CPM EDUCATIONAL PROGRAM

Research Base Excerpt: Synthesis of Research on Cooperative Learning, 2013

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This document contains the Cooperative Learning section of the 2013 Research Base Report.

2013 Introduction to Cooperative Learning

As mentioned in the Executive Summary, there is almost no new research on the effectiveness of cooperative learning because its ***effectiveness is now so widely acknowledged.*** There have been a few papers summarizing previous research, the most complete of which is probably Ruthven (2011), which looked extensively at results from TIMSS (Trends in International Mathematics and Science Study). Smaller summative studies—for example, Slavin et al. (2009) and Wittwer (2008)—are also worth reading but doing new definitive experimental studies is not seen to be worth the expense. Recent studies extend to college-level physics, chemistry and economics as well as to newly-hired adult learners in industry, but there are few new broad educational studies as compared to five years ago.

Most research in the past focused almost exclusively on ***individual intellectual attainment*** where the utility of group work was evaluated based on whether or not it improved the knowledge and skills of an individual student in mathematics, physics, or medicine. Now researchers are moving beyond these basic issues in different ways. Some researchers continue to look at the impact of cooperative learning on individual attainment, but there is much more interest in understanding how certain group processes enhance that learning. There is special interest in helping teachers encourage productive processes. See, for example, Gillies (2004) comparing structured vs. unstructured groups and Webb & Mastergeorge (2003) who look at helping behaviors.

Part of this research that is applicable in schools is also being driven by research on educating employees in the workplace because employers, too, have recognized the effectiveness of learning in teams. This realization also dovetails with the increasing number of demands by businesses for "people who can work on a team." A cursory Internet search can uncover evidence from a variety of businesses that are quite explicit about needing employees with these skills.

So the daily work in teams in the CPM classroom allows not only the deeper learning of mathematics, but also the practice of important social skills as a prelude to becoming an effective member of the workplace.

Research Findings

Does cooperative learning help students learn better?

It is unusual in educational research to see such unanimity of findings—in both individualistic settings and randomized experiments. The consistency of these results over a wide span of age groups and a wide set of topics indicates that a fundamental learning principle must be involved: ***social interaction increases the ability to learn ideas*** as well as the ability to integrate these new ideas into existing cognitive structures. The techniques for using collaborative learning groups can undoubtedly be improved, and more is being learned all the time, but their overall efficacy is not in doubt.

History

In the 1970's and 1980's studies began on the effects of peer tutoring—that is, having older or more able students tutor within classrooms. As was to be expected, students receiving the tutoring gained significantly. Less expected was the discovery that ***students doing the tutoring gained even more***. See Dineen et al. (1977), and Cohen et al. (1982) for summaries of this research and Semb et al. (1993) for evidence that tutoring fosters longer-term retention.

Because both tutors and tutees were found to learn better by means of these conversations many people began to use them as an integral part of the learning experience. Teachers conceived of the classroom as consisting of smaller cooperative learning groups in which every student would have a chance both to tutor and to be tutored. The impacts of having such regular arrangements have been larger than expected.

The effects of various forms of classroom cooperative learning groups (also known as small-group learning or learning teams) have now been studied extensively for over 30 years. For thorough older overviews of the research, the reader is directed to Sharan (1980), Davidson (1985), Qin et al. (1995), Slavin (1996) and Springer et al. (1999). The most recent general articles are those cited above by Slavin et al. (2009) and Wittwer (2008). In two smaller new studies, Tan (2007) looked at junior-high students in Singapore and found no difference in average individual achievement for students in cooperative learning groups when compared to those having whole class instruction. In Hong Kong, Cheng (2008) also found no differences for the same age group.

Other articles of general interest are Webb (1991), Yager et al. (1986), Dees (1991) and Davidson & Kroll (1991). The main result of all of these tens of thousands of hours of research is that ***cooperative learning is a more effective way than direct instruction for students of all ages to learn most concepts—and is especially effective for students learning non-linguistic concepts*** (Qin, op. cit.).

Who does cooperative learning work for?

The short answer is ***almost every group that has been studied***. As a brief cross-section of the results we mention the following: first graders learning math [Fuchs et al. (2002)]; eighth graders learning science [Chi et al. (1994)]; junior-high history and geography classes [Shachar & Sharan (1994)]; high-school geometry classes [Nichols (1996)]; pre-calculus students [Whicker et al. (1997)]; college level classes in physics [Enghag et al. (2007)], chemistry [Overton & Potter (2011)], and economics [Yamarik (2007)]; and adults who are engineers [Cavalier et al. (1995)] or in management training [Nembhard et al. (2009)].

These studies have been carried out not only in the U.S. but also in Great Britain, Australia, Singapore, China, the Netherlands, and Turkey. All in all, the evidence is quite overwhelming.

Does cooperative learning work for high-ability students?

A commonly voiced concern by parents of high-ability students is that being part of a cooperative learning group will interfere with their own child's learning. Stevens & Slavin (1995) addressed this concern directly and concluded after a two-year study in elementary school that "gifted students in heterogeneous cooperative learning classes had significantly higher achievement than their peers in enrichment programs without cooperative learning." More recently, Carter et al. (2003) investigated achievement gains of high-ability fifth-grade students in a science unit and found no significant differences in the benefits to high-achieving students regardless of who they partnered with.

At the high-school level, Saleh et al. (2005) looked at students randomly assigned to homogeneous or heterogeneous ability groups in a plant biology course and the researchers concluded that "low-ability students achieve more […] in heterogeneous groups […] whereas high-ability students show equally strong learning outcomes in homogeneous and heterogeneous groups." In Hong Kong, Cheng et al. (2008) reported from a study of 367 groups that both "low and high achievers reported higher collective efficacy than self-efficacy when group processes were of high quality" and concluded that "[the quality] of group processes played a pivotal role."

Thus it appears that the achievement and learning of high-ability students is not hindered by their participation in cooperative learning groups and may, in fact, be increased by the fact that they have the chance to act as tutors within the group.

Is teamwork valued in business?

[Note: The internet websites that are summarized in this section follow at the end of the academic references.]

The most complete recent study was done by Google as Project Oxygen, which examined what traits are important in a good manager. In a data-driven analysis—doubtless far more thorough than any an academic researcher could ever afford to carry out—they found that four of the eight most important skills for a manager involved the ability to work with and lead teams. A commentator, Paul Sohn, observed that "many of the habits Google identified are the very same principles that make up good management on invariably any organization."

In a memo on hiring, Cisco's first point about current college graduates noted their "strong interest in working collaboratively in teams to reach a goal or solve a problem." In the Keller Graduate School of Management list of five Traits of Effective Employees, #3 is "Effective employees work well with others." Joe Hadzima, Chair, MIT Enterprise Forum, asserts that one of the characteristic of a highly effective entrepreneurial employee is that "The Right Stuff Employee is a true team player." There are many other such quotes available—and ***no one*** talks about how they want to hire employees who prefer working by themselves.

As an anecdote, a friend mentioned in passing that her son is applying to engineering programs at some of the best schools in the nation and several of them said during campus visiting days that they built their programs around team projects, presumably in order to prepare their graduates to work in team-oriented environments.

Returning to formal research results, Gillies has done a series of studies investigating the long-range impact on students who work in cooperative groups. In Gillies (2000) she showed that first-grade "children who have been trained to cooperate […] are able to demonstrate these behaviors in reconstituted groups without additional training a year later." She followed up these results in Gillies (2002) by showing that fifth-graders who had been trained in cooperative groups two years earlier were "more cooperative and helpful than their untrained peers." So the impact of the ability to cooperate in a group lasts well beyond the end of the year or the situation in which that learning occurred.

References for Research on Cooperative Learning

Carter, G., Jones, M. G., Rua, M. (2003). Effects of partner's ability on the achievement and conceptual organization of high-achieving fifth-grade students. *Science Education* 87 (1): 94-111.

Cavalier, J. C., Klein, J. D., Cavalier, F. J. (1995). Effects of cooperative learning on performance, attitude, and group behaviors in a technical team environment. *Educational Technology Research and Development.* 43 (3): 61-71.

Cheng, R. W., Sam, S., Chan, J. C., (2008). When high achievers and low achievers work in the same group: The roles of group heterogeneity and processes in project-based learning. *British Journal of Educational Psychology,* 78 (2), 205-221.

Chi, M. T. H., DeLeeuw, N., Chiu, M. H., Lanancher, C. (1994). Eliciting self-explanations improves understanding. *Cognitive Science* 18 (3): 439-477.

Cohen, P. A., Kulik, J. A., Kulik, C. L. C. (1982). Educational outcomes of tutoring – a meta-analysis of findings. *American Educational Research Journal* 19 (2): 237-248.

Crouch, C. H., Mazur, E. (2001). Peer instruction: Ten years of experience and results. *American Journal of Physics* 69 (9): 970-977.

Davidson, N. (1985). Small group learning and teaching in mathematics: A selective review of the research. In *Learning to Cooperate, Cooperating to Learn,* edited by R. Slavin et al. Plenum Press, New York.

Davidson, N., Kroll, D. L. (1991). An overview of research on cooperative learning related to mathematics. *Journal for Research in Mathematics Education* 22 (5): 362-365.

Dees, R. L. (1991). The role of cooperative learning in increasing problem-solving ability in a college remedial course. *Journal for Research in Mathematics Education* 22 (5): 409-421.

Dineen, J. P., Clark, H. B., Risley, T. R. (1977). Peer tutoring among elementary students – educational benefits to tutor. *Journal of Applied Behavior Analysis* 10 (2): 231-238.

Enghag, M., Gustafsson, P., Jonsson, G. (2007). From everyday life experiences to physics understanding occurring in small group work with context rich problems during introductory physics work at university. *Research in Science Education* 37 (4): 449-467.

Fuchs, L. S., Fuchs, D., Yazdian, L., Powell, S. R. (2002). Enhancing first-grade children's mathematical development with Peer-Assisted Learning Strategies. *School Psychology Review* 31 (4): 569-583.

Gillies, R. M. (2000). The maintenance of cooperative and helping behaviours in cooperative groups.

British Journal of Educational Psychology 70 (1): 97-111.

Gillies, R. M. (2002). The residual effects of cooperative-learning experiences: A two-year follow-up. *Journal of Educational Research* 96 (1): 15-20.

Gillies, R. M. (2004). The effects of cooperative learning on junior high school students during small group learning. *Learning and Instruction* 14 (2): 197-213.

Nembhard, D., Yip, K., Shtub, A. (2009). Comparing competitive and cooperative strategies for learning project management. *Journal of Engineering Education* 98 (2): 181-192.

Nichols, J. D. (1996). The effects of cooperative learning on student achievement and motivation in a high school geometry class. *Contemporary Educational Psychology* 21 (4): 467-476.

Overton, T. L., Potter, N. M. (2011). Investigating students' success in solving and attitudes towards context-rich open-ended problems in chemistry. *Chemistry Education Research and Practice* 12 (3): 294-302.

Qin, Z. N., Johnson, D. W., Johnson, R. T. (1995). Cooperative versus competitive efforts and problem-solving. *Review of Educational Research* 65 (2): 129-143.

Ruthven, K. (2011). Using international study series and meta-analytic research syntheses to scope pedagogical development aimed at improving student attitude and achievement in school mathematics and science. *International Journal of Science and Mathematics Education* 9 (2): 419-458.

Saleh, M., Lazonder, A. W., De Jong, T. (2005). Effects of within-class ability grouping on social interaction, achievement, and motivation. *Instructional Science* 33 (2): 105-119.

Semb, G. B., Ellis, J. A., Araujo, J. (1993). Long-term memory for knowledge learned in school. *Journal of Educational Psychology* 85 (2): 305-316.

Shachar, H., Sharan, S. (1994). Talking, relating, and achieving – effects of cooperative learning and whole-class instruction. *Cognition and Instruction* 12 (4): 313-353.

Sharan, S. (1980). Cooperative learning in small groups: Recent methods and effects on achievement, attitudes, and ethnic relations. *Review of Educational Research* 50: 241-271.

Slavin, R. E. (1996). Research on cooperative learning and achievement: What we know, what we need to know. *Contemporary Educational Psychology* 21 (1): 43-69.

Springer, L., Stanne, M. E., Donovan, S. S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of Educational Research* 69 (1): 21-51.

Treisman, U. (1985) A study of the mathematical performance of Black students at the University of California, Berkeley. Thesis, University of California, Berkeley.

Vigotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Webb, N. M., Mastergeorge, A. M. (2003). The development of students' helping behavior and learning in peer-directed small groups. *Cognition and Instruction* 21 (4): 361-428.

Whicker, K. M., Bol, L., Nunnery, J. A. (1997). Cooperative learning in the secondary mathematics classroom. *Journal of Educational Research* 91 (1): 42-48.

Yager, S., Johnson, R., Johnson, D., and Snider, B. (1986). The impact of group processing on achievement in cooperative learning groups. *The Journal of Social Psychology* 126 (3): 389-397.

Yamarik, S. (2007). Does cooperative learning improve student learning outcomes? *Journal of Economic Education* 38 (3): 259-277.

Internet references to working as a part of teams

Cisco (2012) *Attracting and Engaging the Gen Y Workforce*
http://www.cisco.com/en/US/solutions/collateral/ns340/ns1176/business-of-it/Trends_in_IT_Gen_Y_Flexible_Collaborative_Workspace.html

Engineering Schools.com: *Top Ten Qualities of a Great Engineer*
http://engineeringschools.com/resources/top-10-qualities-of-a-great-engineer

Google (2011) *Project Oxygen: Eight Habits of Effective Google Managers*
http://www.nytimes.com/2011/03/13/business/13hire.html?pagewanted=all
http://paulsohn.org/the-eight-habits-of-effective-google-managers/

Joe Hadzima, *Seven Characteristics of Highly Effective Entrepreneurial Employees*.
http://web.mit.edu/e-club/hadzima/seven-characteristics-of-highly-effective-entrepreneurial-employees.html

Keller Graduate School of Management of DeVry University, *Traits of Effective Employees*
http://smallbusiness.chron.com/traits-effective-employees-18302.html