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This brief is one of five perspective briefs developed as part of the Promoting Student Success in Algebra I (PSSA) project that summarize the perspectives of district administrators and math teachers about research on five strategies to help struggling students in Grades 6–9 succeed in algebra. For additional information regarding the project and the products developed, please visit http://www2.ed.gov/programs/dropout/resources.html

Student Success in Algebra I Through Instructional Practices

Perspective Brief

This perspective brief offers an in-depth look at how district math leaders and Algebra I teachers think about research on using instructional practices that simultaneously promote *procedural fluency* and conceptual understanding as a strategy to support student success in Algebra I. As defined by the National Research Council (2001), procedural fluency is "skill in carrying out procedures flexibly, accurately, and efficiently" and *conceptual understanding* is "comprehension of mathematical concepts, operations, and relations; an integrated and function grasp of mathematical ideas" (pp. 5, 118). These competencies are important components of mathematical and algebraic proficiency.

The Promoting Student Success in Algebra I (PSSA) project, funded by the U.S. Department of Education, recently reviewed existing research on using instructional practices to support student success in Algebra I,[1] but the findings from these studies may not capture practitioners' perspectives, which are shaped by their experience in the field. This brief examines whether the research findings resonate with practitioners' experience, and if not, why not. It also examines practitioners' perspectives on what program developers and administrators may need to consider when supporting the development and implementation of this strategy—the key challenges and barriers to success. Practitioners are uniquely positioned to identify key considerations given their knowledge and experience with this strategy to support struggling students.

[1] See http://www2.ed.gov/programs/dropout/resources.html

With recent recommendations for student learning that emphasize not only mastery of algebraic procedures but also an understanding of the underlying mathematical concepts (National Governors Association Center for Best Practices [NGACBP] & Council of Chief State School Officers [CCSSO], 2010; National Mathematics Advisory Panel, 2008; National Council of Teachers of Mathematics [NCTM], 1989, 2000, 2006) and adoption of more rigorous college and career readiness standards, including the Common Core State Standards for Mathematics (CCSSM; NGACBP & CCSSO, 2010), educators are beginning to rethink traditional approaches to algebra instruction. Instead of focusing only on symbolic manipulation and algebraic "rules," as is typically done in Algebra I classes, professional organizations recommend that teachers find ways to implement instruction that promotes procedural fluency and conceptual understanding. Research provides recommendations for instructional practices that promote these proficiencies. Knowing practitioners' perspectives on this research is particularly important now, as they shift to teaching to more rigorous standards of learning.

To better understand practitioners' perspectives on research on instructional practices that simultaneously promote conceptual understanding and procedural fluency, we asked a focus group of four district math leaders (math coordinators, coaches, and instructional leaders) and a focus group of five Algebra I teachers to read the PSSA project's research brief outlining evidence to date—*Instructional Practices to Support Student Success in Algebra I: Research Brief* [2]—and discuss whether and how key research findings resonated with their experience. Key findings from the research brief are summarized briefly in Exhibit 1.

Exhibit 1. Key Findings From the Review of Research on Instructional Practices

A review of research on instructional practices that simultaneously promote conceptual understanding and procedural fluency suggested the following:

- Instruction that provides students with opportunities to struggle productively with algebraic concepts and make connections between these concepts and algebraic procedures promotes conceptual understanding as well as procedural fluency.
- One way to do this is through instructional practices that emphasize sense making through the following:
  - Promoting meaning for algebraic symbols through prediction, exploration, modeling, and justification
  - Reasoning about worked-out solutions to algebraic equations
- Implementation of instructional practices to promote conceptual understanding throughout a whole course results in conceptual understanding as well as procedural fluency.

[2] See http://www2.ed.gov/programs/dropout/instructionalpractices092414.pdf

To ensure that the practitioners' perspectives reflected at least some of the challenges facing both urban and rural educators, each focus group included one representative from a rural district and three or four representatives from some of the 100 largest districts across the country.[3] Both district mathematics leaders and Algebra I teachers were asked to make connections between research and practice by addressing the following broad questions:

- *How do the research findings resonate with your experiences in the field?*
- *What challenges do you foresee in implementing recommendations from the research, and what supports are needed?*
- *Are there any important factors to consider that are not addressed in the existing research?*

An analysis of the focus group data indicated that teachers and district leaders generally agreed with the findings from the research brief (see Exhibit 1) but provided additional thoughts regarding aspects of instruction that research has overlooked, challenges faced in implementing the recommendations highlighted in the research, and supports needed to do so successfully.

In short, district mathematics leaders and Algebra I teachers suggested the following:

- Teaching for conceptual understanding promotes procedural fluency in Algebra I, including for struggling students. However, because teachers did not experience instruction that promotes conceptual understanding as students and curricular materials and tests emphasize procedural fluency, algebra instruction tends to focus on using procedures to solve traditional algebra problems.
- Instructional practices that emphasize sense making promote conceptual understanding and procedural fluency in Algebra I. Examples include instructional approaches that provide opportunities for students to make predictions, conduct algebra exploration, justify their thinking, and compare and contrast algebra concepts and approaches to solving problems.
- Access to resources, time, and collaborative activities; professional development; and support from administrators are needed to implement instruction that promotes conceptual understanding and procedural fluency.

[3] See the appendix of this brief for additional information about the methods used to collect and analyze practitioners' perspectives.

These perspectives of practitioners are elaborated in the following sections, and implications of these perspectives for program development and administration are highlighted at the end of this brief. Because the perspectives highlighted in this brief represent only nine practitioners, we encourage readers to use caution when drawing conclusions. Nonetheless, these practitioners' voices give depth and richness to the findings in the research brief.

Participants' Perspectives on the Research

The following sections highlight the perspectives of district mathematics leaders and Algebra I teachers that emerged from focus group discussions. These findings are organized by major themes that arose from discussions regarding the research. In each section, we begin with a brief summary of the relevant research findings, followed by an exploration of key themes from the focus group participants' reactions to the research.

TEACHING FOR UNDERSTANDING PROMOTES FLUENCY

Research on mathematics teaching indicates that instruction often focuses on applying mathematics procedures with little attention to the underlying concepts (Hiebert et al., 2003; Stigler & Hiebert, 2004). As standards for student learning that emphasize conceptual understanding and procedural fluency are put into place, attention has turned to new forms of instruction. Research suggests that instruction that explicitly provides students with opportunities to make sense of symbols and procedures, focuses on mathematical connections, emphasizes the big ideas in mathematics, and allows students to struggle with (i.e., expend energy to reason about) mathematical ideas promotes the development of conceptual understanding. This form of instruction also promotes procedural fluency (Hiebert & Grouws, 2007).

A focus on conceptual understanding also promotes procedural fluency and can support success in Algebra I for struggling students.

Teachers and district leaders agreed with research suggesting that a focus on conceptual understanding also promotes procedural fluency. One teacher explained, "I think the procedural stuff comes after the understanding—after you understand the math."

Participants added that a focus on conceptual understanding can be particularly effective in supporting struggling students to be successful in Algebra I. Often, as one district leader explained, "The fluency may not be there because the conceptual has never been there…[teachers] show them these procedures…however, they're not going to remember those procedures if…they aren't understanding where it's coming from." Participants agreed that if students understood the underlying mathematical concepts, they would have a better chance of remembering how and when to apply the procedures and therefore would be more successful in Algebra I. The teachers also suggested that a

focus on conceptual understanding can be motivating to struggling students, which in turn would foster success. As one teacher explained, "I think that some of our kids struggle so much because they don't understand why…so that's why they really don't care. I think a lot of it is motivation of those students that don't do well." If students understand the content, they will be more motivated to learn more.

Although they agreed that teaching for understanding is important, respondents were not surprised by the research finding that the focus of mathematics instruction is often the application of procedures, particularly in Algebra I, and provided insight into why that might be the case. They emphasized that the instruction that Algebra I teachers experienced as middle school or high school students focused on the development of skill, not understanding. Because they experienced this form of instruction as students, these teachers are likely to structure their lessons similarly. Furthermore, as student tests have focused on rote application of skill and textbook series have emphasized the same, teachers are more likely to focus instruction on skill development. One teacher explained, "The procedural stuff to me seems the easy part…I think the teachers who have always taught procedures have a hard time moving to conceptual teaching because it is not how they grew up." Another teacher added, "The procedural stuff is easy to find. It's everywhere." Teaching for understanding, and supporting student success, will require teachers to shift their practice and implement the instructional approaches that emphasize conceptual understanding.

Because the focus of instruction, materials, and tests has been procedural fluency, teaching for conceptual understanding will require a shift in teacher practice.

SENSE MAKING TO PROMOTE UNDERSTANDING AND FLUENCY

To promote conceptual understanding in algebra, research suggests that instruction should emphasize sense making through instructional activities that (a) promote meaning for algebraic symbols and (b) provide students with opportunities to reason about algebraic procedures. Instructional practices that promote meaning (a) give students opportunities to investigate mathematical models and the equivalence of algebraic expressions through a process of making predictions, performing an experiment, and providing mathematical justifications for the outcome of that experiment (Graham & Thomas, 2000; Kasmer & Kim, 2011, 2012; Roschelle et al., 2007) and (b) encourage students to compare and contrast different solution methods for solving the same algebraic equation (Booth, Lange, Koedinger, & Newton, 2013; Rittle-Johnson & Star, 2007, 2009). When implemented on a regular basis, instructional practices that

emphasize sense making have been found to enhance conceptual understanding and support, rather than detract from, procedural fluency in algebra (e.g., Huntley, Rasmussen, Villarubi, Sangtong, & Fey, 2000; Pane, Griffin, McCaffrey, & Karam, 2013; Rakes, Valentine, McGatha, & Ronau, 2010; Reys, Reys, Lapan, Holliday, & Wasman, 2003).

On the whole, teachers and district leaders agreed that the instructional practices focused on sense making specified in the research would be effective in promoting conceptual understanding and procedural fluency in algebra. In their discussion, the district leaders connected the instructional practices identified in the research with the mathematical standards for practice outlined in the CCSSM. In contrast to the content standards, which specify mathematical concepts and procedures that students are expected to know and understand, the CCSSM standards for mathematical practice identify the mathematical "processes and proficiencies" (NGABP & CCSSO, 2010, p. 9) that students at all levels are expected to develop. These include proficiencies such as mathematical problem solving, reasoning, and communication.[4] As one district leader indicated, "You can't build conceptual understanding without having engaged in the mathematical practices." In order to develop conceptual understanding, students need to have engaged in the mathematical practices in ways emphasized by the instructional practices emphasized in the research brief.

Instructional practices focused on sense making, including those that provide opportunities to predict, critique, and justify, promote conceptual understanding and procedural fluency in Algebra I.

More specifically, district leaders and teachers discussed the value of predicting, critiquing others' approaches to solving a problem, and presenting justification. One teacher explained, "Doing the investigations and predicting allows them to problem solve and apply the information they have." When students are asked to make predictions involving algebraic expressions and equations, they are required to draw on prior understanding and make connections to a new situation. This process promotes conceptual understanding as well as procedural fluency. Similarly, when students are asked to compare and contrast two different approaches, they begin to make connections between mathematics procedures and concepts. One teacher explained, "If you had both of these approaches written and they had to…compare and contrast the two different approaches…that's the critiquing others' work that they really need to be able to do" [to promote conceptual understanding and procedural fluency]. Another district leader added, "Having students grapple with

[4] The standards for mathematical practice include the following: make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure, and look for and express regularity in repeated reasoning.

the mathematics, come up with their own solution, and then…defend it, and then other students have to interpret what that student was doing…and then they're having to rethink their own way…[it] sparks a connection in their mind."

When asked whether any instructional practices were missing from the list, one teacher mentioned sorting activities in which students are given a set of mathematical concepts or procedures and asked to sort them into groups having similar characteristics. In order for students to put the concepts into groups, they must compare and contrast the underlying ideas, thus promoting a deeper understanding of concepts and procedures.

SUPPORTING TEACHING FOR UNDERSTANDING AND FLUENCY

Although teachers and district leaders emphasized the value of instruction that promotes conceptual understanding and procedural fluency, they recognize that it is not always easy to focus on both. The research reviewed for the research brief did not focus explicitly on supports needed to implement these instructional practices, but it was an issue that arose continually in the participants' discussions. To implement instructional practices that simultaneously promote conceptual understanding and procedural fluency, teachers and district leaders stressed the importance of (a) instructional resources, time, and collaborative opportunities; (b) professional development; and (c) support from district- and school-level administrators. These issues were particularly salient for teachers and district leaders representing rural districts.

To implement new instructional practices, teachers and leaders need access to resources, time, and collaborative opportunities; professional development; and administrator support.

Access to Resources, Time, and Collaborative Opportunities

An overarching theme of the focus group conversations was that teachers need instructional resources that provide examples of activities aligned with the instructional practices described in the research brief. As one teacher explained, "I think what's difficult is when you're looking at a textbook that's probably pretty concrete, how do you create those situations?" The teachers agreed that it takes time to create or search for examples of those activities. Then, once they find examples, they need to spend time determining (a) whether or not they are of high quality and (b) how to weave the activity into the flow of other activities outlined in the textbook. As one teacher explained, "I [spend] half of my planning time reading this lesson …that encourages conceptual understanding. And

it's no good. I just wasted half of my planning time." Another teacher added, "You can go online or to other places to find investigations and things but to figure out where they blend in seamlessly [to what I am already doing] is the difficult part." Finding and judging the quality of resources takes time and, even then, teachers need to determine when to implement them within their instructional program.

Some of the teachers in the group indicated that they are able to work with other teachers in their school to share the task of finding and determining the quality of resources that might be used in their instruction. Others in the group mentioned that there was not enough dedicated planning time to work with other teachers in this way or, if there was time, other things typically got in the way. As one teacher said, "Every other day, I'm covering the class of a teacher who's out, and they couldn't find a sub, or I'm doing some paperwork task…there's just more and more and more stuff that gets placed on us to do." Too often, the time teachers have for collaborative planning needs to spent completing administrative tasks.

Given the time required to find, analyze, and incorporate activities aligned with the instructional practices identified in the research, district leaders emphasized the need for a cohesive set of district-approved curricular materials (textbooks or other resources) that support the implementation of such practices. As one district leader explained, it needs to be "embedded in the system where you have instructional materials that have [those types of] activities on a day-in, day-out kind of basis." District-approved curricular materials would reduce the burden on teachers to find and determine high-quality materials. If teachers have access to preapproved materials outlined in the pacing guide, they can use their prep time to consider implementation and execution of the activities rather than searching for quality resources and determining where to incorporate tasks into the sequence of lessons.

Professional Development

Teachers need access to professional development that focuses on (a) enhancing teachers' conceptual understanding and (b) instructional approaches that promote this understanding in students.

In addition to access to instructional resources, time, and collaborative opportunities, participants emphasized the importance of professional development focused on (a) the enhancement of teachers' conceptual understanding and (b) instructional practices that promote that type of understanding in students. They suggested that such professional development should provide teachers with opportunities to experience as students the instructional practices that research suggests is effective. One teacher

explained, “I would like to have professional development time where somebody… comes in and models to us how I might teach this in my class. Let us be the students and participate in it and see where we go.” Ideally, as one district leader explained, teachers would “grapple with the mathematics on their own…making sense of it on their own…[and] at the same time…they’re kind of thinking about how their students would be receiving that and how they would attack it.” These forms of professional development would provide teachers with an opportunity to experience instruction focused on conceptual understanding as a learner and hopefully better prepare them to deliver such instruction.

In addition to experiencing this form of instruction from the standpoint of a student, teachers and district leaders agreed that it would be helpful for teachers to observe these instructional practices modeled with real students. Participants explained that teachers often experience resistance from students because instructional practices that emphasize conceptual understanding and promote procedural fluency are not what students are used to experiencing. As a result, teachers become apprehensive about engaging students in these kinds of instructional activities. Watching someone else deliver instruction with real students can alleviate this concern. As one district leader explained, “They don’t believe their kids could do it, but if somebody sits there with their kids in front of them and models it, and they do it, well then [it is possible].” Once teachers see this type of instruction modeled with students, they are more likely to try it themselves.

District leaders emphasized that professional development opportunities such as those described above should be sustained over time, throughout the year. As explained by one district leader, “There needs to be a professional development cycle, right? So it’s not just about the once a quarter kind of thing we’re going to talk about something but what’s going on in between to continue the conversations.” Professional development needs to be ongoing.

Support From District- and School-Level Administrators

As district leaders discussed the importance of the resources and professional development opportunities mentioned above, they emphasized the value of support from district- and school-level administration. Often, district mathematics leaders find themselves competing against other initiatives for the time, staff, material resources, and budget needed to give teachers the supports they need to implement instruction that promotes conceptual understanding and procedural fluency. In particular, district leaders emphasized the need to garner support from the principals.

In order to support teachers in implementing instruction that promotes understanding and fluency, principals need to know what those approaches look like.

As one district leader explained, “The action is [really] between principals and teachers and teachers and students.” The principal is, therefore, in a position to have an impact on the kinds of instructional practices that teachers implement day to day.

For principals to support change in teachers’ instruction, focus group participants argued that principals need to understand what that instruction might look like and what it takes to support teachers in implementing it. To that end, one district leader described a professional development program the district offers to principals:

> [The goal of the professional development is to] provide them with a lens into what a classroom should look like, and not necessarily where they become experts in mathematics because that’s not the point. It’s really the point of being able to walk into a classroom and actually understand that quality mathematics is going on, and how to support a teacher, not necessarily in their day in and day out, but in what are the kinds of things they want to be seeing.

As principals learn what instruction promotes procedural fluency and conceptual understanding in Algebra I looks like, they are better equipped to provide feedback to teachers on their instruction and support them in making the shift to implementing more of these approaches.

SUMMARY OF PERSPECTIVES ON INSTRUCTIONAL PRACTICES

In summary, focus group participants provided useful insight into the design of algebra instruction that promotes procedural fluency and conceptual understanding and provided suggestions for supports needed to implement that instruction. They indicated that teaching for conceptual understanding promotes procedural fluency, including for struggling students, but noted that algebra instruction often emphasizes the latter. Because teachers experienced instruction focused on algebraic procedures as students and because curricular materials and tests tend to emphasize using algebraic procedures, teachers tend to focus on using procedures to solve algebraic equations. Teaching for understanding will require a shift in their practice. Focus group participants noted that a focus on sense making through predication, exploration, justification, and comparison supports conceptual understanding and procedural fluency and indicated that teachers will likely need support to implement these instructional approaches. Both district leaders and teachers suggested that those supports could include access to resources, time, and collaborative opportunities; professional development; and administrative support.

Implications for Program Developers and Administrators

The findings from the analyses of the focus group data provide useful information for program developers and administrators who are working to design and implement instructional practices that simultaneously promote procedural fluency and conceptual understanding. Although the practitioners often agreed with the research findings, they did expand on that research with insights relevant to their own experiences. As program developers and administrators consider implementation of practices that support these proficiencies in Algebra I, they should consider how the reactions of the participants in this particular project may or may not relate to their own instructional contexts. Exhibit 2 summarizes those insights along with potential implications for implementation.

Exhibit 2. Key Findings From Focus Group Participants' Perspectives on the Research and Implications for Practice

Key Focus Group Findings	Considerations for Program Developers and Administrators
Teaching for conceptual understanding promotes procedural fluency, including for struggling students.	Place emphasis on practices that support conceptual understanding for students at all skill levels.
Practices focused on sense making promote conceptual understanding and procedural fluency in algebra. These practices also support development of the standards for mathematical practice outlined in the CCSSM.	Encourage implementation of instructional practices that support sense making through the following: • Prediction, exploration, and justification • Comparing/contrasting multiple approaches to algebra problems • Critiquing alternative approaches to algebra problems • Sorting activities that require students to compare and contrast attributes of algebraic concepts
Supports are needed to implement instructional practices that promote conceptual understanding and procedural fluency, including the following: • Access to resources, time, and collaborative opportunities • Support from district- and school-level administrators	Provide teachers with a coherent set of curricular resources (e.g., textbooks, activities) that focus on making sense of algebra. Provide teachers with professional development opportunities in which they do the following: • Experience instructional practices that promote conceptual understanding and procedural fluency. • Observe as these practices are implemented with students. Obtain district- and school-level administrative support by providing professional development opportunities for administrators.

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Appendix

To examine how district policymakers and teachers use and make sense of research on instructional practices to promote procedural fluency and conceptual understanding, the project team convened a group of experienced district math leaders (including math coordinators, district math coaches, and other district-level instructional leaders) and teachers of Algebra I to participate in focus group discussions about key findings from the research.

Using a multistep process, we purposively selected focus group participants to include district administrators and teachers on the basis of their degree of knowledge and experience with the strategies of interest as well as to ensure representation of diverse types of educational contexts (e.g., rural and urban settings, middle and high schools). We identified school districts among the 100 largest local education agencies and from a list of all U.S. rural districts with which project team members had previously worked or which had been referred to us by external experts as strong candidates for discussions focused on helping struggling students succeed in Algebra I. Making sure we nominated no more than two districts from the same state, we identified 14 initial districts—10 urban and four rural—which we contacted by e-mail with information about the project and a request for an informational interview. Each nominated district was asked to nominate a teacher representative and to share biographical information for both district and teacher representatives. Nominated representatives subsequently participated in a brief interview designed to assess their experience and familiarity with five focal strategies for the *Promoting Student Success in Algebra* project, as well as their interest and availability in participating in the focus groups, to be conducted as part of a two-day meeting held at the offices of American Institutes for Research (AIR) in Washington, D.C. The U.S. Department of Education's Office of Elementary and Secondary Education (OESE) and AIR ultimately selected seven of the 14 districts (five urban, two rural) from seven states located in different regions of the United States to participate in the focus groups, including one district and one teacher representative for each district (14 individuals total). District and teacher representatives collectively averaged 15 years of experience teaching math, and teacher representatives averaged nine years of experience teaching Algebra I specifically.

Participants were asked to read the research briefs in advance, and received a series of open-ended questions to guide their reading. For each of the five topic areas of focus in this study, two 90-minute focus groups with either four or five participants were conducted, one with district leaders and one with teachers. This configuration provided space for participants to focus on the issues most salient to the role they play in the district and be forthright in their responses as they were surrounded by their district- or classroom-level peers. The project team ensured that each focus group included at least

one participant from a rural district. The facilitators of the focus groups were careful to ensure that they monitored the time during the focus groups so that they covered all topics during the discussion.

The focus group protocol featured open-ended questions designed to elicit deep conversation about specific research findings from the research briefs. To facilitate conversation, each question was followed by focused probes to ascertain insights into important areas. For example, probes explored questions regarding "how," "under what conditions," and "why" to gain a full understanding of participants' perspectives on each strategy as well as contextual factors that affect those perspectives.

To facilitate data collection, all focus group sessions were audio-recorded and featured a note-taker, who captured information that provided context for the audio-recording (e.g., keeping a record of which remarks came from which participant in case it was difficult to distinguish speakers on the audio-recording). Following the meeting, transcriptions of each focus group were created and content-coded. The study team analyzed and coded data with an initial set of codes based on themes that emerged in the research briefs and, in iterative fashion, codes were combined and/or revised as patterns emerged. Transcripts were double-coded and assessed for interrater agreement, with disagreements resolved to agreement. Findings from these analyses form the basis of this perspective brief, with the goal of documenting key insights from administrators and teachers on the extent to which the research resonates with their own experience and the important factors that are not addressed in the existing literature.

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