The Development and Evaluation of Literacy Interventions for Deaf and Hard-of-Hearing Children

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Abstract and Keywords

Literacy intervention research tests our best ideas about instruction and forges a pathway forward toward deeper and more nuanced understandings of how children think, communicate, and learn. This chapter describes the components of the development of literacy interventions, explaining how to construct and evaluate each component in sequence to generate robust, reliable evidence for practice. In doing so, the chapter discusses some of the specific contexts of, and challenges for, literacy intervention research in deaf education. In order to illustrate important considerations for designing and interpreting literacy intervention studies in this context, two case studies of interventions developed or applied with deaf and hard-of-hearing children are included.

Keywords: deaf and hard-of-hearing, literacy, intervention design, evidence for practice, interventions for deaf and hard-of-hearing learners

The Design and Impact of Intervention Research

Over the past decades, policymakers, administrators, and researchers have placed increased emphasis on using evidence-based practices in education. Reviews have consistently shown that there is a dearth of such practices in the field of deaf education (Luckner, 2017; Luckner, Sebald, Cooney, Young, & Muir, 2006; Strassman & Schirmer, 2013). In this chapter, we examine one model that has been developed in the United States (US)over the last 20 years for developing evidence-based interventions. Of course, this model is not restricted to US researchers (see MacSweeney et al., 2019). Our goal is to encourage more researchers and educators to engage in this highly rewarding work.

In 2002, the U.S. Department of Education formed the Institute of Education Sciences (IES). Since its inception, IES has striven to support projects that use rigorous scientific methods, with the goal of providing causal evidence to determine “which programs and approaches work best for which students under what circumstances” (U.S. Department of

Education, Director's Biennial Report, 2007, p. 1). The IES Request for Proposals details the elements that the institute regards as critical to developing and evaluating innovative educational interventions. The elements are reviewed here, with a specific focus on the description of the development goal, because this may be the most novel and relevant for researchers developing interventions.

The IES grant program encourages researchers to engage in a sequential series of studies to develop effective educational programs, beginning with exploratory studies and continuing with development, efficacy, and replication studies. Whether the goal of a study is to explore, develop, evaluate, or replicate an educational program, IES aims to "expand the knowledge base and understandings of children by advancing understandings of practices for teaching, learning, and organizing education systems" (U.S. Department of Education, 2018, CFDA.324A). This comprehensive approach to research and development is a scientific approach to developing practical solutions for education problems while contributing to scientific knowledge and (p. 404) theory in the field. By following a sequential progression from exploration to replication, researchers build understandings not only of teaching and learning, but also of the systems and organizations that support them. The first two goals in the sequence, exploratory and development goals, are explored in the sections that follow.

Exploratory Research

The first step, called exploratory research, is research that serves as the basis for a framework for developing effective interventions:

> Exploratory research examines relationships among important constructs in education and learning to establish logical connections that may form the basis for future interventions or strategies to improve education outcomes. These connections are usually correlational rather than causal (Common Guidelines).

The vast majority of published research on literacy of deaf and hard-of-hearing children (DHH) children is exploratory, seeking to describe ways in which hearing loss and/or language deprivation influence literacy, as well as examining both child and environmental factors that correlate with literacy outcomes. Occasionally, the research is sufficient to identify malleable factors that lead to improved outcomes and changes in educational practice. In the field of deaf education, correlational research on the effect of age of identification on DHH children's language was so persuasive that there was quick and nearly universal adoption of universal newborn screening and subsequent early intervention. More frequently, though, research can only lead to hypotheses of how best to intervene to improve literacy outcomes. The hypotheses then can be used to generate ideas about educational interventions. For example, research that found high correlations between DHH children's reading and speech reading skills (Kyle, Campbell, & MacSweeney, 2016) led MacSweeney and colleagues (Pimperton et al., 2019) to develop a speechreading intervention. Similarly, research on the importance of fingerspelling ability fostering reading skills (Lederberg et al., 2019) led Schick, Lederberg, Bridenbaugh, Boll, and Burke (2018)

to develop a supplemental intervention that incorporated fingerspelling to support reading development. Exploratory studies on speechreading and fingerspelling did not demonstrate whether, when, or for whom such interventions would be effective, but they suggested these skills as possible targets for intervention development that could support literacy learning.

Therefore, while exploratory research is useful in creating evidence for likely targets for intervention and for understanding learning processes and development, it is not likely to have direct impact on educational practice. In contrast, development grants are designed to do just that, and they are the area that has received the most IES funding for projects that focus on DHH children. In this chapter, we focus on development studies because the processes of developing an intervention are rarely discussed in publications, yet understanding the processes is a powerful way to develop new interventions.

Development and Innovation Studies

Development and innovation studies "support the development of new interventions and the further development or modification of existing interventions that are intended to produce beneficial impacts on student education outcomes when implemented in authentic education settings" (U.S. Department of Education, 2018, CFDA.324A, p. 11). This section describes the components that IES envisions for developing a successful intervention.

Significance

Researchers must propose an intervention designed to improve a specific problem that exists in student outcomes. This involves demonstrating there is a problem in student outcomes (e.g., low literacy rates, weak phonological awareness skills, compromised spelling), and that the proposed intervention is different in key ways from current educational practice, so that the field of education can reasonably expect better outcomes when the intervention is implemented. The design of the intervention needs to be based on theoretical and empirical research that suggests its components or active ingredients will lead to changes in student outcomes. The intervention must be tailored to a specific target population, typically defined by age, abilities (e.g., DHH children), and other student characteristics that are important to the design of the intervention (e.g., language modality). This is illustrated in a theory of change (TOC) that includes a target population and intervention components linked to underlying learning processes that, in turn, are linked to student outcomes. See Figure 28.1 for an example of a TOC.

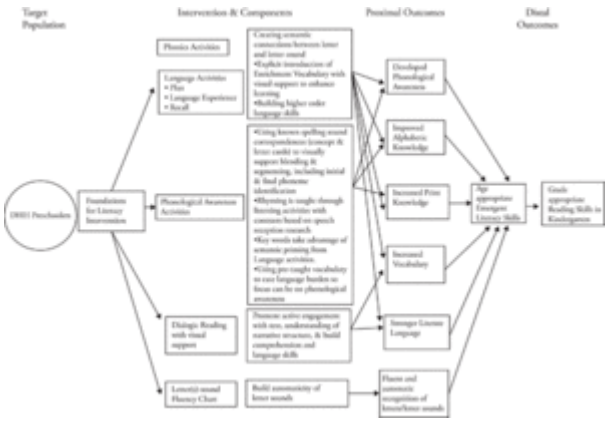

Figure 28.1. Foundations of Reading Theory of Change.

The TOC is a foundational component of any development and innovation study because it demonstrates how a proposed intervention is grounded in a coherent, evidence-based understanding of literacy and learning, and how it builds on existing evidence to engage likely targets for improvement. (p. 405) In other words, a TOC grounds the suggested change in existing theories about how literacy and learning work. This not only ensures that evidence accumulates in coherent ways to build understanding in the field, but also demonstrates the logic and reasoning behind the intervention design. Finally, the intervention needs to be feasible or reasonable for teachers to implement in real classrooms. That is, it may be theoretically powerful, but if it is not practical, it does not meet the expectations for development and innovation studies.

Interventions may be completely novel or adaptations of existing interventions. In our experience, interventions for DHH children are frequently based on effective interventions for hearing children that are changed in major ways to be more suitable to the unique needs of DHH children. This is because there is a long history of research on hearing children that can inform interventions for DHH children. However, if such interventions were equally effective for DHH children, there would be no need to develop interventions specific for DHH learners. Therefore, the key differences articulated in a TOC must address the unique educational needs of DHH students in theoretically logical ways. For example, there is a strong evidence base for the use of interactive writing instruction with typically hearing (TH) children (Englert & Dunsmore, 2002; Mariage, 2001), the use of strategic instruction with developing student writers (Applebee, 2000; Harris, Mason, Graham, & Saddler, 2002; Flower & Hayes, 1980), and supporting the development of metalinguistic awareness and linguistic competence with language learners (see Ellis et al., 2009; Jackendoff, 1994; Krashen, 1994; Pinker, 1995). Given the unique language histories of DHH students, the combination of these approaches creates a likely target for an intervention that supports language and literacy development simultaneously (see Wolbers et al., 2018). In this way, researchers harnessed evidence from language and literacy research to design an approach specific to the language and literacy needs of DHH children.

Research Plan

In order to address the requirements described in the section above, IES recommends that researchers include a proposed development process, measures, and a pilot study in the research plan section to strengthen the methodological rigor of the proposed development and innovation work. Each of these elements is described below.

Development Process

The research plan begins with a chronological description of the steps taken to develop the intervention. It is displayed on a timeline and explains in detail how the intervention will be created, observed, revised, and adjusted to ensure usability and feasibility. The goal is to have a design process that is iterative, that is, repeating with refinement in each stage, but systematic so that each step of the process is informed by evidence gathered in the previous step or phase. This is often represented as a timeline with an action plan that explains how each iteration of the intervention will build on the last until it is refined to the point of generating consistent positive outcomes that other researchers could replicate with success.

Measures

The research plan must also include a description of the measures that will be used to generate data about the intervention. Researchers often use a combination of existing measures, validated by previous research, for which evidence of reliability and validity is available, and researcher-created measures whose reliability and validity must be demonstrated within the project. In both cases, an explanation of the choice of measure should include information about usability, feasibility, fidelity of implementation, student education outcomes, and expected intermediate outcomes. This ensures that studies of proposed and developing interventions use measurement tools that can reliably produce indicators of growth and that the tools are used in ways that are psychometrically sound. Like the TOC, the section on measures is an opportunity to connect novel developments (e.g., researcher-created measures) to existing measures. It is also an opportunity for researchers to demonstrate how their proposed uses of specific measures align with their understanding of the construct being measured (e.g., spelling development) and how the intervention affects constructs of interest.

Researchers use three broad sets of measures in an intervention and development study: (1) measures of student learning, which document the impact of the intervention on students learning; (2) measures of feasibility, which document how likely it is that the intervention can and will be implemented with fidelity in an authentic education setting (e.g., various classroom contexts); and (3) measures of the fidelity of implementation, which document whether and how well the intervention was applied in an authentic setting. Each measure is described below.

(p. 406) (p. 407) **Measures of Student Learning.** Measures of student learning may include existing or researcher-created measures. However, a detailed description of any instrument(s) used to measure student learning must include evidence of its reliability,

validity, feasibility, and appropriateness for use with a given purpose and population. Ensuring the appropriateness of existing, standardized measures of student learning for all DHH students often requires considering the role of language and modality in test administration.

Feasibility of Implementation. In order to ensure that researchers develop interventions that teachers in schools can use practically beyond the project, researchers must measure feasibility: "The extent to which the intervention can be implemented within the requirements and constraints of an authentic education setting" (U.S. Department of Education, 2018, CFDA.324A, p. 62). In order to demonstrate an intervention is feasible, researchers must test it in an environment similar to what is intended, with protocols and students as intended for the future, and gather data about usability and practicality throughout the study. This can include surveys or interviews with those responsible for implementation and systematic investigations of patterns of use in different settings. Though researchers have many ideas for interventions that can be explored successfully in highly controlled settings with particular students, the requirement to measure feasibility of implementation challenges researchers to conduct their research in realistic settings and to systematically measure the extent to which their design can be actualized in schools. See Cawthon and Easterbrooks, this volume, for a discussion about including school administration and teachers in the decision-making process.

Fidelity of Implementation. In order to ensure the theory, hypothesis, and design of a study are being tested as intended, researchers must measure the fidelity of instructional implementation. This can include using observations to measure how often teachers use different aspects of the intervention as intended, and/or conducting interviews and surveys regarding participants' levels of use of the innovation or intervention under investigation. The goal of observing and inquiring about fidelity is to ensure that student outcomes can be linked to the intervention itself. When implementation is not feasible, and fidelity is low, student outcomes cannot reliably be attributed to the intervention. However, when an intervention proves to be feasible, and is implemented with greater fidelity, researchers can be confident that results may be related to the intervention and that similar results might be achievable in other settings.

Pilot Study

A plan for a pilot study in the development and innovation process will determine the intervention's promise for generating beneficial student education outcomes and serves as an initial test of study ideas that supports further investigation of the intervention during replication studies. The pilot study embedded in a development project should include all the same detail and components of a full study, but it is conducted on a smaller scale in order to analyze the cost and potential benefits of implementing a scaled-up version of the intervention. The key to evaluations of interventions is to provide experimental evidence that the developed intervention improves student outcomes. Single-case designs (SCD) are one way to provide initial evidence that components of an intervention are linked to student learning. These are particularly helpful during the design stage to establish functional relations between a component and student learning, as well as for de-

veloping interventions with low-incidence populations, such as DHH children. In addition, randomized controlled study designs, where teachers or students are randomly assigned to either intervention or control (i.e., business as usual or alternative treatment), are the gold standard for educational research. For a pilot study, this design is typically underpowered because the study involves a small sample size.

An efficacy study is the next step in the sequence and is funded under a different goal. A fully scaled randomized controlled study provides evidence for effectiveness of an intervention in idealized conditions. While IES guidelines suggest that SCD research can be conducted to provide evidence of efficacy, a review of funded projects as well as personal experience suggests that reviewers do not regard SCD research to be sufficient to show that a developed intervention is better than alternatives.

Personnel

When planning for a development and innovation study, it is important to demonstrate that the research team has the experience and expertise needed to develop and implement a promising intervention in ways that generate knowledge for the field. This includes describing the qualifications of each member of the research team, as well as their specific roles and responsibilities within the team. (p. 408) Individually and collectively, the research team members must demonstrate that they have the qualifications, time, capacity, and potential to complete the proposed study successfully. Research on literacy interventions for DHH students often requires the collaboration of researchers who span fields of study. Understanding the development of language and literacy could require researchers with knowledge of linguistics, psychology, audiology, literacy, pedagogy, sociology, statistics, and more. (See Branum-Martin, this volume, for a discussion of longitudinal analysis for language and literacy research among DHH individuals.) In addition to including perspectives from a range of relevant fields of study, research teams must also demonstrate the cultural and linguistic competence to engage fruitfully with diverse DHH students, teachers, parents, and school administrators (this is discussed in greater detail in Chapters 16, 17, and 29 by Morere; Enns and McQuarrie, and Cawthon and Easterbooks, this volume). That is, researchers must be able to form, maintain, and develop relationships with research sites, participants, and collaborators, and this may require working between languages, using a range of communication systems, and demonstrating an understanding of a range of language philosophies and educational commitments. Therefore, research teams studying literacy interventions for DHH students not only must be interdisciplinary, but also often must be multilingual, multicultural, and inclusive of a range of perspectives on language and pedagogy.

Resources

Just as a research team must have the capacity to design and implement a large-scale study, there must also be institutional capacity to support such work. In literacy intervention research, this often means having access to, and partnerships with, schools for the deaf and deaf education programs within mainstream settings. It also may require access to individuals who could be trained to administer assessments or to provide instruction in

a range of settings, which may require the use of American Sign Language (ASL) or various communication systems (e.g., Cued Speech). In other words, researchers investigating the literacy development of DHH students must have partnerships that support research in settings where DHH students are educated. Such settings may require various linguistic and cultural competencies at each stage of the research process. This includes finding linguistically and culturally responsive ways to recruit participants in order to ensure informed consent from parents and informed assent from children. It also means conducting assessments, providing instruction, and interpreting student data with knowledge of students' language histories and proficiencies in mind. In some cases, an interdisciplinary team is needed to design data collection instruments and analyze the data that are collected so that analyses may be informed by an understanding of both English language development (e.g., What stages of orthographic development are indicated by these spelling miscues?) and sign language use (e.g., What features of ASL are surfacing in this student's writing?). Finally, and importantly, it means disseminating findings in accessible settings and modalities to ensure that all members of the broader deaf education community can benefit from the findings of research.

Case Studies

Next, we present two case studies of how to develop a literacy intervention specifically for DHH children. Foundations for Literacy was developed by the authors of the intervention based on evidence-based early literacy interventions with TH preschoolers at risk for reading failure and on knowledge of the specific challenges of DHH preschoolers. Strategic and Interactive Writing Instruction (SIWI) was developed by adapting and combining existing theories and practices used with a variety of student and adult writers and was refined for DHH learners in collaboration with teachers of the deaf during development studies. We offer these as case studies of how to apply the IES framework for developing effective interventions for DHH students.

Foundations for Literacy

Foundations for Literacy is an early literacy intervention developed for DHH 3- to 5-year-olds (Lederberg et al., 2018). We (the research team) developed Foundations for classroom teachers to use an hour a day for an academic year. Targeted learning objectives include vocabulary, narrative skills, alphabetic knowledge, phonological awareness (PA), and reading decodable words and short connected text. Each lesson includes strategies for differentiating instruction using engaging, multisensory, age-appropriate, integrated activities. Foundations was developed over 12 years with two IES development grants. The IES-funded Center for Literacy and Deafness funded a randomized controlled trial to establish efficacy.

(p. 409) Personnel

The interdisciplinary team of researchers and teachers who developed Foundations included an educational psychologist with expertise on the development of DHH children, a deaf educator with experience as a classroom teacher and professor of deaf education, and a speech pathologist with expertise in developing literacy interventions for hearing children. Graduate students who had extensive experience with DHH children both as classroom teachers and, in two cases, parents, joined the team. These teachers had experience with both Listening and Spoken Language and bilingual environments. Other collaborators included experienced literacy specialists for hearing children and a specialist in deaf children and preschool intervention, who joined us for quarterly review meetings. Finally, many teachers of the deaf and their DHH children provided valuable input.

Initial Conceptualization

Proposal. As a result of universal newborn screening, cochlear implants, and digital hearing aids, many DHH children use spoken language as a basis for reading. However, most DHH children are still delayed in both language and foundational preliteracy skills, such as PA (Lederberg, Schick, & Spencer, 2013). The target population for Foundations was DHH prekindergarteners with functional hearing. The team used the term *functional hearing* to refer to auditory access to spoken language. We thought—and think even more strongly now—that DHH children who hear to some extent may learn to read differently from those who are profoundly deaf. In this initial grant, we knew we wanted to focus on sound-based decoding skills, such as letter–sound correspondences and spoken PA, and we decided to start with children most likely to use spoken English phonology to read.

One premise of our research was that evidence-based interventions developed for hearing children could form the basis for an intervention for DHH children. Thus, during the initial grant application, we proposed to adapt an existing preschool intervention for hearing children called Literacy Express (Lonigan, Clancy-Menchetti, Phillips, McDowell, & Farver, 2005) to meet the needs of DHH children. We chose Literacy Express because there was considerable evidence that it improved outcomes for hearing preschoolers at risk for future reading failure and because we knew the authors.

Reconceptualization. When we received the good news we were funded, we had the time to carefully examine Literacy Express and visit our local schools. We realized there were many obstacles to what we proposed. There was a mismatch between the level of instruction in Literacy Express and DHH preschoolers' abilities. To name just a few of the obstacles we found, instruction was too fast and implicit, many DHH children would not know the vocabulary used in phonological awareness (PA) activities and thus would need vocabulary lessons, and alphabetic instruction that taught letter–sound correspondence relied on children's PA abilities (e.g., sounds were taught through alliteration—*b* is the first sound in boat). We realized adapting Literacy Express to fit the needs of DHH children would require a complete rewrite of the intervention. We also realized that we would have to share the intellectual property rights to the resulting adapted intervention with the authors of Literacy Express.

We then stepped back from our grant application and redesigned our development project. We decided to develop our own intervention. We committed to developing an intervention that teachers of DHH children could use. This may seem self-evident, but many times researchers test an intervention to investigate a research question, examining if a specific strategy results in a change in children's learning. We then developed a framework that guided our development work with the following three assumptions. We began with the assumption that our intervention should be based on the critical elements of an effective intervention for hearing children who were at risk for reading failure. During our first year, we examined evidence-based interventions like Literacy Express to develop our framework and lesson plans, as well as interventions that were being used with DHH children (e.g., Tade & Vitali, 1994). Second, the instructional activities needed to be adapted to the characteristics and challenges of DHH children with functional hearing, especially their language delay and distorted and weak access to spoken phonology. Third, the large individual differences among DHH children meant we had to build individualization into our lessons to support children's language and auditory abilities. Foundations was developed in two phases, and then it was tested in an efficacy study. Here we highlight some of the critical elements of the development process.

Development Phase One

During the first phase, research teachers (i.e., teachers who were part of the development team) taught Foundations to small groups of children between (p. 410) the ages of 3;8 and 5 years throughout the school year. We developed Foundations in two schools—one with a Listening and Spoken Language philosophy, the other a bilingual school. Both schools allowed research teachers to deliver our participants' literacy instruction so we would know learning was not due to additional time in language arts instruction. Initially, the lead developer of Foundations also taught, but it soon became apparent she could not teach and develop Foundations at the same time. We collected data in multiple ways. Independent assessors who were not part of the research team administered standardized assessments at the beginning and end of the school year to measure gains in vocabulary, alphabetic knowledge, and PA. We developed curriculum-based assessments that aligned with our learning objectives; research teachers administered these assessments at least quarterly. Research teachers kept daily notes on child engagement and learning. Research teachers video recorded their lessons. We also developed a fidelity rubric toward the end of this phase and assessed teacher fidelity from the videos. As we developed Foundations, we utilized iterative, single-case, and comparative research designs.

Iterative Design Study. Iterative designs are critical to development work. By definition, this meant the team periodically evaluated its data to make informed decisions on the instructional elements of Foundations. Research teachers taught 4 days a week and met on campus on the fifth day to discuss the week's activities and to review and develop activities for the following week. The ability to have immediate feedback from experts who were involved in the development process was critical to the success of the intervention. This feedback could happen daily, since, unlike classroom teachers, research teach-

ers had the time to reach out to the developer. The whole research team met quarterly to reflect on data and discuss any changes to the overall structure of Foundations.

Pilot Studies. ***Single-Case Research Design (SCRD).*** Typically, pilot studies occur at the end of a development project. However, we embedded our pilot work within the iterative design study. We conducted several multiple-baseline SCD studies to assess specific instructional strategies. During the first 2 years of development, we focused on establishing a functional relation between instruction of letter–sound correspondences and children's learning (Beal-Alvarez, Lederberg, & Easterbrooks, 2012; Bergeron, Lederberg, Easterbrooks, Miller, & Connor, 2009). Each week of Foundations had a series of instructional activities that were designed to establish an association between a phoneme and its associated letter(s). A phoneme was introduced embedded in a story that created a semantic association for that sound (e.g., a girl going down a slide and saying eee, for the long vowel e). The story is repeated throughout the week and is enacted in a language experience activity (e.g., going outside and saying eee while going down the slide). The phoneme is associated with its corresponding letters (i.e., e, ee, ea). While interventions for TH children create semantic associations for remembering letters (Ehri, 2014), our adaptation was to use this strategy for remembering sounds, a more difficult task for DHH children. Because instruction of each letter–sound correspondence was separated by time in Foundations, we were able to conduct multiple-baseline across-content studies while teachers followed Foundations' hourly lesson plans without changing instruction except for daily data collection.

After establishing that our instructional strategies for alphabetic knowledge were effective, we turned our attention to PA—a more challenging study because acquisition was slower. In addition, PA was not traditionally taught to DHH children and some of the research team felt that PA instruction could be too challenging for DHH children, especially learning to rhyme. Based on the initial premise that Foundations would include learning objectives for hearing preschoolers until they were shown to be inappropriate for DHH children, other members of the research team insisted we attempt to teach rhyming skills. In the second year of implementation, we systematically tested three instructional strategies to teach rhyme. First, we exposed one group of DHH children to nursery rhymes, rhyming songs, and other preschool activities and found the children's rhyming recognition abilities did not improve. Next, we tested explicit instruction on rhyming with picture support; that is, children were shown pictures of rhyming pairs and asked if they rhymed or not (e.g., displaying pictures of a bat and a mat, teachers said, "Bat and mat rhyme, they share the same last sound."). The children still did not learn to rhyme, which we found surprising, since picture support was an effective tool for vocabulary instruction, reading, and instruction in other PA skills. We decided that picture support might actually be distracting the children, who were trying to look for similarities in the pictures. Next, we taught rhyming through explicit instruction without picture support, placing an emphasis on auditorily discriminating rhyming and (p. 411) nonrhyming pairs (e.g., "Do these words rhyme: *moon–spoon*? Do they sound the same at the end? Do these words rhyme: *moon–snake*?) The last approach worked for both children and was replicated with three other children. The following year we conducted a multiple-baseline across-content

SCD study with three PA skills—syllable segmentation, initial phoneme isolation, and rhyming—taught sequentially across the school year. The results established functional relations between instruction and acquisition of a PA skill for most (though not all) DHH children (Miller, Lederberg, & Easterbrooks, 2013; Tucci & Easterbrooks, 2015).The advantage of including SCD research in a development study is that it provides preliminary evidence for the effectiveness of that intervention that can be published, unlike data collected for an iterative design study. On the other hand, the challenge with SCD research is that data collection can interfere with implementation of the intervention.

Comparative Design Study. While we were developing Foundations with small groups of children in two schools, our assessors also administered the same battery of language and literacy tests to DHH children who were enrolled in other schools. We were able to form a comparison group by selecting a subgroup of children who met our inclusion criteria for participation in the Foundations intervention. Lederberg, Miller, Easterbrooks, and Connor (2014) found that children taught using Foundations showed more gains across the school year on standardized tests of PA and alphabetic knowledge, but not vocabulary, than children in the comparison group. Interestingly, one criticism from reviewers was that we could not describe instruction for the comparison children. While we did not have the resources to conduct these observations, researchers planning a quasi-experimental design should attempt to define instruction in all classrooms.

Our strategy of collecting the same data over time from all the DHH children in our area also resulted in assessments for a large number of children, even though we obtained data on small numbers of children every year. This meant we could examine the psychometric properties of our assessments (Webb & Lederberg, 2014; Webb, Patton-Terry, Bingham, Puranik, & Lederberg, 2018), describe the factor structure of language and literacy skills of DHH preschoolers (Webb, Lederberg, Branum-Martin, & Connor, 2015), and examine the 2-year longitudinal development of vocabulary, alphabetic knowledge, and PA of a subset of children (Scott, Goldberg, Connor, & Lederberg, 2019).

Development Phase Two

We received a second development grant with several objectives. These included adding narrative and Theory of Mind to our learning objectives, creating a parent component, implementing Foundations with DHH children without functional hearing, and having classroom teachers use Foundations in authentic educational settings.

Iterative Design Study. The iterative design study was the major activity of this phase, and it became focused on measures of feasibility and classroom teachers' fidelity. Teachers provided feedback on a structured written form and in focus groups. We reviewed video recorded lessons and did live observations. We collected the same formal fidelity measures that were used in the first phase (see Lederberg et al., 2014).Throughout the 4 years of development, we made revisions to the teacher manual, curriculum material, coaching, progress-monitoring measures, and 2-day professional development training.

Input from teachers was invaluable in making Foundations a feasible and effective intervention.

We also continued to collect the same measures of student learning that were used in phase one, and we added narrative and Theory of Mind. Our curriculum-based measures became progress-monitoring measures and allowed us to monitor progress during the year and to adjust lessons when necessary. The team continued to collect Fall and Spring assessments to compare student outcomes for children classroom teachers taught with those obtained for children research teachers taught. Results indicated that students who were taught Foundations by classroom or research teachers made similar progress in alphabetic knowledge and PA and significantly more progress than students in the comparison group. In addition, students taught by classroom teachers made more progress in vocabulary than those taught by either research teachers or comparison teachers. Perhaps most exciting, students taught using Foundations ended the school year with age-appropriate skills in these three areas (Thomas et al., 2016).

Phase 3: Efficacy Study

As part of the Center for Literacy and Deafness (see clad.education.gsu.edu), the team conducted a randomized controlled study during 2016–2017. We spent the spring of 2016 recruiting 48 teachers in 10 states. Classrooms were diverse and included urban and rural schools, those with DHH children in self-contained classes, and those integrated with hearing students, as well as a range of communication philosophies. An independent researcher, blind to the (p. 412) names of the schools, randomly assigned teachers to groups blocked by communication modality. Intervention teachers agreed to attend a 2-day training during the summer, to implement Foundations during the school year, video recording their instruction 1 week out of every 5 weeks, and to be available for remote coaching. Control teachers agreed to video record their language arts instruction three times during the school year and were given the opportunity to attend Foundations training the following summer. DHH children taught with Foundations made significantly larger gains in alphabetic knowledge, PA, and word reading than children in the control group, with moderate to large effect sizes. There were no differences between intervention and control children on language outcomes. Both intervention and control children made significant gains in standard scores on vocabulary tests. On an end-of-the-year survey, 95% of teachers said they enjoyed teaching Foundations, felt their children benefited, would recommend it to other teachers, and planned to continue using it the next year if they have an appropriate class.

Dissemination

We have been disseminating Foundations for 2 years. Our goal is to provide Foundations for Literacy to classroom teachers at a reasonable cost and in a form so that implementation is feasible and teachers will use it with fidelity. We require attendance at a 2-day professional training workshop in order to buy Foundations. After training, teachers can purchase Foundations for Literacy at cost. By the summer of 2019, over 500 teachers had re-

ceived training, most frequently at statewide training workshops. We are also piloting a British version in the United Kingdom.

Strategic and Interactive Writing Instruction

SIWI is an evidence-based framework for writing instruction created for DHH students. SIWI comprises seven foundational principles, of which strategy instruction, interactive writing instruction, and linguistic competence and metalinguistic awareness are highlighted as driving principles.

Strategy instruction has a rich tradition of research and practice in both general and special education settings (see Applebee, 2000; Harris, Mason, Graham, & Saddler, 2002; Flower & Hayes, 1980). Since writing instruction for DHH students is often characterized by a focus on remediation of basic skills, the use of strategy instruction in the context of authentic construction of text was a novel approach in deaf education settings. Interactive writing instruction has a long history of theory and practice in general education settings. It includes a focus on co-construction and negotiation of texts and meaning, which is informed by sociocultural theories of teaching and learning (Lave & Wenger, 2003; Vygotsky, 1978, 1994; Wertsch, 1991) as well as research on language acquisition (Jackendoff, 1994; Pinker, 1995) and second language learning (Ellis et al., 2009; Krashen, 1994). The pedagogical focus on expressive and receptive language development in SIWI lessons is informed by research on first and second language acquisition. Therefore, SIWI engages theory and builds on empirical evidence from general education, special education, and writing research.

Researchers have investigated SIWI as both a short- and a long-term writing intervention in several teacher partnership grants and two IES grants: a development grant and an efficacy grant. For more information about SIWI and related research, visit siwi.utk.edu.

Research Team

In its current iteration (2019), an interdisciplinary team of researchers and practitioners have developed and refined SIWI for over more than a decade. As evidence of positive outcomes accumulated, more educators, researchers, and specialists joined the team, bringing new perspectives to investigate different aspects of the intervention. Over the years, the team has included deaf education, literacy, and special education researchers with experience as classroom teachers of the deaf and educational interpreters, and/or extensive experience developing writing interventions and related professional development for student writers. Also, the team has included reading and writing specialists, intervention coordinators, classroom-based and itinerate teachers of the deaf, and speech-language pathologists. Other collaborators include a researcher and methodologist who investigates the language development of DHH students, a statistician with expertise in the design of research with DHH children, and a former school-based speech-language pathologist who researches the spelling patterns of DHH students. Consultants from a variety of backgrounds have further advised the SIWI team on specific aspects of language and literacy; for example, bilingual literacy development, teacher professional develop-

ment and learning, composition studies, and literacy and new literacies. Additionally, the team has been joined by practicing classroom teachers of the deaf across the United States in bilingual, Listening and Spoken Language, and Total Communication settings.

(p. 413) The next sections describe three broad phases of SIWI development, with the goal of illustrating the iterative and elaborative process of designing and testing an intervention. The three phases include: initial development and field testing, expansion and refinement, and a third phase focused on demonstrating efficacy at scale.

Phase One

During initial development and field testing, the researchers combined and extended empirically and theoretically grounded approaches to writing instruction, which led to the conceptualization of SIWI as an instructional framework for teachers working with DHH students (see Wolbers, 2007, 2008a, 2008b). After implementing SIWI in another classroom, we (i.e., the research team) conducted quasi-experimental studies, with one of the researchers serving as the teacher-of-record to increase the empirical evidence of the approach and to further explore the pedagogical tools used during the implementation of SIWI (see Bowers, Dostal, McCarthy, Schwarz, & Wolbers, 2015; Dostal & Wolbers, 2014, 2016; Dostal, Bowers, Wolbers, & Gabriel, 2015; Wolbers, 2008a, 2008b; Wolbers, Dostal, & Bowers, 2012; Wolbers, Bowers, Dostal, & Graham, 2013; Wolbers, Graham, Dostal, & Bowers, 2014). Engaging in research to develop an intervention in which the researcher is using the instructional approach or intervention allows for ongoing reflection, a focus on feasibility of implementation under authentic conditions, and responsive revisions to the approach based on student feedback and outcomes.

During the initial set of quasi-experimental studies, we demonstrated the effectiveness of SIWI as an intervention (see discussion above) and the reciprocity of language and literacy learning among DHH students (see Dostal & Wolbers, 2014; Wolbers, 2008a). Results from studies of elementary and middle-grade DHH students showed us how students who had previously demonstrated little or no growth in literacy development over several years of schooling made significant gains in both language (i.e., ASL) and literacy proficiency (i.e., genre features, writing traits, written language complexity and clarity) when engaged in SIWI. We therefore began sharing SIWI with teachers of the deaf (TODs) as part of four consecutive state Teacher Quality Partnership Grants within which small cohorts of TODs engaged in a 1-week summer workshop with in-school support during the school year. Sharing elements of SIWI with practicing teachers allowed us to develop and refine further the professional development model we used to support participants in later research studies. By gathering evidence about teachers' fidelity of implementation over time, we learned that it takes up to 3 years for a teacher to master the principles of SIWI for full implementation, and that teachers' knowledge and implementation grow steadily over time (Wolbers, Dostal, Skerrit, & Stevenson, 2016).

Phase Two

Though we drew upon principles from our work in SIWI when supporting and teaching pre- and in-service TODs, there had never been a large-scale study of SIWI outside of a researcher/developer's own classroom. Therefore, we built a team of researchers to apply for and secure an IES Goal 2 Development and Innovation grant in order to scale-up investigations of SIWI to include multiple classrooms across a range of school settings and state/regional contexts.

The goals of the project focused on collaboratively developing and refining SIWI and related instructional and professional development materials with practitioners across new and previously studied grade levels. During this 3-year project, we were committed to (a) engaging in an iterative development process with a focus on each driving principle of SIWI with participating teachers, (b) testing the feasibility of the intervention across settings, (c) measuring student writing outcomes from before to after intervention over one academic year, and (d) refining the professional development process. We explored these commitments by conducting a 2-year feasibility study that included six TODs across three schools, a quasi-experimental study with a small comparison group (Wolbers et al., 2018), a SCD study (Wolbers et al., 2015), several action research projects, and a 1-year pilot study (Wolbers et al., 2018), which included a SIWI experimental group and a control group. Therefore, researchers were not only investigating whether SIWI was effective, but also discovering when, for whom, and under what circumstances it was effective.

This work produced robust results related to student learning and teacher implementation (described above), but highlighted in here are three key ideas related to the intervention design process during the development and innovation phase:

1. Developing an intervention in partnership with teachers creates an intervention that is usable and relevant.
2. Collecting and connecting student-level data and teacher-level data during the implementation of (p. 414) the intervention provide teachers with compelling evidence for how the work they do impacts student performance.
3. Developing a community of practice among teacher participants increases the likelihood of future expansion of the intervention.

The first and third key ideas identified above were closely connected in our studies. We developed a community of practice, in part, by the partnerships formed with teachers through ongoing professional development and collaboration. Teachers and researchers worked together during summer and winter professional development sessions, online group meetings, and weekly individual meetings that embedded video recording instruction from their classrooms. During these sessions, we evaluated student data (e.g., writing samples across genres, scores on standardized assessments of reading) and teacher data (e.g, measures of knowledge and implementation) to guide decisions about the development of materials and instructional approaches to responsively address the core elements of the intervention. By engaging in the sessions, teachers became invested in the project and intervention and shared the work with their colleagues who participated in

the research during phase three. This, in turn, supported our future recruitment efforts and created an intervention that was relevant to teachers (i.e., key idea 1). We used findings to refine and extend the intervention as well as deepen understandings of how to implement and support its use.

Phase Three

Following the IES Goal 2 Development and Innovation grant, we designed our efficacy study to test the impact of SIWI on language and literacy outcomes in the intervention students compared to outcomes in students receiving typical writing instruction across a range of settings. The efficacy study included a randomized controlled trial of SIWI, as well as a focus on the impact and feasibility of teacher development. This ongoing study (2017–2021) aims to provide new understandings regarding the extent to which (1) teacher knowledge, instruction, and efficacy account for DHH student writing and language outcomes, and (2) teacher implementation fidelity impacts student outcomes. In addition to exploring teacher development, the study also aims (3) to replicate the student-based writing and language outcomes of the development project, and (4) to explore additional language- and literacy-related outcomes (i.e., measures of reading, writing motivation, language proficiency, performance on state assessments).

The focus on teacher professional development is especially important for understanding how to share and implement interventions that have a record of success. It is not enough to know that SIWI has been successful in research studies conducted across a range of settings. It is also important to know how to prepare teachers efficiently and effectively to engage with SIWI in classrooms beyond those involved in a research project. As part of the current research project, teachers attend a 1-week training and receive ongoing in-person and online coaching to support their understanding and application of SIWI. Findings from our current study of teacher development will inform a development model that could be used by those who want to engage with SIWI outside the context of a research study.

Conclusion

One of the biggest challenges of literacy intervention research among DHH students is the logistics of managing participants across a wide range of education settings. In order to recruit enough teacher and student participants for robust sample sizes, and in order to achieve a balance of languages and settings within the sample, researchers have to reach out to many schools and districts. While some intervention research can be done in a single school or district setting, literacy intervention research among DHH students may include a small number of participants distributed across a robust number of schools, districts, and states. As more research on DHH students is funded, there will be increasing demand for participants in studies. In order to avoid overtesting and overanalyzing DHH students as they grow, it is important for researchers developing interventions to consider efficient, noninvasive ways to gather and share data about instructional innovations (Gabriel & Dostal, 2013). One important way to develop interventions that are

responsive to teachers' needs includes field-initiated studies that arise from the work of teachers in their own classrooms (see Cawthon and Easterbookshis volume, for a discussion).

Foundations and SIWI benefited from initial development and field testing in classroom settings and from steady growth beyond implementation in a single classroom, to implementation in multiple classrooms within a state, and later multiple classrooms across several states. The pairing of researchers working closely with teachers over time has ensured that both practical and theoretical issues are addressed, often simultaneously, with challenges in practice driving theoretical understandings and vice versa. In order to facilitate this close engagement in the context of a (p. 415) large-scale research study, researchers invest a significant amount of time in watching video-recorded lessons and in coaching individual teachers throughout the school year. In turn, teachers spend a significant amount of time gathering data about each individual student in order to inform coaching conversations and to guide instruction. Though the work is meaningful and beneficial for teachers learning more about their craft and their students, the time required to support implementation is part of the reality of an intervention that requires and builds teacher expertise.

As discussed in this chapter, the development and testing of educational innovations require the sustained commitment of interdisciplinary teams with a range of competencies and resources. It may take more than a decade to develop and test a literacy intervention fully. However, students and teachers can benefit enormously from participating in the processes of research along the way. Teachers who were given early versions of innovative practices not only had the opportunity to expose their students to instruction they would not normally have had, but also were able to provide input that shaped and refined that instruction for future students. Therefore, even if interventions are still in development over a long period of time, teachers and students may be benefiting both from the intervention and their engagement in the processes of research along the way. This is why robust partnerships with schools and educators are so important for research teams, and why participating in research is so important for educators, schools, and students.

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