



The Impact of Collaborative, Scaffolded Learning in K-12 Schools: A Meta-Analysis

The Metiri Group

Author:

Susan M. Williams, the Metiri Group. Commissioned by Cisco Systems.

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Executive Summary

Although Americans view themselves as a nation of self-sufficient individuals, in reality much of the work they do is accomplished in collaboration with others. With the advent of technology and Web 2.0 tools, such collaboration has dramatically increased and is accomplished online. Outside of school, learning new tasks often comes about by working collaboratively with more experienced peers. In contrast, learning in school has traditionally been an individual activity, where collaborating is considered “cheating.” And, since many Web 2.0 collaboration tools are currently banned from K-12 schools, online collaboration is not typically used to augment K-12 learning. As a result, students are underprepared to work as part of a team when they graduate from high school.

Recently state and national policy leaders have begun to call for a greater emphasis on teaching students in K-12 schools about teaming and collaboration. The rationale for this new direction is two-fold, to increase and deepen learning, and to prepare students to be collaborative team members in work environments that are increasingly dependent on virtual, online collaborations.

The most recent comprehensive reviews of research to date on collaboration were conducted in the late 1990s. Those reviews consistently reported findings that collaboration was a more effective learning strategy than traditional, didactic teaching. The current study is a meta-analysis of the experimental research on collaboration for the period 1999-2009. Two research questions guided this review.

1. How does collaborative learning affect student achievement when compared with traditional didactic instruction? Do outcomes vary for simple versus complex tasks?
2. How does the presence of scaffolds to support collaborative student learning affect student achievement as compared to collaborative learning without the scaffolds? Do outcomes vary for simple versus complex tasks?

This review indicates that overall there is a moderately positive result on achievement for collaborative learning when compared with teacher-directed, whole-class learning ($ES = +.29$). The complexity of the tasks that students solve during collaborative learning has a considerable effect on students' achievement. Complex problems may be too difficult for a group of students to solve successfully. Scaffolds such as the help of teachers, tools such as computer simulations or visualizations, and prompts that structure the problem solving process may be needed! The effect of scaffolds on students' achievement was moderate to large for students working collaboratively on complex tasks ($ES = +.489$) when compared with students working collaboratively without the support of scaffolds on the same problems. Scaffolds were less important for students solving simple problems ($ES = +.225$). This research is consistent with previous meta-analyses demonstrating the positive effect of collaborative learning over whole-class teacher-directed instruction.

Background

In the 1980s, Dr. Geert Hofstede, a research psychologist working at IBM, interviewed employees in IBM offices in 50 countries to learn how culture affects values in the workplace. He found the United States to be the most individualistic country in the world on a continuum of individualism to collectivism. Americans were most likely to believe in self-reliance and to have loose bonds with others in the workplace.² In a more recent international study, American professionals were more likely to prefer working alone than workers in other countries.³

Everyday Realities of the Workplace

Despite a preference for working alone, research shows that much of the work people do is accomplished in collaboration with others and that workers are likely to be more successful when they collaborate.

Research on real-world scientists also indicates that breakthroughs are often a result of intensive collaboration.⁴ One scientist may frame the problem, a second and third may add facts, and a fourth might develop a way to combine the facts to solve the problem. For example, in early 2003 the SARS virus spread rapidly until it was realized that it had become a global crisis. At this point 11 laboratories in 9 countries collaborated to control its spread. Connected by a network and shared website as well as constant emails and teleconferences, the labs shared data in real-time and within one month this collaboration had identified the pathogen and sequenced its DNA.⁵ In another example of how workplace collaboration supports breakthroughs, the superintendent of Rio Tinto's Australian mining operation was having difficulty with a multi-million dollar bulldozer whose brakes were failing intermittently. After working for over a year on the bulldozer, he posted the problem on the company's web forum and received an immediate solution from an engineer in California who had had the same problem.⁵

Employers rank teamwork/collaboration as one of the three most important applied skills. A detailed survey of 431 human resource managers in 2006, revealed that teamwork/collaboration ranked behind only professionalism and work ethic as the skills most important for new entrants to the workplace regardless of their educational level.⁶ Human resources (HR) managers ranked applied skills such as teamwork/collaboration and critical thinking as more important than basic skills such as reading comprehension and writing.

In another study demonstrating the importance of collaboration in business, Frost & Sullivan³ surveyed 946 decision makers from companies of various sizes in the U.S., Europe, and Asia about the extent of collaboration in their companies and the ability of the companies infrastructures to support collaboration. The surveys were used to create a collaboration index for each company. Collaboration was found to be the most important indicator of a company's overall performance.

Tony Wagner, co-director of the Harvard School of Education's Change Leadership Group, emphasizes the way technology has had a profound impact on how workers collaborate with one another.⁷ Technology allows the formation of virtual teams. Workers from around the world living in different time zones and coming from different cultures work together on the same project. Although not in the same office, they meet frequently using conference calls and web-based meetings. Business leaders interviewed by Wagner indicated that skill in developing relationships and negotiating virtual collaborations is becoming essential for the growing number of multinational organizations.

In the workplace, collaboration is the ability to build cooperative relationships with colleagues and customers and be able to work with diverse teams to negotiate and manage conflicts.

Learning in the Workplace

In January 2008, the median number of years that wage and salary workers had been at their current jobs was 4.1.⁸ If this finding stays constant, a worker is likely to have 7–10 jobs during his or her lifetime. When beginning a new job, a worker must acquire new knowledge and learn new skills. Sometimes this involves formal classes that look much like school. Sometimes it involves on the job training through an apprenticeship. Traditionally, an apprentice or intern joins a company and starts out in a job that is necessary but peripheral to the central focus of the company. For example, an apprentice tailor might start out by sewing on buttons and, by observation, imitation, practice, and feedback, gradually learn the skills necessary to become a master tailor. Working with colleagues who are more proficient allows an apprentice to observe and get the feedback necessary to learn and improve. Much of what people learn on the job is accomplished by observing more experienced colleagues and applying what they learn to real tasks that are valued by their employers.⁹ While in the past, the novice worker might learn only from experts located in the same office or factory, technology makes it possible to learn over the Internet from colleagues in many locations. In addition, employees can go to their company's knowledge center, online databases of FAQs (frequently asked questions), to learn information that may not be related to a formal course, but is needed to solve a current problem.¹⁰

Learning in School

A major difference between learning in the workplace and in school is that learning in school has traditionally focused on individual work.¹¹ In most classrooms, students interact with each other during the course of the day, but they are assessed individually. Important learning activities, such as homework or in-class exercises, are typically done alone. There is little connection between one student's success or failure and the success or failure of other students.

Attempts to address this disconnect between what is learned in school and what is needed in the workplace began as early as the 1896 opening of Dewey's Laboratory School in Chicago. Dewey's classrooms represented small communities with students working on practical projects with everyone helping each other.¹² More recently, the release of the SCANs report¹³ identified interpersonal skills/participating as a member of a team as one of five essential skills that students need for work in the 21st Century. For the past decade, there has been increased emphasis on collaboration and other 21st Century Skills by numerous organizations that advocate and support the teaching of these skills in K-12 classrooms.^{14,15}

New Theories of Knowing

A changing conception of the very nature of what it means to know and to learn is also driving interest in collaborative learning. The traditional view of knowledge is that it is something to be acquired. In this theory, the "mind is a container of knowledge and learning is a process that fills the container."¹⁶ Individuals accumulate concepts that are transmitted to them through books or by teachers. Knowledge is a property of the individual mind and learning is the acquisition or construction of this property.

More recently, theorists have begun to think about learning as the process of developing the ability to participate in the culture and activities of a community. The emphasis is on the process (learning), in addition to the outcome (academic achievement). There is a growing recognition that knowledge cannot be separated from context; it is integral to the relationships among people and situations.

If learning is a process of growing in the ability to participate in a community, then collaboration and learning to collaborate is an essential activity for school. Students (much like the previously mentioned apprentice tailors) take part in activities to the extent that they are able, observing and receiving feedback from those with more expertise (the teacher or more advanced students).¹⁷

Benefits and Disadvantages of Collaboration

Researchers studying collaboration list many benefits of students working together including increased achievement, engagement, and pro-school attitudes. There are several reasons that collaborative learning benefits achievement. For example, students working in groups can be introduced to new ideas that conflict with their own understanding. This can lead them to seek new information to clarify the conflict or to attempt to explain and justify their own position. Both of these outcomes can lead to learning. In addition, students working together can generate new approaches to solving problems that none of them knew prior to working together. Individuals then adopt these approaches to use in future problem solving. Finally, students also benefit by giving and receiving help. Giving help requires the giver to clarify and reorganize their understanding, helping him or her to understand the material better. Receiving help may fill in gaps in the receiver's understanding or help them clarify misconceptions. Receiving help from peers increases the quality of the feedback available to students.¹⁸⁻²¹

Technology can add the flexibility of time and space as students collaborate with anyone at any time and place. Although learners often state that they miss face-to-face interaction during online learning, to date, research indicates that there is no significant difference in achievement between online learning and traditional learning.²² In addition to convenience, there is emerging evidence that computer supported collaborative learning benefits students in the development of higher order thinking skills, student satisfaction, and increased productivity!

Researchers have also found that working in collaborative groups sometimes benefits motivation, although the reason for this is not well understood. It is thought that students praise and encourage each other's efforts and that this leads to increased motivation and effort.^{20,23} Motivation may also be increased, when rewards and recognition are offered to groups who succeed in their work.²⁴

Working in groups can have considerable drawbacks for learning as well. Many students do not know how to work together and must have good models and instruction for the process. The status of individuals within a group can make some students consistent leaders and others always followers. The person whose ideas are respected in general may not be the person with the best understanding of the problem to be solved. Collaborative learning must also be organized in ways that tap diversity as a positive resource and counteract classroom stereotypes.²⁵

There is some research indicating the problem solving of collaborative groups is superior to that of individuals working alone. Teachers must take care to understand what individual students are learning. Working together to produce a single product can advance each member's understanding of a problem, or it can mask the lack of understanding of some.^{18,25}

Designing Collaborative Learning Environments

Many states and national standards include recommendations for the use of collaborative learning; however, designing effective classroom collaboration is a complex task. Teachers need to understand how peer interaction promotes learning in order to make decisions about group size, the use of rewards, or what kinds of tasks to assign.²⁶ Not only do teachers or curriculum designers need to understand collaborative learning techniques and how to select one that is appropriate for their goals, they also need to coordinate activities in order to design effective learning environments.¹⁷

Selecting the appropriate learning tasks to use for collaborative learning is one of the critical choices that a teacher makes. Many of the learning tasks that are assigned to pupils are not cognitively challenging and not structured for group work.²⁷

Cohen distinguishes between tasks that are inherently individual tasks and those that are more appropriate for groups.²⁸ Group tasks require knowledge, skills, and resources that no single individual is likely to possess. Solving such problems alone is either impossible or very difficult. Techniques for collaborative learning that support complex problem solving are likely to be less structured than those that focus on rehearsal and practice of basic skills.²⁶

Simple knowledge acquisition tasks such as memorization of lists require less effort and may be less interesting than complex tasks. Some highly structured forms of collaborative learning, which help students learn strategies for memorization, are very useful for simple tasks. Other forms of collaborative learning may be less useful for such simple tasks.²⁶

As the goals for schooling change, in particular the need for students to learn to solve more complex problems and think critically, there is a need for understanding the interaction of collaborative learning and task complexity.

When working in groups, students may work on a variety of tasks. Some tasks may be ill structured and open; others may be highly structured and closed. Cohen's²⁸ review of small group learning found that groups were not productive when tasks were closed with only one fixed answer to the question; groups were more productive when tasks were open to multiple perspectives and solutions. Cohen argued that in the former case, extended group discussions may not be necessary; whereas in the latter case, open exchange and elaborated discussion are necessary to facilitate conceptual learning through cognitive dissonance and elaboration.²⁹

Scaffolds for Collaborative Learning

Complex problems that are too difficult for a single student to solve make the process of collaboration necessary and authentic. They may also introduce complexity that may be beyond the ability of students to handle without assistance from an expert. Furthermore, a substantial amount of research shows that productive collaboration does not often happen when learners are left to their own devices, without the provision of support structures or scaffolds.³⁰

The concept of scaffolding was introduced by Woods, Bruner, and Ross³¹ to describe a situation in which a more knowledgeable person helps a learner to accomplish something that would otherwise be outside their reach. In recent decades, the concept has become increasingly important as theorists consider the idea of learning as participation in a community.³² Students are assisted by their teachers or by a more able peer when they are unable to continue.

More recently, research has focused on how tools, in particular technological tools, can assist students.³³ Such tools can reduce the effort required of learners and allow them to focus on specific parts of tasks, e.g., word processors with spell checkers allow students to focus on the content and structure of their writing without taking time to check spelling. Visualization tools such as weather maps can assist students in seeing patterns and gaining a deeper understanding of processes. Software can also focus students on parts of the problem or the process that they might have missed. In this way, scaffolds not only allow learners to solve problems, but also increase what is learned from their problem solving. Whereas the original intent of scaffolds was to temporarily provide assistance in a task, to be removed as learners became more expert in the task, today many of the technological and visualization scaffolds are intended to be intellectual partners to be continually tapped.

“Generic tools such as e-mail, file attachments, electronic bulletin boards, chat, blogs, wikis, digital audio and videoconferencing systems, asynchronous/synchronous communication tools of Web-based Instructional Management Systems, and virtual learning environments. These tools are not only widely used for business or educational delivery of information purposes, but are also used to support online collaboration. There are an increasing number of tools and online environments emerging that are especially designed with affordances to support collaborative learning or knowledge building.”¹”

Technology can also facilitate collaboration by helping groups to structure and monitor their joint progress through the use of tools such as online agendas and organizational charts. Students from different locations can work together over the Internet using software tools to jointly construct shared documents, illustrations, or presentations. They can be connected to remote experts and resources that are not available locally.

Systematic Review of Research on Collaborative Learning

The literature base for collaborative learning is large and varied. Previous meta-analyses have retrieved from 600 to over 4000 studies depending on the criteria included for inclusion. In 1991, almost 20 years ago, Johnson, Johnson, & Smith wrote

During the past 90 years, more than 600 studies have been conducted by a wide variety of researchers in different decades with different age subjects, in different subject areas, and in different environments. We know far more about the efficacy of cooperative learning than we know about lecturing... or almost any other facet of education.³⁴

Numerous meta-analyses and reviews of the literature on collaborative learning have been conducted: Some focus on a particular technique and are often conducted by the originators of this technique.^{19,35-38} Some meta-analyses compare different techniques³⁹ while others investigate the combination of collaborative learning with technology.^{1,29} Most focus on the effect of collaboration on achievement but some focus on social and behavioral outcomes.⁴⁰ Some summarize research on all populations, while others look at specific groups or content areas.⁴¹⁻⁴³ The methodology and the results of these reviews are varied, but, in general, they show a positive effect for collaborative learning over more traditional, didactic approaches.

Although theorists have suggested that the level of complexity of the learning task may influence the degree to which collaboration effects learning outcomes,^{26,28,44} there have been no systematic analyses to date of research that studies such differences. Likewise research on the use of scaffolds used to guide student collaboration in support of learning, has not been systematically reviewed. This review seeks to fill those gaps. It utilizes a systematic search of the literature to answer the following questions:

1. How does collaborative learning affect student achievement when compared with traditional, didactic instruction? Do outcomes vary for simple versus complex tasks?
2. How does the presence of scaffolds to support collaborative student learning affect student achievement as compared to collaborative learning without the scaffolds? Do outcomes vary for simple versus complex tasks?

Methodology

This meta-analysis examines the effect of collaborative learning on student achievement and student engagement at the elementary and secondary level. Two groups of studies were identified and analyzed independently to answer the 2 research questions. Analysis 1, which addressed the first research question, included studies comparing student's academic outcomes where students were grouped for learning with those where students were not grouped. Analysis 2, which addressed the second research question, included studies about collaborative learning in which students received, scaffolds compared to the same collaborative learning approach without scaffolds. The procedures employed to conduct this investigation of both of the 2 research questions are outlined below.

Literature Search

The studies used in this meta-analysis were located through a comprehensive search of the literature. Electronic searches were performed on ERIC (Education Resources Information Center), Education Full Text (Wilson), and Proquest Dissertations and Theses. As each database uses a different indexing method and vocabulary, exact terms varied. List of search terms were compiled in three different categories: intervention, population, and outcome. For example, ERIC search lists included 14 terms for collaboration (e.g., collaborative learning, cooperative learning, peer tutoring, etc.), 20 terms for population (e.g., middle school, elementary school, secondary school, first grade, etc.), and 13 terms for outcomes (e.g., academic achievement, student outcomes, grades (scholastic), etc.). Each of these terms was combined systematically so that all possible combinations of all terms were searched. This resulted in citations and abstracts being retrieved for 1852 studies. These articles were then analyzed to determine if they were eligible for this study as outlined in the following section.

Inclusion/Exclusion Criteria

To be eligible for this analysis, a study met all of the following criteria:

1. Research was conducted with students at the elementary or secondary level.
2. Studies were conducted in a school classroom setting.
3. The study compared some form of collaborative learning with traditional learning; or it compared variations of the same form of collaborative learning where one was used scaffolds, and the other did not.
4. Studies described the learning procedures and the assessment tasks in sufficient detail to be coded in our analysis.
5. Studies were either experimental or quasi-experimental in design.
6. Studies included achievement as a dependent variable.
7. The minimum group size was 2 and the maximum size was 10.
8. Outcomes were reported for both treatment group(s) and control groups.
9. Studies did not involve students with learning disabilities or students classified as gifted except where these students were included with other students in a regular or "mainstreamed" classroom setting.
10. Sufficient data were reported so that effect sizes could be calculated for the comparisons of interest.
11. The research was published in 1999 or later.

The use of technology to support collaboration was not an explicit requirement for inclusion; however, included studies were coded to indicate their use of technology or their use of instructional activities that could be enhanced by the use of technologies. For example, in one included study, students interacting over a network to construct a concept map were compared to those working face-to-face at the same computer. In another, students collaborating on a research project and using Internet materials were compared to those in a traditional classroom without access to the Internet.

Each of the 1852 retrieved studies was analyzed in three phases to determine if they met these criteria. In the first phase, only the citation and the abstract were searched to determine study eligibility. Studies that clearly did not meet the inclusion criteria were eliminated. In addition, a decision was made to eliminate the large number of dissertations on the topic of collaborative learning because the quality of these studies was highly variable. Dissertations that were published in peer-reviewed journals were not excluded. When the abstract and citation did not provide enough information to include or exclude, the studies were coded as unsure and advanced to the next phase of coding. At the end of this phase, 194 articles remained. Phase I coding was carried out by 2 researchers who trained on a sample of 41 studies. The reliability for this phase of coding was 90%.

In the second phase, the full text of each of the 194 articles was retrieved and read to determine if the study could be included. The application of the same exclusion criteria used in the initial phase, resulted in the exclusion of 133 additional articles. Because several meta-analyses were conducted on the topic of collaboration during the previous decade (1990s), it was decided to limit this analysis to studies published in 1999 or later.

Study Features Coding

In the third phase, the full text of the 61 remaining articles was analyzed to determine the type of collaborative learning treatment and outcome measures that were used. Collaborative learning treatments were characterized according to approaches developed and tested by researchers and reported in the literature, e.g., Student Teams Achievement Divisions (STAD),⁴⁵ Team Assisted Individualization (TAI),⁴⁶ Group Investigation (GI),⁴⁷ etc. When a well-known method was not used, the approach was characterized with more general terms such as peer tutoring, reciprocal teaching, etc.

Outcome measures were classified as either simple or complex. When achievement was measured by the retrieval of simple facts or procedures that had been memorized, e.g., spelling words, the task was classified as simple. When achievement was measured by open-ended or ill-structured problems requiring multiple steps, inferences, and/or the comprehension of complex material, the task was classified as complex. Studies whose outcome measures could not be classified were excluded.

Other features of the study were also coded, such as the number of treatment groups, the number of students in collaborative groups and their method of assignment, the types of outcome measures used, the specific instruments, and their reliability, and students' use of technology.

After training on a subset of 4 studies, two researchers each coded half of the remaining studies. Additional studies were excluded during the coding due to missing data about the details of the collaborative learning approach and outcome measures or information needed to calculate effect sizes. If one researcher excluded a study, the other researcher verified the exclusion. At the end of this phase, 13 studies remained in the pool of articles.

Results

Number of Findings Extracted

Several effect sizes were extracted from single studies in cases where the effect sizes were distinguishable at a level that enabled the researchers to further their investigation of the research questions. Multiple effect sizes were extracted from a single study only when they were independent, e.g., different effect sizes were extracted for students in different treatment groups. Each effect size was weighted by sample size.

Two coders extracted the effect sizes for study outcomes. Twenty-nine findings were selected for the achievement analyses (See Table 1).

Table 1: The number of findings and studies analyzed for each category of study

	Simple Tasks	Complex Tasks
A. Collaborative learning vs. traditional instruction	9(7)	11(5)
B. Scaffolded vs. unscaffolded collaborative learning	4(3)	5(3)

Note: Values in parentheses are the numbers of studies from which the findings were extracted. Some studies provided outcomes in more than one category.

Effects of Collaboration Versus Traditional Instruction

In total, 20 of the 29 independent effect sizes were extracted from a total of 10 studies involving 3029 students comparing the effects of collaboration versus traditional instruction on student achievement (see Table 1, line A). Collaborative groups in these studies include many kinds of peer-assisted learning and were characterized by students working with other students to solve problems or practice skills independent of direct supervision by the teacher. Traditional classrooms were characterized by lecture or individual seatwork with feedback provided only by the teacher.

Nine of the 10 studies utilized researcher developed tests. Of these, 6 studies provided reliability data on their measures. The remaining studies used a standardized achievement test. All studies were published and employed either experimental or quasi-experimental methodology with random assignment of either individuals or classes of students.

The combined data from these studies, using 20 independent effect sizes across simple and complex tasks, indicate that students working in collaborative groups learn more than those in traditional classrooms ($ES=+.29$). To look at this a different way, an effect size of $+0.29$ means that a student in the 50th percentile prior to the collaborative treatment might expect to be in the 62nd percentile following the treatment whereas a student at the 50% percentile in the control group who had traditional instruction would remain there.

In order to identify the relative advantage of collaboration for simple and complex problems, these results were also analyzed separately. Students working on simple problems such as practice of math facts and spelling words or simple arithmetic problems with a single procedure and right answer learn more than students in traditional, teacher directed classrooms working on the same kinds of problems ($ES = +.34$). This advantage is greater than students working collaboratively on complex problems (e.g., problems with multiple steps and more than one correct answer) when compared with students working on complex problems in traditional classrooms. ($ES = +.23$). The bottom line is that whether the task is simple or complex, collaborative learning results in moderate but significant gains in academic achievement in comparison to traditional learning.

Effects of Collaboration With and Without Scaffolds

In order to understand what effect scaffolding had on student outcomes from collaborative learning, 9 effect sizes were extracted from 6 studies that compared academic achievement levels of scaffolded and unscaffolded collaborative learning

involving 878 students (see Table 1, line B). All of these studies were published in peer-reviewed journals and all employed either an experimental or quasi-experimental method with random assignment of either students or classrooms to condition. The outcome measures were all designed by the researchers and 3 of the 6 studies provided reliability information regarding these measures.

Students who were provided scaffolds to structure their problem solving learned more than those who attempted to solve the same problems without scaffolds (ES = +.34). Scaffolds included techniques that structured the groups interactions, e.g., assigned roles; metacognitive prompts that reminded them about steps in the process, e.g., reminders to generate explanations, reflect on their work, etc.; and resources about the content of the problem, e.g., a list of websites containing information that might be helpful. This result means that a student who is learning collaboratively and achieving at the 50th percentile can increase his/her academic achievement to the 63rd percentile through the use of scaffolding.

In order to determine if problem complexity had an effect on students' learning during scaffolded versus unscaffolded problem solving, these results were analyzed separately. Students who had the support of scaffolds were more successful solving simple problems than those who did not have scaffolds (ES = +.22). Simple problems included memorization of simple science facts and concepts and solving simple consistent arithmetic problems. Students who were solving complex problems with the support of scaffolds were much more successful than students solving the same problems without scaffolds (ES = +.48). This means that, for complex tasks, a student in the scaffolded group who is in the 50th percentile prior to the treatment could expect to be in the 69th percentile following the treatment. Complex problems included ill-structured problem-based learning tasks such as planning a balloon trip around the world.

Table 2: Average effect sizes for each category of study

	Simple Tasks	Complex Tasks
A. Collaborative learning vs. traditional instruction	.330	.225
B. Scaffolded vs. unscaffolded collaborative learning	.225	.479

Attitude Toward Learning

The primary focus of the present study is to examine the effect of collaborative learning on achievement. (Studies not reporting achievement data were excluded from the analyses.) However, previous reviews of collaborative learning have documented a close relationship between interventions involving collaborative learning and positive changes in social, self-concept and behavioral measures.⁴⁸ Therefore, it is interesting to note what the studies included in this report determined about the effects of collaborative learning on these measures.

Five of the 12 studies that met the criteria for inclusion in this meta-analysis reported measures of attitude toward learning or motivation to learn. Five effect sizes were extracted from these studies. The combined data from these studies indicate that students working in collaborative groups had more positive attitudes toward learning and were more motivated to learn than those studying in traditional classes (ES = +.249). Students working collaboratively had more positive attitudes toward the subjects they were studying and toward their classmates. In addition, they had higher confidence and lower anxiety levels.⁴⁹

Discussion

This meta-analysis is consistent with the outcome of several previous reviews covering earlier time periods—students learning in collaborative groups learn more than students learning individually in traditional teacher directed classes consisting of lecture and individual seatwork. The effect size of $+0.29$ approached what is considered a medium size of $.3$ for the social sciences⁵⁰ and was consistent with those of other meta-analyses with similar methodology and populations of interest. See, for example, Lou and colleagues study²⁹ which found an effect size of $+0.31$ for small group learning over individual learning.

Like Lou,²⁹ this study's analysis found that students solving simple tasks (those with a single correct answer) were more likely to benefit from working collaboratively than those solving complex, ill structured problems when compared with students in teacher directed classes. It should be noted that students benefited from collaborating on both types of problems, indicating the superiority of collaborative learning over individual learning in traditional classes.

Without more studies that directly examine the interaction between task complexity and collaboration, it is difficult to interpret this finding. It is possible that even with the assistance of collaborating peers, the tasks were still too difficult for students.

Vygotsky, a developmental psychologist, discussed the "zone of proximal development" in thinking about how to choose a task that was just the right degree of difficulty. Problems in the zone of proximal development are more difficult than those that a student can solve alone, but at a level of difficulty that the student could solve with the help of a teacher or a more able peer (or perhaps tools or other scaffolds). This point of "just manageable difficulty"⁵² is just beyond the students' reach. The problems in some of the studies under discussion may have been far outside the students' reach.⁵¹

It is beyond the scope of this study to determine how well the tasks and collaborative activities were matched to each other and to the students' abilities and preferences. Determining the optimal approaches for different kinds of tasks is a fruitful area for further research. It may be that well matched activities and tasks increase the already positive effect of collaboration on complex tasks.

Students' attitudes toward learning were also more positive during collaborative learning. The group of studies included in this analysis had a greater effect size ($+0.249$) than in Lou's⁴² research where the effect size for learning in small groups was $+0.189$ when compared with whole class learning.

Thus, this systematic review of the literature from 1999-2009 has similar findings to those in the reviews of the literature from the previous decade:^{29,42} Collaborative learning produces greater achievement and more positive attitudes than traditional, whole-class, teacher-directed instruction.

This study extends previous work by looking at the effects of scaffolds on students working collaboratively. This analysis compared groups of students who were working collaboratively, one with scaffolds and the other without. It should be noted that the presence of a peer or a teacher itself might be considered a scaffold or support. The scaffolds present in these studies were in addition to the assistance of teachers or peers and consisted of scripts, prompts, or hints about either the content to be learned or the process to be followed. In several cases, scaffolds were provided by computer tools.

Scaffolds can improve learning for students on both simple, closed tasks and on complex, ill-structured tasks; however, in this analysis students solving complex tasks benefitted more from scaffolds than those solving simple tasks. The effect size for comparing scaffolded collaborative learning with unscaffolded collaborative learning for complex tasks was $+0.48$, a level nearly equal to the $.5$ level that Cohen⁵⁰ described as a large effect.

The results from the three meta-analytic analyses conducted in this study indicate that all students, regardless of the level of complexity of task, can increase their academic achievement through collaborative learning. The shift from traditional to collaborative learning for the student achieving at the 50% percentile can translate into a gain of 13 percentiles academically for simple tasks and a gain of 10 percentiles academically for complex tasks. In addition, a student whose learning is already increased through unscaffolded collaborative learning can further increase his/her academic achievement through scaffolding. For a student achieving at the 50th percentile through unscaffolded collaborative learning with simple tasks, his/her learning could be increased by 10 percentiles by adding scaffolding. With complex tasks the increase through scaffolding (compared to non-scaffolding) would be 19 percentiles.

Collaborative learning has been widely documented as a successful approach in hundreds of studies and various meta-analyses. More research is now needed to examine the elements of collaborative learning, such as how to improve the level of student interaction, rather than focusing solely on determining which approach is the most effective. Researchers should focus on matching collaborative activities to types of tasks and determining which are most suitable for different types of learners and content.

In recent years, there has been increased interest in how computer technology, in particular network enhanced computer environments, can support collaborative learning.^{1,33} Early research has focused primarily on whether online learning is better than face-to-face. In general, the research indicates that they produce similar levels of achievement.²² However, it should be noted that such studies typically did not research the impact of online collaboration, but rather the impact of distance learning overall.

Indication of growing interest in this field is represented by *The International Journal of Computer Supported Collaborative Learning*, an entire journal devoted to research on collaborative learning with the aid of computers and computer networks. A review of this field suggests that future studies should focus less attention on the question of whether computer-supported collaborative learning is better than face-to-face collaborative learning, and instead focus on what is uniquely feasible with new technology (group cognition, collaborative knowledge building) and the different ecologies and affordances of computer-supported collaborative learning environments and tools that are diverging further and further from face-to-face learning environments.¹

Limitations

The goal of this research was to retrieve and analyze all published peer-reviewed studies on collaboration meeting the inclusion criteria. The readers should be advised that some studies may have been overlooked because they were not included in the databases of educational research that were searched or because they were missing an abstract or keyword indices that linked them to the topic of collaboration. The studies included were limited to K-12 students in classroom settings* and therefore, caution should be taken when generalizing these findings to other populations and settings.

*Classroom settings were face-to-face classes that were sometimes scaffolded through the use of Internet and other computer-based tools.

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