RESEARCH RELATED TO DISCUSSION

Research About Pedagogy

These short excerpts from educational research highlight some important findings and conclusions.

The value of "wrong" answers. "...Knowing why the wrong answer is wrong in academic discourse can be just as important as knowing why the right answer is right" (Osborne, 2010). Deep understanding of science concepts comes from examining evidence that allows us to eliminate possible explanations. This process of moving ever closer to accurate explanations by eliminating inaccurate ones is at the heart of reasoning and science discourse. Critique and challenging ideas with evidence is central to science and is just as central to science education. Even when learners are not certain of the "right answer" (or the right answer is not knowable), they learn tremendous amounts by understanding why some explanations are not possible. This process takes place most effectively through discussions.

Henderson, J. B., MacPherson, A., Osborne, J., & Wild, A. (2015). Beyond construction: Five arguments for the role and value of critique in learning science. *International Journal of Science Education*, *37*(10), 1668–1697.

Osborne, J. (2010). Arguing to learn in science: The role of collaborative, critical discourse. *Science*, *328*(5977), 463–466.

Discussion increases cognitive abilities. Early evidence indicates that opportunities to discuss ideas in one discipline can have positive impacts on student achievement in other disciplines, as well. In essence, discussion "grows the mind."

Resnick, L. B., Michaels, S., & O'Connor, C. (2010). How (well-structured) talk builds the mind. In D. D. Preiss & R. J. Sternberg (Eds.), *Innovations in educational psychology: Perspectives on learning, teaching, and human development* (pp. 163–194). Springer Publishing Company.

Peer-to-peer discussion deepens learning. Research shows that peer-to-peer discussion is a critical component of the learning process. Learners who reason and discuss together often come up with more accurate ideas than they can as individuals, even when no one in the group enters the discussion with the "right answer." Studies show that scientifically accurate ideas tend to come out of peer discussions, even if each individual originally had inaccurate conceptions. Peer discussion between pairs or groups of learners is less hindered than adult–child interaction. Peer groups seem to support both divergent thinking and the development of new ideas. The perceived superiority of adults sometimes intimidates children from freely expressing their ideas, while peer groups can offer more opportunity for discussion and reciprocal exchanges. This promotes the types of social interaction that support construction of understanding.

Smith, M. K., Wood, W. B., Adams, W. K., Wieman, C., Knight, J. K., Guild, N., & Su, T. T. (2009). Why peer discussion improves student performance on in-class concept questions. *Science*, *323*(5910), 122–124.

RESEARCH RELATED TO DISCUSSION (continued)

Smith, M. K., Wood, W. B., Krauter, K., & Knight, J. K. (2011). Combining peer discussion with instructor explanation increases student learning from in-class concept questions. *CBE-Life Sciences Education*, *10*(1), 55–63.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context*. NY: Oxford University Press.

Wait time improves and increases participation. The concept of "wait-time" as an instructional variable was originated by Mary Budd Rowe (1972). The "wait-time" periods she found—periods of silence that followed teacher questions and students' completed responses—rarely lasted more than 1.5 seconds in typical classrooms. She discovered that when these periods of silence lasted at least 3 seconds, many positive things happened to students' and teachers' behaviors and attitudes. To attain these benefits, teachers were urged to "wait" in silence for 3 or more seconds after their questions and after students completed their responses (Rowe 1972; Stahl 1990; Tobin, 1987). With this undisturbed wait time, the length and correctness of responses increase; the number of *I don't know*-responses and no-answer responses decreases; the number of volunteered, appropriate answers and the number of students volunteering them greatly increases; and the scores for students on academic achievement tests tend to increase. When teachers wait patiently in silence for 3 or more seconds at appropriate times, there are also positive changes in their own behaviors: their questioning strategies tend to be more varied and flexible; they decrease the quantity and increase the quality and variety of their questions; they ask additional questions that require more complex information processing and higher-level thinking; and they call on a wider variety of students to respond.

Cohrssen, C., Church, A., & Tayler, C. (2014). Purposeful pauses: Teacher talk during early childhood mathematics activities. *International Journal of Early Years Education*, *22*(2), 169–183.

Rowe, M. B. (1972). "Wait-time" and rewards as instructional variables: Their influence in language, logic, and fate control. Paper presented at the National Association for Research in Science Teaching, Chicago, IL.

Rowe, M. B. (1986). Wait time: Slowing down may be a way of speeding up! *Journal of Teacher Education*, *37*(1), 43–50.

Stahl, R. J. (1990). Using "think-time" behaviors to promote students' information processing, learning, and on-task participation: An instructional model. Tempe, AZ: Arizona State University.

Tobin, K. (1987). The role of wait time in higher cognitive level learning. *Review of Educational Research*, *57*(1), 69–95.

Research About Equity and Inclusion

Boys are given more opportunities than girls. Research confirms that teachers call on boys more often than girls, accept more called-out responses from boys than girls, give boys more wait-time to respond, and give boys more praise and remediation than girls (Lavy & Sand 2015; Lindberg, Hyde,

RESEARCH RELATED TO DISCUSSION (continued)

Peterson 2010; Sadker & Sadker, 1994 and 2010; Biklen & Pollard, 1993). Teachers usually are not aware that they favor the boys over girls in this way and are genuinely surprised when they learn of these inequities when they confer with trained observers or watch videotapes of their own teaching (Wellhousen & Yin, 1997).

Educators need to acknowledge that they play an ongoing role in perpetuating racial inequality in schools, experts say. Teachers' racial biases tend to influence the expectations they have for their students, the quality of their teaching, and the choices in how they manage their classrooms. Research has found that black students are **less likely to be placed in gifted education classes** and **more likely to receive exclusionary discipline** (such as detentions and suspension) when they have white teachers. White teachers also tend to have **far lower expectations** for black students than they do for white students, which can contribute to high school graduation rates and college enrollment rates. Teachers' bias levels are related to student outcomes—the more biased teachers are, the worse students' outcomes are.

Biklen, S. K., & Pollard, D. (1993). Sex, gender, feminism, and education. In *Gender and education: Ninety-second yearbook of the National Society for the Study of Education*, 1–11. Chicago: The University of Chicago Press.

Sadker, M., & Sadker, D. (1994). *Failing at fairness: How America's schools shortchange girls.* New York: Scribner.

Sadker, D., & Zittleman, K. R. (2009). *Still failing at fairness: How gender bias cheats girls and boys in school and what we can do about it.* New York: Simon and Schuster.

Starck, J., Riddle, T., Sinclair, S., & Warikoo, N. (2020). Teachers are people, too: Examining the racial bias of teachers compared to other American adults. American Educational Research Association (AERA). (https://www.aera.net/Newsroom/Teachers-Are-People-Too-Examining-the-Racial-Bias-of-Teachers-Compared-to-Other-American-Adults)

Wellhousen, K., & Yin, Z. (1997). "Peter Pan isn't a girls' part": An investigation of gender bias in a kindergarten classroom. *Women and Language*, *20*(2), 35. VA: George Mason University.

Will, Madeline (2020). Teachers are as racially biased as everybody, study shows. *Education Week.* (https://www.edweek.org/teaching-learning/teachers-are-as-racially-biased-as-everybody-else-study-shows/2020/06)

A few students will dominate, if you let them. As reported in "The One or Two Who Talk Too Much" (1988), researchers Karp and Yoels found that in classes with fewer than 40 students, 4 or 5 students accounted for 75 percent of the total interactions per session. In classes with more than 40 students, 2 or 3 students accounted for 51 percent of the exchanges. Instructors can play an important role in ensuring more equitable discussions by forming group agreements (e.g., Take space, make space) and facilitating contributions (e.g., "Is there anyone who hasn't spoken yet who would like to?")

Karp, D., & Yoels, W. (1988). The one or two who talk too much. *Teaching Professor, 2*(7).

RESEARCH RELATED TO DISCUSSION (continued)

All students have the capacity and the right to be independent learners. "Classroom studies document the fact that English learners, poor students, and students of color routinely receive less instruction in higher order skills development than other students. Their curriculum is less challenging and more repetitive…This type of instruction denies students the opportunity to engage in what neuroscientists call **productive struggle** that actually grows our brain power. As a result, a disproportionate number of culturally and linguistically diverse students are dependent learners."

Hammond, Z. (2015). *Culturally Responsive Teaching & the Brain*. CA: Corwin