Part 2
Research on Instruction
13

INTRODUCTION TO RESEARCH ON INSTRUCTION

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In the opening pages of *Talks to Teachers*, William James (1899/1979) contrasted the science of psychology with the art of teaching. As the father of educational psychology wrote:

To know psychology, therefore, is absolutely no guarantee that we shall be good teachers. To advance to that result, we must have an additional endowment altogether, a happy tact and ingenuity to tell us what definite things to say and do when the pupil is before us. That ingenuity in meeting and pursuing the pupil, that tact for the concrete situation, though they are the alpha and omega of the teacher’s art, are things to which psychology cannot help us in the least.

(p. 7)

Thankfully, since James gave those groundbreaking lectures that put our discipline on its current course, many educational psychologists have set aside the belief that teaching must be relegated only to art or that “psychology cannot help us in the least.” As the ensuing chapters strongly establish, educational psychology has a great deal to say to those concerned with the academic development of others. Even more importantly, the mission of this collection of exceptional chapters is to demonstrate there are critical processes and techniques that have been shown—through science—to contribute to the learning of students. Our commitment in developing this section of the *Handbook* was to set aside the “arts” of teaching when those arts have not been put to empirical test or when they operate solely at the level of pedagogical intuition. What we can see in the pages that follow is that science has so very much to contribute to teachers and about teaching and about the interactions between teacher and students. These chapters are aimed at, in essence, science in teaching.

Thus, we begin this scientific exploration of instruction with a detailed consideration of the nature and influence of feedback on student learning by John Hattie, Mark Gan, and Cameron Brooks (Chapter 14). What these researchers allow us to appreciate is not only how complex and varied this seemingly commonplace process of giving feedback can be, but also how very powerful the effects can be on all those who populate
the classroom community. Indeed, the evidence that Hattie, Gan, and Brooks present positions feedback among the top 10 influences on student achievement, although, as they also caution, “merely prescribing lots of feedback does not imply that learning will take place” (p. 290). Instead, it is understanding how to craft and deliver feedback effectively that matters to learning and academic performance.

Like feedback, examples are commonplace components of instruction that we all may have come to take for granted. As with feedback, Alexander Renkl (Chapter 15) takes care to remind us that examples per se do not produce the thinking and performance desired. Rather, evidence points us in a direction as to the more effective use of examples. What do good examples look like and when should they be introduced into the instructional context? Renkl’s detailed analysis also helps us understand why well-crafted and well-positioned examples translate into positive learning. He also outlines nine principles of effective instruction with worked examples that have been empirically tested, so that learning and achievement will more likely result.

According to Renkl, one of the reasons that examples can facilitate the deeper processing of content has to do with the self-explanations that they promote. The chapter by Bethany Rittle-Johnson and Abbey Loehr (Chapter 16) offers both a historical and contemporary survey of self-explanation, which they define as “generating explanations for oneself in an attempt to make sense of new information” (p. 349). As Rittle-Johnson and Loehr effectively demonstrate, there has been decades of experimental research establishing that “the prompting for self-explanation can improve comprehension . . . and transfer . . . across a broad range of ages and tasks” (p. 350).

Rittle-Johnson and Loehr close their informative chapter by considering three critical issues that involve the use of self-explanation as an instructional technique. First, they tackle the question of when the instigation of self-explanation would be most beneficial for learning. Second, the authors explore how self-explanation works in conjunction with other instructional techniques. Third, Rittle-Johnson and Loehr describe several methods that serve to introduce self-explanations into the dynamic context of the classroom.

While the first three chapters in this section convey how common pedagogical and cognitive processes can be effectively re-cast to extend and deepen human learning, the next collection of chapters deals more expressly with human relations and verbal exchanges. For example, the chapter on peer interactions by Kathryn Wentzel and Deborah Watkins Edelman (Chapter 17) turns our attention to student-to-student relations and the significance of those relations to learning and development. The authors open their chapter with a simple yet powerful acknowledgment: “Peers are of central importance to children throughout childhood and adolescence” (p. 365). The remainder of their chapter, which summarizes the empirical literature on peer interaction drawn from educational and social psychology, supports that initial claim. What Wentzel and Watkins Edelman make transparent is that learning is inevitably tied to the social context in which it occurs, and that the opportunities provided by peers within that context matter greatly. Based on the evidence they present, we could not agree more.

The power of social relations that Wentzel and Watkins Edelman established for peers is further evidenced in Robert Slavin’s (Chapter 18) consideration of cooperative learning. As a leading authority in cooperative learning, Slavin articulates a particular configuration of social relations where there is an expressed and shared purpose of learning or academic performance. Through his detailed and well-substantiated presentation, Slavin examines cooperative learning from four theoretical perspectives that differ in their goals and underlying processes. He also offers a characterization
of various forms of cooperative learning that have been empirically tested. One of those characterizations is the role of the teacher in not only forming these cooperative groups, but also in systematically monitoring their progress toward mutual learning and performance goals.

What the chapters on peer interactions and cooperative learning share is a systematic exploration of learning and cognitive processing as it takes place within groups. In the chapter on inquiry-based instruction by Sofie Loyens and Remy Rikers (Chapter 19), this investment in co-constructed understanding or enhanced performance continues, but at the level of the class. In their framing of this chapter, Loyens and Rikers remind readers that inquiry as an instructional approach has roots as old as recorded history, and it remains as viable and effective in its more recent iterations. Although there are innumerable versions of inquiry instruction that have been implemented, most contemporary forms reflect a constructivist perspective on learning, according to the authors. In addition, Loyens and Rikers ascribe four basic elements to such methods: prior knowledge, social negotiation, self-regulation, and meaningful tasks. As an illustration of the elements in practice, these authors compare specific inquiry-based methods that have populated the empirical literature: Inquiry-Based Learning (IBL), Problem-Based Learning (PBL), and Project-Based Learning (PjBL).

Across many of the chapters in this section, there is the shared recognition that words matter. Whether those words come in the form of feedback, self-explanations, or peer interactions, what is said and how it is said is core to human learning. With the chapter entitled, “Instruction Based on Discussion” (Chapter 20), Karen Murphy, Ian Wilkinson, Anna Soter, and Carla Firetto take on the topic of one specific form of verbal exchange that has had a presence in human learning long before Socrates engaged in pointed dialogues with young Greek students. Murphy et al.’s treatment of discussion begins with an exceptional survey of the philosophical and sociological roots of this foundational method. The authors then consider two theoretical frames guiding current discussion research—cognitive and social constructivist/sociocultural theories—and consider specific approaches to discussion that have been empirical testing, such as Paideia Seminars, Collaborative Reasoning, Philosophy for Children, and Quality Talk. What these researchers effectively argue by means of empirical evidence is that all discussions are not equal. In fact, there are many instances when the inclusion of discussion does little more than increase talk—not achievement. With that awareness, Murphy et al. specify the forms or characteristics of discussion that are, in fact, related to higher levels of student learning; in sum, getting beyond simple talk to argument and justification.

The final grouping of four chapters in our Research on Instruction section have the shared attribute of examining instructional methods that are often implemented with computer-based technologies that are part and parcel of students’ lives not only in school but in the world outside the classroom. Although these chapters highlight computer-based media, the authors are careful to note that it is the instructional methods—involving tutoring, graphics, simulations, and supports—that cause learning. In short, when effective instructional methods are implemented according to research-established guidelines, they can promote or enhance learning. Further, the instructional methods implemented with computer-based media can also be effective in face-to-face learning environments, and vice versa.

For instance, in their chapter on tutoring (Chapter 21), Arthur Graesser, Vasile Rus, and Xiangen Hu remind us that the value of shared thinking and shared learning described by Robert Slavin (Chapter 18) or the effectiveness of feedback established by
Hattie et al. (Chapter 14) is predicated on the availability of someone with particular knowledge or expertise to support the learning of another. This is the foundation of tutoring, which is a special case of one-to-one instruction. While the chapter begins with a consideration of human-to-human tutoring, the discussion centers primarily on intelligent tutoring systems (ITS) that allow for the delivery of services that are generally beyond the reach of human tutors. Further, building on the extensive literature, the authors forward several claims about human tutoring processes and strategies, which they juxtaposed to the utility of ITS. Specifically, they address the claims that complex tutoring strategies are infrequent; tutoring sessions are organized around problems, challenging questions, and tasks; and, that the tailored dialogues that arise in tutoring sessions are framed to address certain expectations and misconceptions.

According to Richard Mayer (Chapter 22), instructional visualizations are visual-spatial representations—pictures or videos—intended to promote understanding and contribute to learning. Such visualizations fill the multimedia landscape in which we live and work. But does adding pictures or videos actually enhance learning? That is one of several critical questions that Mayer explores in this empirically grounded chapter, and he uses the expanding literature to show why the answer to that question is “yes.” With the potential value of instructional visualizations empirically established, Mayer turns to other equally critical questions, including when, how, and where visualizations give rise to greater comprehension, higher recall, and better achievement. Building on the extensive literature he has helped to forge, Mayer ponders the future direction for research on instructional visualization, such as the articulation of new evidence-based principles for multimedia design and the role of motivation and metacognition in multimedia learning.

Next, Ton de Jong (Chapter 23) delves into the realm of computer simulations, which have become viable forms of instruction because of continued advances in computer-based. As de Jong makes evident, there are important learning experiences that occur in the real world that cannot be simply, safely, or effectively brought into the classroom. As Mayer did in the chapter on instructional visualizations, de Jong uses the empirical evidence to document the conditions under which computer simulations function as effective tools for enhanced learning and performance. For instance, he describes how computer simulations well crafted according to design principles can effectively reduce and abstract real world phenomena that could not otherwise be introduced into educational contexts by means of simplification. De Jong also addresses the practical implications of the timely and significant research on computer simulations for learning and performance in both in-school and out-of-school contexts.

In the final chapter of this section (Chapter 24), Vincent Aleven, Elizabeth McLaughlin, R. Amos Glenn, and Kenneth Koedinger of Carnegie Mellon’s Human-Computer Interaction Institute tackle the complex subject of adaptive learning technologies. Their purpose in this examination was to focus on the empirical work pertaining to adaptive learning technologies and encompassed intelligent tutoring systems, conversational agents, and educational games. The adaptive nature of such technologies required consideration of the demands of the domain, learner characteristics, and the learner’s path in the ongoing learning activity. As an innovative way to deal with the complexity of the field, Aleven et al. forward their 3 (forms of adaptivity) × 5 (psychological realms) Adaptivity Grid and elaborate on the cells that populate that grid.

All the contributions in this section of the Handbook stand in testament to the fact that effective instruction cannot be and must not be divorced from science—regardless of James’s claim to the contrary. These chapters also argue strongly that there are any
number of processes or techniques that teachers can apply with the assurance that their pedagogical decisions come with the backing of empirical evidence that such processes and techniques work to the betterment of learning and achievement.

Another important lesson to be learned from all these chapters is that these effective processes and techniques can be based on actions and materials that already populate learning environments—from verbal exchanges to well-chosen examples and from shared learning to self-explanations. Further, these evidence-based processes and techniques embrace the hypermedia and multimedia world in which we all live and learn. But, as with discussion, inquiry, or cooperative learning, these researchers remind us that simply infusing intelligent tutoring systems, visualizations, simulations, and supports into the curriculum does not guarantee better learning. To summarize the authors contributing to this section of Research on Instruction, the how, when, where, and why of these methods and approaches must be afforded their due respect if enhanced learning and performance are ultimately to be realized.

REFERENCE