualistic conditions. High-ability students interacted equally across treatments, but low-ability students interacted 30% more when placed in heterogeneous pairs. Students in the heterogeneous groups achieved and cooperated significantly more than did students in the homogeneous pairs (or the individualistic condition).

Simsek and Hooper (1992) compared the effects of cooperative and individual learning on student performance and attitudes during interactive videodisc instruction. Thirty fifth- and sixth-grade students were classified as high or low ability and randomly assigned to cooperative or individual treatments. Students completed a level II interactive video disc science lesson. The achievement, attitudes, and time on task of high- and low-ability students working alone or in cooperative groups were compared. Results indicated that both high- and low-ability students performed better on the posttest when they learned in cooperative groups than did their counterparts who learned alone. Students who worked individually spent less time on task. Members of cooperative groups developed more positive attitudes toward instruction, teamwork, and peers than did students studying alone.

Simsek and Tsai (1992) compared the effects of homogeneous versus heterogeneous ability grouping on performance and attitudes of students working cooperatively during interactive videodisc instruction. After two cooperative training sessions, 80 fourth- through sixth-grade students, classified as high and low ability, were randomly assigned to treatments. Students completed a level II interactive video disc science lesson. The amount of instructional time for each group was also recorded. Homogeneous low-ability groups scored significantly lower than the other three groups, while the difference in
achievement of high-ability students in homogeneous versus heterogeneous groups was not statistically significant. Homogeneous low-ability groups consistently used the least amount of time. Low-ability students in heterogeneous groups had significantly more positive attitudes than did their high-ability group-mates.

Hooper (1992b) compared individual and cooperative learning in an investigation of the effects of ability grouping on achievement, instructional efficacy, and discourse during computer-based mathematics instruction. A total of 115 fifth- and sixth-grade students were classified as having high or average ability and were randomly assigned to group or individual treatments. Students in the cooperative condition were assigned to either heterogeneous or homogeneous dyads, according to ability. Results indicated that students completed the instruction more effectively in groups than alone. In groups, achievement and efficiency were highest for high-ability homogeneously grouped students and lowest for average-ability homogeneously grouped students. Generating and receiving help were significant predictors of achievement, and average-ability students generated and received significantly more help in heterogeneous groups than in homogeneous ones.

Hooper et al. (1993) compared cooperative and individualistic learning on academically high- and low-performing students. They classified 175 fourth-grade students as high or average-low-performing academically and randomly assigned them to pairs or individualistic conditions by performance level. Performance level was determined by scores on the mathematics subscale of the California Achievement Test. All cooperative pairs consisted of one high- and one low-average-low-performing student. They found that the students in the cooperative conditions performed higher on a computer-assisted symbolic reasoning task than did the students in the individualistic conditions. The greatest beneficiaries from the group learning experience appeared to be the highest-performing students. Overall achievement increased by almost 20% for high-ability students but only 4% for average-ability students. High-ability students may have benefited from generating explanations of their less able partners and less able partners might have adopted more passive roles. Mulryan (1992) found that the highest-achieving students adopted the more active roles in cooperative learning groups and the least able students demonstrated high levels of passive behavior, a pattern that, according to Webb (1989), further increases the achievement of the passive students.

The results of these studies indicate that cooperative learning may be used effectively with both homogeneous and heterogeneous groups, but that the greatest educational benefits may be derived when heterogeneous groups work with technology-supported instruction. In heterogeneous cooperative learning groups, low-average-ability students increased their achievement considerably and high-average-ability students generally either increased their achievement or achieved at the same level as did their counterparts in homogeneously high groups.

30.8.6.2 Gender. The gender of group members has been hypothesized to be an important factor in determining the success of technology-supported cooperative learning. D. W. Johnson, Johnson, Richards, and Buckman (1986) found that computer-assisted cooperative learning, compared with competitive and individualistic computer-assisted learning, increased the positivity of female students’ attitudes toward computers, equalized the status and respect among group members regardless of gender, and resulted in a more equal participation pattern between male and female members. Whereas females in cooperative groups liked working with the computer more than males did, there was no significant difference in oral interactions between males and females. Dalton et al. (1987) examined interactions between instructional method and gender and found that cooperative learning was rated more favorably by low-average-ability females than by low-average-ability males. Other studies noted no significant differences in performance between males and females in computer-based instruction cooperative learning settings (Mevarech et al., 1987; Webb, 1984). Carrier and Sales (1987) compared female pairs, male pairs, and mixed pairs among college juniors and noted that female pairs verbalized the most, whereas male pairs verbalized the least, and that male–female pairs demonstrated the most off-task behavior. Lee (1995) found that males tended to become more verbally active and females tended to become less verbally active in equal-ratio, mixed-gender groups.

A study that looked at mixed-gender groups versus single-gender groups was done by Underwood and McCaffrey (1990) in England. Two classes of students between 10.5 and 11.4 years of age from a single school participated in the study. The 40 females and 40 males were randomly assigned to male/male, female/female, or male/female pairs. The study was divided into three sessions. The first session had the subjects working individually. In the second session subjects worked in pairs. The third session also involved pairs, but subjects who were in mixed pairs were shifted to single-gender pairs and single-gender pairs were assigned to mixed pairs. The subjects worked with a computer program in language tasks that required them to place missing letters into text. The results showed that single-gender pairs completed more stories and had more correct responses than did mixed-gender pairs. When subjects were shifted from single-gender pairs to mixed-gender pairs, their level of activity decreased but there was no change in their overall performance. The study found no overall differences for gender on any of the measures. No cooperative training was given and mixed pairs rarely discussed their answers. Rather, one subject operated the keyboard and the other gave directions.

Overall, there is mixed evidence concerning the impact of technology-supported instruction on males and females. A conservative interpretation of the existing research is that there will be no performance differences between males and females on technology-supported cooperative learning, but females will have more positive attitudes toward using technology when they learn in cooperative groups.

30.8.7 Relationships: Networking into Teams

Technology such as electronic mail, bulletin boards, and conferencing can be used to create teams of individuals who are widely separated geographically. In an electronically networked team,
interaction no longer has to be face-to-face, team members can be anywhere in the world. Meetings require only that members be at their terminals. Communication between meetings can be asynchronous and extremely fast in comparison with telephone conversations and interoffice mail. Participation may be more equalized and less affected by prestige and status (McGuire, Kiesler, & Siegel, 1987; Siegel, Dubrovsky, Kiesler, & McGuire, 1986). The egalitarian "network" structures may coexist with substantial hierarchy and centralization in patterns of communication.

Electronic communications influence interaction style and work flow. The use of electronic mail compared to telephones, for example, enables workers to control the pace of their response and thus facilitates multitasking. Digital conferencing may make employees less riskaverse and render group decision making less predictable, more time-consuming, and more egalitarian (Sproull & Kiesler, 1991; Wellman et al. 1996). Whether these effects on decision making enhance organizational performance or will continue as the technologies develop and change is uncertain in part because they depend on the specific ways in which the technological systems are designed and implemented (O'Mahony & Barley, 1999; Sproull & Kiesler, 1991).

Electronic communication, however, relies almost entirely on plain text for conveying messages, text that is often ephemeral, appearing on and disappearing from a screen without any necessary tangible artifacts. It becomes easy for a sender to be out of touch with his or her audience. And it is easy for the sender to be less constrained by conventional norms and rules for behavior in composing messages. Communicators can feel a greater sense of anonymity, detect less individuality in others, feel less empathy, feel less guilt, be less concerned over how they compare with others, and be less influenced by social conventions (Kiesler, Siegel, & McGuire, 1984; Short, Williams, & Christie, 1976). Such influences can lead both to more honesty and more "flaming" (name calling and epithets).

Hara, Bonk, and Angeli and his associates (2000) conducted a content analysis of online discussions. They examined participation rates, interaction patterns, social cues within student messages, cognitive and metacognitive components, and depth of processing. They concluded that messages became more lengthy and cognitively deeper over time. The messages were also embedded with peer references, became more interactive over time, and were thus indicative of a student-oriented environment.

### 30.8.8 Other Factors

#### 30.8.8.1 Cost Effectiveness

The use of cooperative learning increases the cost effectiveness of technology. Although the range of technology that could be used in schools is increasing yearly (Hancock & Betts, 1994), the cost of adopting new technologies is an inhibiting factor to its use. Ensuring that every student is provided with the latest technology is beyond the financial resources of most school districts. Giving each cooperative learning group access to the latest technology is much more cost effective. An historical example is the adoption of computers by schools. By having groups work at computers (instead of individuals) schools were able to reduce significantly the cost of obtaining and maintaining computers (Johnson & Johnson, 1985; Wizer, 1987).

#### 30.8.8.2 Innovation in Groupware and Hardware

In creating joint workspaces for team members to work together, and in creating hardware and communication networks that facilitate teamwork, considerable innovation has taken, is taking, and will take place. The promise of the current technology is that in the future, more effective, efficient, and productive ways of teaming will be created through technology.

Of special interest for technology-supported cooperative learning is the use of self-powered, palm-sized computers and low-cost, high-bandwidth wireless communications. Just as computers made communication asynchronous, these mobile innovations make communication independent of place. The ability to communicate with anyone at anytime and anywhere geometrically increases the possibilities of technology-supported cooperative learning. And the widespread use of such technologies will undoubtedly inspire even more effective ways to use hardware and software to enhance human cooperation. Both students and teachers, furthermore, benefit from high-bandwidth, as it allows various technologies (i.e., high-quality video, sophisticated teleconferencing, and Internet-based communication and assessment tools) to converge and be delivered together, thereby providing richer content and stimulating cooperative interaction.

### 30.9 Questions About Technology-Supported Cooperative Learning

Given the powerful effects of cooperation on achievement, relationships, and psychological health, and given the numerous advantages of using technology-supported cooperative learning, there are a number of questions about the use of technology that may tentatively be answered. First, Does technology effect achievement or is it merely a means of delivering instruction? In a review of research, Clark (1983) concluded that technology is merely a means of delivering instruction. There are cognitive consequences of discussing what one is learning with classmates that technology may not be able to duplicate. The extent to which social interaction is essential for effective learning, the transformation of the mind, and the development of expertise is unclear.

Second, Is a "dialogue with a computer" as effective in promoting achievement, higher-level reasoning, and ability to apply learning as a dialogue with a peer? The answer is probably no. It takes more than the presentation of information to have a dialogue. There needs to be an exchange of knowledge that leads to epistemic conflict and intellectual challenge and curiosity. Such an exchange is personal as well as informational. It involves respect for and belief in each other's abilities and commitment to each other's learning. Our results and the results of other researchers indicate that a dialogue with a peer is far more powerful than one with a computer.
Third, Can a computer pass as a person? The answer, again, is probably no. A person interacts quite differently with a computer than he or she does with another person. Machines and people are not equally interesting or persuasive. With other people there is a commitment to their learning and well-being. It is rare to feel the same emotions toward a machine.

Fourth, Is the effectiveness of a message separate from the medium? Generally, the research on cognitive development indicates that the same information, presented in other formats (especially nonsocial formats) is only marginally effective in promoting genuine cognitive development (Murray, 1983; D. W. Johnson, 2003).

Fifth, Is technology an amplifier or a transformer of the mind? An amplifier serves a tool function like note taking or measuring. A transformer leads to the discovery and invention of principles. If technological learning devices are transformers, the habitual technology users eventually will be in a new stage of mental functioning. Postman (1985) believes that the introduction into a culture of a technique such as writing or a clock is not merely an extension of humans’ power to record information or bind time but a transformation of their way of thinking and the content of human culture. Generally, therefore, it may be concluded that technology such as the computer is a tool to amplify the minds of students. As a tool, the computer (as well as the calculator) can free students from the rote memorization of methods of mathematical formulation and formula-driven science, allowing more time for underlying concepts to be integrated with physical examples. A danger of the computer is that student will know what button to push to get the right answer without understanding the underlying process or development of principles. If technological learning devices are transformers, the habitual technology users eventually will be in a new stage of mental functioning.

Finally, Can technology such as computers prepare a student for the "real world"? Technological expertise is helpful in finding and holding a job. Working in a modern organization, however, requires team skills such as leadership and conflict management and the ability to engage in interpersonal problem solving. Although it is clear that cooperative learning is an analogue to modern organizational life, experience in using technology in and of itself may only marginally improve employability and job success. A person has to have interpersonal competence as well as technical competence.

30.10 THE FUTURE OF TECHNOLOGY-SUPPORTED COOPERATIVE LEARNING

The interdependence between the use of technology-supported instruction and cooperative learning is relatively unexplored. Technologies can either facilitate or obstruct cooperation. The ways in which technology may enhance or interfere with cooperative efforts have not been conceptualized, placed in a theoretical framework, researched, and applied in classrooms. Cooperative learning has a well-formulated theory validated by hundreds of research studies, translated into a set of practical procedures that teachers and administrators may use, and actually implemented in tens of thousands of classrooms throughout the world. Technology is transforming the way in which work and communication are conducted. Despite the success of cooperative learning and technology, there are a number of shortcomings of the work on technology-supported cooperative learning.

First, there is a lack of theorizing. If technology-supported cooperative learning is to continue to develop, it needs to become more articulate about the theories that underlie its use. Currently, social interdependence theory is the most clearly spelled out theoretical base for cooperative learning, but the way in which technology provides unique opportunities for cooperation have not been tied to social interdependence theory. John Dewey has been widely quoted, but his work does not provide a precise theory on which to base either cooperative learning or technology-supported instruction. The same may be said for Vygotsky. Conceptual models of how technology and teamwork may be productively integrated are practically nonexistent. The variables unique to the combination of technology and cooperation have not been identified and defined. Two theoretical perspectives are needed that can be contrasted and compared in research studies. The field needs such rivalry to develop.

Second, relatively little research has been done. Overall, the quality of the existing research is quite high. Only a few of the potential outcomes, however, have been studied. There are many gaps in the research on technology-supported cooperative learning. The unique strengths of technology-supported cooperative learning have not been assessed and documented. The impact of technology-based cooperative learning on relationships among students (especially in face-to-face and non-face-to-face situations and among diverse individuals) has not been studied. The specific ways that use of technology affects various aspects of psychological health (such as social adjustment, personal happiness, self-esteem, anxiety levels, social competencies, and ability to cope with stress and diversity) is largely unknown. Almost all of the research that has been conducted has focused on the effectiveness of technology-based computer instruction or specific software programs without testing theory. In the future, theoretically oriented research needs to be conducted.

Third, the lack of conceptual models and the scarcity of research have created a corresponding lack of operational procedures for practice. Operational procedures are needed for designing and implementing instructional procedures that optimize the impact of technology-supported cooperative learning. Equivalent procedures need to be designed for work environments where technology and teamwork are used together. Once the operational procedures are clarified, decisions about training teachers and students can be made. Teachers can be trained to implement cooperative learning, but training in the specific procedures for implementing technology-supported cooperative learning is underdeveloped. The nature and amount of training students need to work together cooperatively while utilizing technology are largely unknown. Whereas the social skills required to cooperate have been clear for some time (D. W. Johnson, 1991, 2003; D. W. Johnson & E. Johnson, 2003),
the social skills required to utilize technology cooperatively have generally been ignored. More needs to be known about the skills students need to maximize the constructiveness of technology-supported cooperative learning.

In addition to using validated theory to operationalize teacher and student procedures, new software development should be more closely tied to validated theory. Effective cooperation depends on the existence of five basic elements (positive interdependence, individual accountability, promotive interaction, appropriate use of social skills, and group processing) in operational procedures (D. W. Johnson & Johnson, 1989). Whereas there are many groupware programs, the extent to which groupware incorporates the five basic elements of cooperation has not been discussed or researched, and whether there are other elements essential to technology-supported cooperative learning programs has not been determined by research. Attention to ensuring that the groupware developed is based on social interdependence theory as well as on technology hardware and software potentialities is needed.

In summary, what is needed is a theory to stimulate research that, in turn, will validate and modify the theory. The results need to be used to design specific procedures for operationalizing technology-supported cooperative learning at every grade level and in every subject area. Groupware needs to be tied more closely to theory. Without this combination of theory, research, and operational procedures and software, proponents of technology-supported cooperative learning cannot present a persuasive case for adoption or an effective training program for teachers. On the positive side, there has been so little research on technology-supported cooperative learning that the future is wide open to interested social scientists.

There are, however, several areas on which researchers can focus. First, there is a need for long-term studies that track the use of technology-supported cooperative learning across at least 1 school year and, ideally, several years. Short-term studies of initial use are not enough. The real question is whether the use of technology-supported cooperative learning will be maintained over several years.

Second, the critical factors that result in technology and cooperative learning enhancing each other need to be identified and researched. One important factor may be epistemic conflict, that is, the collision of adverse opinion. Cognitive growth and the development of problem-solving skills depend on epistemic conflict (D. W. Johnson & R. Johnson, 1979, 1995; Piaget, 1950). Students need the opportunity to experience and resolve academic controversies. Technology rarely engages students in intellectual conflict the same way other students can. The role of technology in promoting and facilitating intellectual conflicts among students has not been thoroughly investigated.

Third, there is a question whether technology-supported instruction will increase inequality in educational outcomes (Becker & Sterling, 1987). Students who have access to the new technologies in their homes will be more skilled and sophisticated in their uses than will students who do not. Equality in the classroom may require heterogeneous grouping where students who are skilled in the use of instructional technologies work with students who are not. Cooperative learning is an essential aspect of such equalization. New studies need to be conducted on group composition focusing on the ability of students to use instructional technologies.

Fourth, the implementation process by which technology-supported cooperative learning is institutionalized within schools needs to be documented and studied. Whereas advocates of technology see a revolution coming in instruction, historians point to the virtual absence of lasting or profound changes in classroom practice over the past 100 years. Despite brief periods of popularity, new instructional technologies such as educational television, language laboratories, and programmed learning were tried and dropped. Life in classrooms remains largely unchanged. Lepper and Gurtner (1989) argue that the last "technology" to have had a major impact on the way schools are run is the blackboard. Most often new technologies are used in ways that do not disrupt regular classroom practices, which means that they can be dropped with no disruption to ongoing classroom life. Similarly, software selection is often conducted with the intention of supporting existing classroom practices rather than transforming them. Considerably more research is needed on the implementation process by which the combination of cooperative learning and learning technologies becomes integrated and institutionalized in classroom and schools.

Fifth, studies need to focus on the role of teachers and administrators in the implementation process. No matter how good technology is, unless teachers decide to use it and gain some expertise in how to implement it, the technology will not be adopted by schools.

Sixth, studies need to examine the support services required for technology to be used in the classroom. Who repairs the technology and how often repairs are needed are important questions. Teachers, for example, cannot be expected to be computer technicians. As the quantity of research on technology-supported cooperative learning has grown, so has the networking among interested social scientists and educators. In 1996 an international conference on computer-supported cooperative learning took place, followed by similar conferences in Toronto in 1997, at Stanford University in 1999, in The Netherlands in 2001, and in Boulder, Colorado, in 2002. Conferences such as these are helpful in advancing the development of relevant theory, research, and operational procedures and software.

30.11 SUMMARY

We live in a networked, information-based society in which teams and technology are needed to manage the complexity of learning, work, and living. Schools have become a strategic place. For education to develop the technological and teamwork competencies of children, adolescents, and young adults, if must overcome the individualistic assumption historically connected with technology-supported instruction and utilize cooperative learning as an inherent part of instruction. The individual assumption is that instruction should be tailored to each student’s personal aptitude, learning style, personality characteristics, motivation, and needs. Computers were originally viewed as an important tool for providing individualized learning experiences. The difficulties and shortcomings of individualizing
instruction call into question the wisdom of focusing technology on delivering individualized instruction. Technology may be more productively used when it is used in combination with cooperation learning.

Cooperative learning is the instructional use of small groups so that students work together to maximize their own and each other’s learning. There are four types of cooperative learning—formal cooperative learning, informal cooperative learning, base groups, and academic controversies.

Technology-supported cooperative learning exists when the instructional use of technology is combined with the use of cooperative learning groups. What underlies cooperative learning’s worldwide use is that it is based on a well-formulated theory that has been validated by numerous research studies and operationalized into practical procedures that can be used at any level of education. The three theoretical perspectives that have contributed to cooperative learning are cognitive-developmental theory, behavioral learning theory, and social interdependence theory. The latter has had the most profound influence on the development of cooperative learning. Between 1898 and 1989, over 550 experimental and 100 correlational studies were conducted comparing the relative effectiveness of cooperative, competitive, and individualistic efforts. Generally, cooperative efforts result in higher achievement, more positive relationships, and greater psychological health than do competitive or individualistic efforts. Not all groups, however, are cooperative groups. To be a cooperative group, five basic elements must be structured within the learning situation—positive interdependence, promotive interaction, individual accountability, social skills, and group processing. For schools to adopt technology and maintain its use over time, the school organizational structure must change from a mass-manufacturing structure to a team-based, high-performance structure (which is known as the cooperative school).

There is a growing body of research on technology-supported cooperative learning. The results indicate that compared with technology-supported instruction, cooperative learning tends to increase achievement (both academic achievement and learning how to use technology), promote positive attitudes (toward technology and cooperation), promote development (cognitive development, learning control, social competencies), promote positive relationships with team members, promote positive effects on both high and low-performing students and both male and female students, be cost effective, and promote innovation in groupware and hardware. What this research illuminates is that cooperative learning and technology-supported instruction have complementary strengths. The more technology is used to teach, the more necessary cooperative learning is. The computer, for example, can control the flow of work, monitor accuracy, give electronic feedback, and do calculations. Cooperative learning provides a sense of belonging, the opportunity to explain and summarize what is being learned, social models, respect and approval for efforts to achieve, encouragement of divergent thinking, and interpersonal feedback on academic learning and the use of the technology.

A number of questions must be asked about technology-supported instruction. Does technology affect achievement, or is it only a means for delivering instruction? Current evidence indicates that computers deliver instruction but they do not effect achievement in and of themselves. Is a dialogue with the computer as effective as a dialogue with another person in promoting achievement and higher-level reasoning? The answer seems to be no. Can the computer pass as a person? The answer seems to be no. Cooperators are people, not machines. Is the effectiveness of a message separate from the medium? The answer seems to be yes, messages from other people are more powerful and influential than are messages from machines. Is technology an amplifier or a transformer of the mind? The answer seems to be yes, messages from other people are more powerful and influential than are messages from machines.

The future of technology-supported cooperative learning depends largely on the cycle of theory–research–practice. The unique opportunities of technology-supported cooperative learning need to be tied to social interdependence theory (or another theory underlying cooperative learning), research needs to be conducted to validate or disconfirm the theoretical predictions, and operational procedures and groupware need to be developed directly based on the validated theory.

Finally, technologies can either facilitate or obstruct cooperation. The ways in which technology may enhance or interfere with cooperative efforts have not been conceptualized, placed in a theoretical framework, researched, and applied in classrooms. Despite the success of cooperative learning and technology, there are a number of shortcomings of the work on technology-supported cooperative learning. Among other issues, long-term studies of the use of technology-supported cooperative learning are needed, the role of factors that enhance or interfere with cooperation (such as epistemic conflict) need to be studied, the impact of implementation on equality of opportunity needs to be researched, and the role of the teacher and support services needed to be investigated.

Few educational innovations hold the promise that technology-supported cooperative learning does. The combination of cooperation and technology has a potential that is changing the way courses are being delivered and instruction is taking place. More theorizing, research, and refinement of practice is needed to help the field actualize its possibilities.

References


30. Cooperation and Technology


