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Voices from Academia
Initial Evaluation of the Project Core Implementation Model

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ABSTRACT

Many students with significant cognitive disabilities have difficulty expressing themselves through speech or sign language. These students could benefit from aided augmentative and alternative communication (AAC) systems and interventions aimed at teaching communication. Unfortunately, access to such communication systems and interventions is limited for this group of students. Teachers have the potential to address this persistent problem and service need if provided effective training, resources, and support. The current participatory action research study applied mixed methods to investigate changes after classroom professionals had access to the training and resources included in the Project Core implementation model. The results are encouraging with regard to the potential for teachers to develop the knowledge, skills, and dispositions required to help students with significant cognitive disabilities learn to use aided AAC that features core vocabulary. The study provides guidance and a replicable approach to the development of an implementation model aimed at teachers and classroom-based intervention practices.

Keywords: augmentative and alternative communication, aided language input, core vocabulary, significant cognitive disabilities, symbolic communication

INITIAL EVALUATION OF THE PROJECT CORE IMPLEMENTATION MODEL

Students with significant cognitive disabilities comprise approximately 1% of the K–12 population and almost 10% of students with disabilities in U.S. public schools (Thurlow & Wu, 2016). Among these students, at least 165,000 are unable to use speech, signs, or graphic symbols to meet their communication needs (Erickson & Geist, 2016; National Center for Educational Statistics, 2017) and could benefit from access to aided augmentative and alternative communication systems (AAC). Aided AAC refers to a variety of external tools, with or without voice output, that individuals can use to select letters, words or symbols to communicate. Unfortunately, students with significant cognitive disabilities and complex communication needs have little access to aided AAC (Erickson & Geist, 2016). On average, they spend less than an hour per week with specialists like speech-language pathologists (SLPs) who have training in AAC interventions (ASHA, 2018; Brandel, 2020; Brandel & Loeb, 2011). Classroom teachers spend most of the school day working directly with students and have the potential to address this persistent problem and service need. With training and support that is consistent with the needs of teachers and the structure of their classrooms and instructional activities, it is possible that teachers and their staff can deliver effective access to aided AAC and communication intervention within the context of a typical school day.

TARGET AUDIENCE AND RELEVANCE

The current project was inspired by K–12 students with significant cognitive disabilities and complex communication needs who often require increased access to aided AAC systems and more intensive AAC interventions. Significant cognitive disability is a term created by the Office of Special Education Programs (2005) to identify the relatively small group of students with a disability or multiple disabilities that significantly impact intellectual functioning and adaptive behavior to such an extent that they cannot achieve grade level standards even with the best instruction and appropriate accommodations. According to the U.S. Department of Education, students with significant cognitive disabilities are a diverse group of students who receive special education services under a variety of eligibility categories (e.g., autism, intellectual disability, multiple disabilities) and who require extensive, repeated, individualized instruction and support, substantially adapted materials, and targeted instruction to acquire, maintain, and transfer skills across settings (Office of Special Education Programs, 2005). Research suggests 18 (Towles-Reeves et al., 2012) to 35 percent (Browder et al., 2008) of students with significant cognitive disabilities do not use symbolic communication. Those who use AAC tend to use single symbols for an extremely restricted range of purposes (Erickson & Geist, 2016).

Guided by implementation science, the project sought to develop and ultimately provide open-source access to training and resources to support teachers in implementing early symbolic communication instruction for their students across the entire school day. This information may be of interest to school administrators, curriculum coordinators, coaches, teachers, SLPs, and assistive technology providers for the purposes of planning, professional development (PD), and preparing communication materials,

intervention, and ongoing support for teachers and students. The iterative and collaborative approach described may also be of interest to program designers who are engaged in the development of solutions that seek to address related areas of need.

Implementation Science

Many communication interventions that are found to work well (i.e., those that have a strong evidence base) are slow to move from controlled studies to typical classrooms (Olswang & Prelock, 2015). The field of implementation science attempts to address this challenge by leveraging researcher and practitioner collaborations from the outset in order to increase understandings of the context, potential barriers, and necessary resources for effective delivery of practices known to lead to positive outcomes for students (Fixsen et al., 2013; Olswang & Prelock, 2015). Implementation science was first established in healthcare to respond to persistent reports that empirically supported innovations were not demonstrating the targeted outcomes when rolled out in typical settings (Kelly, 2013; Nordstrum et al., 2017). The goals of implementation science include reducing disparities in access to interventions and promoting the use of evidence-based practices and programs in common clinical, home and community-living settings (Eccles & Mittman, 2006; National Institutes of Health, Fogarty International Center, 2018). Implementation science accomplishes this by promoting the adoption, delivery and sustained use of evidence-based interventions while emphasizing external validity and often applying mixed-methods designs (University of Washington, 2020).

The Project Core Implementation Model

The primary goals of Project Core are twofold: (1) to empower teachers and classroom professionals to deliver early symbolic communication instruction during the naturally occurring academic and daily routines of the school day, and (2) to improve communication outcomes of students with significant cognitive disabilities and ultimately improve their academic performance on mandated end-of-year assessments in English language arts. The specific AAC and communication intervention practices targeted by the Project Core implementation model include: (a) attributing meaning to early forms of communication like body movements, facial expressions, gestures, and vocalizations (Rowland, 2011) to support language learning (Yoder et al., 2001); (b) personal access to aided AAC systems (e.g., Douglas et al., 2012; Ganz et al., 2012); (c) use of high-frequency words, called core vocabulary, represented by graphic symbols (e.g., Banajee et al., 2003; Cross et al., in press; Trembath et al., 2007); and (d) aided language input strategies to build receptive understanding of language and show students how to use graphic symbols to communicate (e.g., Brady et al., 2013; Romski & Sevcik, 1996; Sennott et al., 2016).

Design Requirements

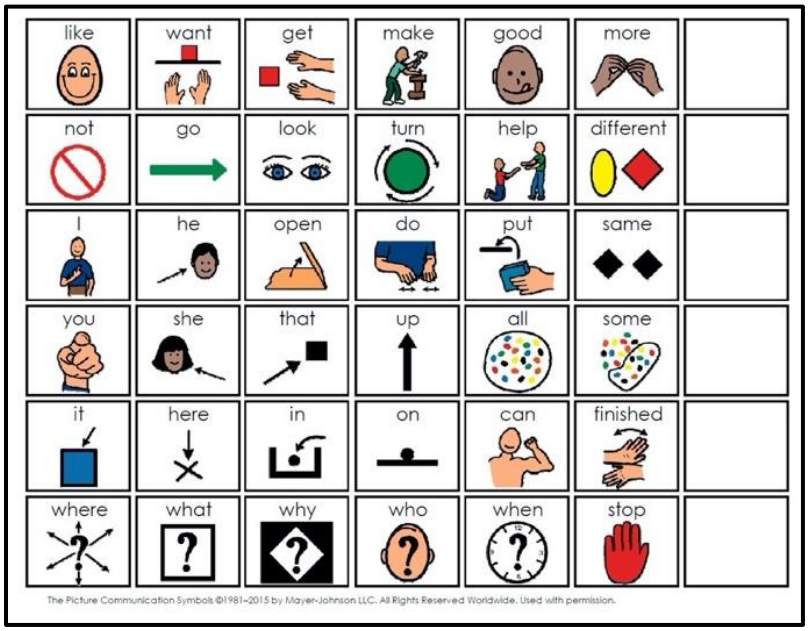
Design efforts were aimed at creating a sustainable implementation model and providing a replicable approach. Design of the Project Core implementation model required careful attention to multiple factors including the need to: (a) fully consider potential funding barriers that could reduce access to the teacher and student-facing components and explore the potential of open-source options as a starting point where needed; (b) ensure the availability of all components for download, distribution, and use on an as-needed basis; and (c) apply a PD approach that allows school-level implementation teams to facilitate

teachers' access to learning and practice opportunities during group sessions and/or through self-directed study.

Aided AAC Formats with Universal Core Vocabulary

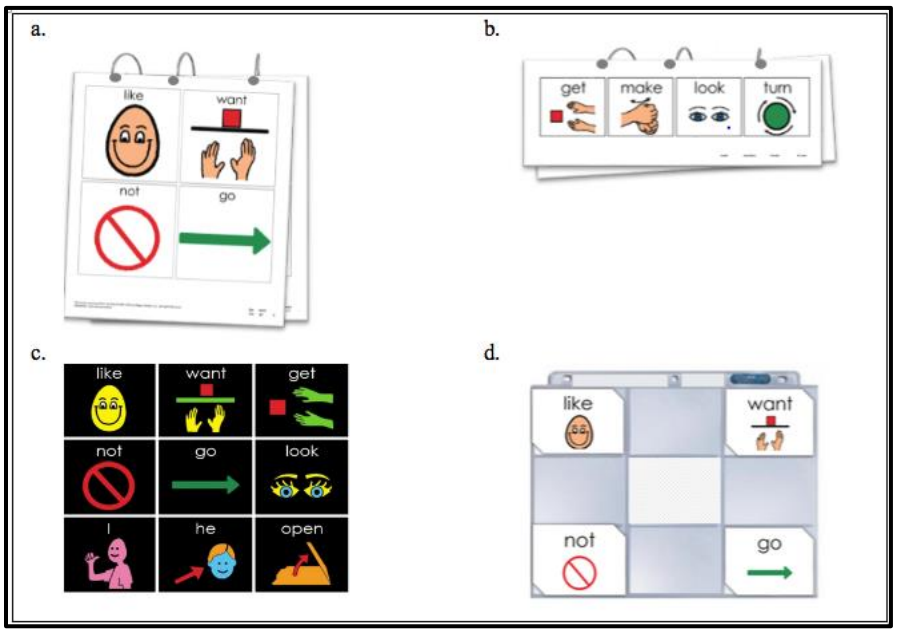
Given the substantial need for aided AAC that is detailed in the current literature (Erickson & Geist, 2016; National Center for Educational Statistics, 2017) and funding barriers reported by partner sites, the research team worked to provide access to aided AAC using core vocabulary in downloadable, open-source formats. A core vocabulary list was defined based on previous research (see Cross et al., in press) that included 36 words (e.g., go, not, like) that are powerful as single-word utterances, can be combined to produce utterances with more complex syntax, and can be used across purposes and contexts. This core vocabulary was given the name *Universal Core*, and each word was paired with a graphic symbol and organized in various grid layouts (see Figures 1 and 2). Good usability (i.e., easy to learn and use) for teachers with little to no background in AAC and support for student access were design priorities. The resulting Universal Core vocabulary formats support access through (a) pointing with a finger or selecting with a whole hand, (b) looking at the intended word and symbol using an approach called eye gaze, or (c) moving through the available choices to a selection using an approach called partner-assisted scanning (e.g., partner says each word and points to the symbol, then waits for the student to indicate in some way that it is the one they want to choose or the desire to move on to the next one). Additionally, 3D symbols were designed and made available, each with a unique raised element, texture, the printed word, and Braille (see Figure 3).

Figure 1: Example of the 36 Location Universal Core Vocabulary Communication System Represented by Picture Communication Symbols© by Mayer-Johnson



Note: Used with permission.

Figure 2: Examples of Multiple Formats of the Universal Core Vocabulary Represented by Picture Communication Symbols© from Mayer-Johnson



Note: Used with permission. Example formats include: The 4 location x 9 page – Direct Selection (a) version designed for students who use direct selection given large targets. At least initially, the communication partner supports navigation from one page to the next. The 4 location x 9 page – Partner-Assisted Scanning (b) version designed for students who require partner-assisted scanning. The symbols are arranged horizontally to maximize the likelihood that partners will scan through the items in the same order each time. The 9 location x 4 page – Direct Selection/High Contrast (c) version designed for students who use direct selection given large targets and high contrast symbols. At least initially, the communication partner supports navigation from one page to the next. All layouts are available in high contrast like this example illustrates. The 4 location x 9 page – Eye-Gaze (d) version designed for students who can indicate choices using eye pointing.

Figure 3: Example of 3D Symbol

The simple layouts in the various open-source formats were aimed at increasing the teaching and learning opportunities for students who did not otherwise have access to personal AAC systems. If students have access to a more robust AAC system, or when they get access to such a desired system, the Project Core implementation model encourages use of each student's personal system to apply the targeted teaching practices. See http://www.project-core.com/app-and-sgd-product-keys/.

Professional Development

The focus of initial PD sessions was informed by the literature. As the project got underway, the focus and content of subsequent sessions were also informed by analysis of teacher self-assessments and classroom observations. All PD sessions focused on communication intervention using core vocabulary, with the specific content for each session emerging as a result of time spent in the school throughout the year as the research team observed, interacted with, and listened to the teachers and students. Table 1 offers a complete listing of topics that were covered during the PD sessions delivered to teachers participating in the current study, and the associated PD modules subsequently made available via the Project Core website after the initial modules were implemented, evaluated, revised, and implemented again in other research sites.

Table 1: Topics Covered and Associated Online Modules

Session #	Topic(s) covered	Associated online modules
1	• Overview of the development project • Overview of teaching principles: aided language input, core vocabulary, naturalistic teaching	• Project Core Overview
2	• Early forms of communication • The Communication Matrix • Importance of personal access to an AAC system with core vocabulary • Aided language input • Universal Core vocabulary formats • Examples incorporating Universal Core vocabulary into literacy instruction	• Beginning Communicators • Supporting Individual Access to the Universal Core • Aided Language Input
3	• Review of Universal Core vocabulary formats and importance of all students having personal access to an AAC system • Examples incorporating AAC and core vocabulary into common activities	• Universal Core Vocabulary
4	• Examples incorporating the Universal Core vocabulary into literacy.	• Teaching Communication During Academic Routines
5	• Review of design-based research goals • Facilitated exchange of examples of specific classroom examples	
6	• Use of core vocabulary during daily routines	• Teaching Communication During Daily Routines and Activities
7	• Attributing meaning • Encouraging versus requiring communication • Modeling communication versus managing behaviors • Ways to support communication of yes and no • Partner-assisted scanning	• Beginning Communicators • Aided Language Input • Supporting Individual Access to the Universal Core Vocabulary
8	• Incorporating the Universal Core vocabulary into literacy instruction: (a) Shared reading, (b) Predictable chart writing, (c) Independent writing	• Shared Reading • Predictable Chart Writing • Independent Writing

The approach and formats for PD were informed by researchers' reflections on their delivery of the initial content and facilitation of learning activities, observations of participant interaction during the face-to-face PD sessions, observations in the classroom after new intervention strategies had been introduced in the PD sessions, and follow-up conversations with teachers in their classrooms about questions, concerns, and perceived barriers to implementation. Teachers consistently expressed the desire for more examples and demonstration of the intervention strategies with students like those they teach, which the researchers addressed through the inclusion of scenario-based case examples. Additionally, teachers frequently had scheduling conflicts during the times the face-to-face group PD sessions were offered. This need for greater flexibility was ultimately addressed by designing the final PD in two formats: facilitated and self-directed. The facilitated format packages the materials needed to deliver the PD in a group setting, and the self-directed format provides online, on-demand access. See http://www.project-core.com/professional-development-modules/.

The aim of the current study was to evaluate and refine components of the Project Core implementation model as designed. The emphasis was on development and formative evaluation of the implementation model itself (Blasé et al., 2015). Data were gathered to evaluate the effectiveness of the professional development and adequacy of implementation supports and resources. The findings guided improvement cycles (see Blasé et al., 2015) aimed at building a final implementation model that is effective across educational settings (Anderson & Shattuck, 2012; Steketee & Bate, 2013). The data were extremely important for the intended purposes and provide preliminary evidence of the overall effectiveness of the implementation model.

METHODS

The study aimed to evaluate and refine the fit of the Project Core implementation model to the specific needs of classroom teachers and related classroom professionals working with students with significant cognitive disabilities and complex communication needs. The study took a participatory action research approach to guide the initial evaluation of the Project Core implementation model. Reflective cycles of observation and interaction, data collection, analysis, and application of findings were applied (Ozanne & Saatcioglu, 2008). The study was aimed at measuring observable changes in targeted teacher practices and student access to AAC after teachers had access to the implementation model. The participatory action research approach was critical to: (a) evaluating and refining the fit of the implementation model to the specific needs of classroom teachers, (b) evaluating changes in observable teacher practices and self-reported knowledge and skills after engaging in PD and using the materials included in the implementation model, and (c) gathering initial information on associated changes in observable student access to AAC and measurable changes in communication ability level. Mixed methods were used to investigate changes after classroom professionals had access to the training and supporting resources included in the implementation model. The study was guided by three primary questions related to teacher practices and one secondary question related to student outcomes, including: (a) did teachers increase their use of graphic symbols and aided language input strategies; (b) did teachers' self-perceptions of their ability to teach communication improve; (c) did teachers provide

students with increased access to aided AAC (e.g., graphic symbols), and (d) did students achieve higher levels of communication?

Setting

The study was conducted in a public separate special education school in the southeastern US. Given that more than 90% of students with significant cognitive disabilities are educated in segregated classrooms or schools (Erickson & Geist, 2016; Kleinert et al., 2015), the site provided maximal access to a relatively large group of students with significant cognitive disabilities and complex communication needs and supported the evaluation of the model in a setting that was representative of the norm. The school serves approximately 130 students ages 3-22 with significant disabilities. The majority (> 90%) of students are eligible for free or reduced lunch. The reported race/ethnicity at the school level is White (40%), Black/African-American (33%), Hispanic (14%), and other (13%). There is a full-time principal, a curriculum coordinator, a team of full-time related service providers (3 SLPs, 2 occupational therapists, 3 physical therapists), a full-time nurse, and a team of part-time specials teachers (i.e., media, adapted physical education, art, and music). In addition, each classroom has at least one paraprofessional, as well as access to a floating paraprofessional to support personal care needs.

Participants

The participants included classroom teachers (*n* = 15) and students (*n* = 71). Initially there were 16 teachers, but one left the school in the middle of the year. On average, participating teachers were experienced special educators (*M* = 13.6 years; *SD* = 8 years). Student participants were in preschool (*n* = 32), elementary (*n* = 16), middle (*n* = 7), and high school (*n* = 16). Originally, there were 79 student participants, but 8 left the school during the year for a variety of reasons (e.g., family moved). All student participants had significant cognitive disabilities and were deemed eligible for special education services under a number of different categories including multiple disabilities (*n* = 20), autism (*n* = 17), developmental disability (*n* = 20), intellectual disability (*n* = 11), other health impairment (*n* = 1), hearing impairment (*n* = 1), and unknown (*n* = 1). Participating students represented racially and ethnically diverse groups, with the majority identifying as White (*n* = 35) or African-American (*n* = 20), and the remaining as Asian (*n* = 6), Hispanic or Latino (*n* = 4), multiracial (*n* = 4), American Indian or Alaska Native (*n* = 1), and one unknown. There were more male (*n* = 45) than female (*n* = 26) students in the study, which reflected the school overall. Baseline classroom observations and meetings with the school leadership team revealed that the majority of participating students (> 80%) did not have personal access to any form of aided AAC at the beginning of the school year.

Procedures

Delivery of Professional Development

Approximately 12 hours of PD were delivered by the research team over eight 1.5-hour face-to-face sessions. Each PD session included didactic sharing of information, videos, student examples, discussion, guided practice, and numerous activities. The research team met after each PD session to debrief on the session and gather researchers' insights on how well the content and examples provided were received by the teachers and to identify necessary revisions and additions (refer back to Table 1

for a complete listing of topics covered during the current study).

Data Collection

Classroom Observations. During the first month of the school year, researchers began conducting classroom observations. Observations applied the methodology of participant observation (Jorgensen, 1989) during 20- to 30-minute periods, with 141 observations completed across the 15 participating classrooms between the fall and spring of the school year. During the observations, researchers recorded descriptive field notes that provided a written record of what was happening in the classroom. These records included specifics about what and how teachers and students communicated and information about the environment itself. The observations were summarized later to determine the presence or absence of teacher and student behaviors including: (a) teacher attribution of meaning to students' communication attempts, (b) teacher use of graphic symbols, (c) teacher demonstration of use of core vocabulary, and (d) student access to AAC with core vocabulary. Interrater agreement was 86% when observation summaries were independently coded by research assistants and compared to initial data for 28% (n = 40) of the total classroom visits.

Teacher Self-Assessments. To gain insights regarding the overall impact of the PD on teacher knowledge and dispositions regarding the communication intervention, participating teachers were invited to complete a 12-question self-assessment at the beginning and end of the school year. Each question used a 5-point Likert-type scale asking teachers to report their level of agreement with each statement. Finally, all adult participants, especially the principal, team of speech-language pathologists, and a couple of teachers, interacted regularly with members of the research team. These unstructured interactions directed the focus of efforts in identifying and refining specific aspects of the communication instruction, the PD, and additional materials recommended for a complete implementation model.

Student Communication Matrix Profiles. Members of the research team completed a Communication Matrix profile (Rowland, 2004; 2011) for each student at the beginning and end of the school year. The Communication Matrix (Rowland, 2004; 2011) is a direct observational tool/behavioral inventory used to measure early communication behaviors, including those that occur before students begin to demonstrate symbolic communication understanding and use. The Communication Matrix includes a set of 24 yes/no questions that are dispersed across four major communication purposes (refuse, obtain, interact socially, and provide or seek information). Each yes response is then further defined using nine categories of communication behaviors (body movements, early sounds, facial expressions, visual behaviors, simple gestures, conventional gestures and vocalizations, concrete symbols, abstract symbols, and language) that occur at seven levels of communication complexity (pre-intentional behavior, intentional behavior, unconventional communication, conventional communication, concrete symbols, abstract symbols, and language). The use of core vocabulary is scored at level 6 for single word utterances and level 7 for word combinations. The researchers observed each student over multiple sessions and recorded all behaviors that were used independently (i.e., without teacher prompting or assistance). In an effort to reduce the risk of researcher bias, beginning- and end-of-year assessments for each student were completed by different members of the research team and the beginning-of-year assessments and scores were not reviewed prior to completing the end-of-year assessments.

Data Analyses

The study employed descriptive data analyses of frequency counts and percentages to describe changes in observable teacher behaviors, self-reported knowledge and dispositions, and provision of student access to AAC with core vocabulary. The non-parametric Wilcoxon signed-rank test was used to compare student Communication Matrix profiles at the beginning and end of the school year.

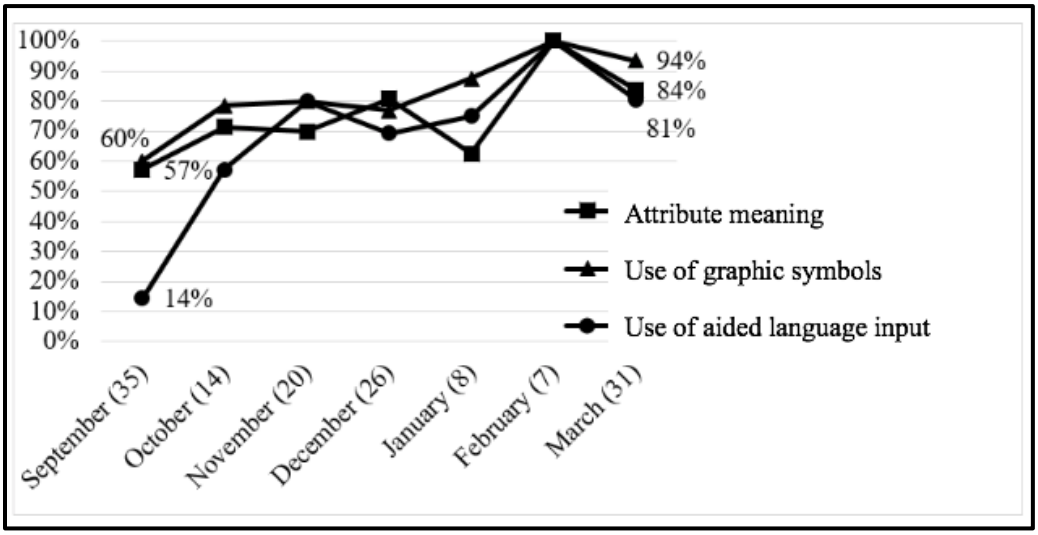
RESULTS

The results provide preliminary evidence of changes in teacher practices given access to the PD and supporting resources included in the implementation model. The results also document changes in student access to AAC and levels of communication after Project Core intervention practices were introduced.

Teachers

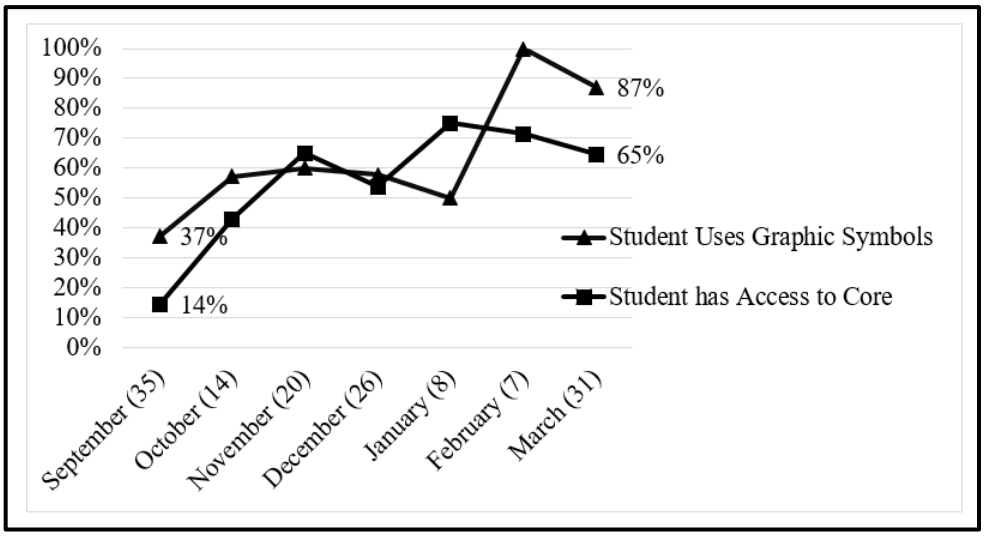
As indicated in Figure 4, frequency counts of teacher behaviors noted in the summaries of each participant observation session reveal that teachers increased their: (a) attribution of meaning to student behaviors (noted in 57% of observations in the fall and 84% in the spring); (b) use of graphic symbols (noted in 60% of observations in the fall and 94% in the spring); and (c) demonstration of core vocabulary (noted in 14% of observations in the fall and 81% in the spring). As indicated in Figure 5, teachers also increased the frequency with which they provided students with access to personal AAC systems with core vocabulary (noted in 14% of observations in the fall and 65% in the spring).

Figure 4: Classroom Observation of Teacher Behaviors



Note: Number of observations per month appear in parentheses.

Figure 5: Classroom Observation of Student Use of Symbols and Access to Core Vocabulary



Note: Number of observations per month appear in parentheses.

Teachers also reported higher levels of confidence in their skills. As reported in Table 2, teachers reported agreement or strong agreement with 71% of items at the beginning and 94% of items at the end of the school year on the self-assessment. Substantial shifts were noted for some items. For example, at the beginning of the year, only 40% stated that they agreed (20%) or strongly agreed (20%) with the statement, "I feel comfortable and confident in my ability to use AAC with my students." By the end of the year, 90% reported agreement (50%) or strong agreement (40%). On a related survey statement, "I understand how to use a core vocabulary approach with my students who need AAC," there were also notable changes. At the beginning of the year, teachers reported strong disagreement (11%), disagreement (33%), or uncertainty (44%), and by the end of the year, 100% reported agreement (56%) or strong agreement (44%).

Table 2: Teacher Self-Assessments

Question	*n*	Pre					Post				
		1	***2***	***3***	***4***	***5***	***1***	***2***	***3***	***4***	***5***
I have experience using symbols to support my students' learning and communication.	11	0	0	0	4	7	0	0	0	3	8
My classroom provides a lot of opportunities for my students to communicate.	10	0	0	0	7	3	0	0	0	5	5
Academic goals are included on my students' IEPs.	11	0	0	2	2	7	0	0	0	3	8
All my students have opportunities throughout the day to make meaningful choices.	10	0	0	0	1	9	0	0	0	3	7
I have experience using augmentative and alternative communication (AAC) with my students.	11	0	0	2	7	2	0	0	1	5	5

Question	*n*	Pre					Post				
		1	***2***	***3***	***4***	***5***	***1***	***2***	***3***	***4***	***5***
I feel comfortable and confident in my ability to use AAC with my students.	10	0	1	5	2	2	0	0	1	5	4
I understand how to use a core vocabulary approach with my students who need AAC.	9	1	3	4	0	1	0	0	0	5	4
I am able to recognize nonverbal communication behaviors in my students.	11	0	0	1	7	3	0	0	0	4	7
I know how to attribute meaning to my students' communication behaviors.	10	0	1	2	4	3	0	0	0	5	5
I regularly use symbols to model communication when interacting with my students.	10	0	2	0	6	2	0	0	0	5	5
I assess my students' communication skills regularly.	11	1	1	0	7	2	0	0	0	7	4
I have used the Communication Matrix to assess my students.	9	4	1	4	0	0	1	2	2	3	1
Percent Total Responses		5%	7%	16%	38%	33%	1%	2%	3%	43%	51%

Note: 1 = strongly disagree; 2 = disagree; 3 = unsure/neutral; 4 = agree; 5 = strongly agree.

Students

Participant observations also provided data regarding students' use of graphic symbols, which was noted in 37% of observations in the fall and 87% of observations in the spring. The Communication Matrix (Rowland, 2004; 2011) provides further evidence of positive change in student communication skills. At the beginning of the school year, participating students' highest level of communication abilities as measured on the Communication Matrix ranged from early pre-intentional communication behaviors (n = 7) to intentional, non-symbolic behaviors (n = 50) to beginning symbolic communication (n = 9). Behaviors required to score on the Communication Matrix were not observed for the remaining 5 students during pretesting. The mean highest communication level for the group at pretest was 4.3 (SD = 1.5). As reported in Table 3, there were increases in the number of students demonstrating intentional (level 3), conventional (level 4), and symbolic (levels 5, 6, and 7) communication skills from pretest to posttest. Furthermore, the mean highest communication level for the group at posttest was 4.9 (SD = 1.5). One-tailed Wilcoxon signed-rank tests at a significance level of 0.05 indicated that the median posttest ranks were statistically significantly higher than median pretest ranks for subscales measuring communication for the purposes of *Refusing* (Z = -1.702, p = .045, r = -.14), *Obtaining* (Z = -3.409, p < .001, r = -.29), and *Social* (Z = -3.990, p < .001, r = -.33). The differences on the subscale addressing communication for the purpose of *Information* were not statistically significant (Z = 1.155, p = .125, r = -.21); however, it is important to note that the information subscale can only be administered to students with communication behaviors at a conventional level or higher (levels 4, 5, 6, and 7) and therefore only included 24 students at pretest.

Table 3: Number of Students of Each Level on the Communication Matrix (Rowland, 2004; 2011)

	Refuse		Obtain		Social		Information	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Not Scored	5	1	1	0	8	0		
1	2	3	5	1	4	0		
2	5	2	13	6	9	6		
3	43	43	23	26	28	28		
4	7	10	6	4	16	26	0	0
5	3	3	7	13	0	3	10	17
6	6	8	13	11	6	8	14	13
7	0	1	3	10	0	0	0	3
Total	71	71	71	71	71	71	24	33

Note: Per the requirements of the Communication Matrix, the ability to communicate to provide or seek information is only measured at levels 4 and higher.

Mandated End-of-grade Tests in ELA

School performance on the state's required end-of-grade alternate assessment based on alternate achievement standards provides additional evidence of the impact of Project Core on this school. Prior to initiating the focus on communication and interaction through Project Core, there were no students in the school who achieved mastery on this required assessment. In fact, 93% of the students scored at the lowest level possible (level 1 on a 4-level scale). After one year of participation, these numbers shifted with 13% of the students achieving proficiency and 58% scoring at the lowest level.

Summary

Overall, these results are encouraging with regard to the potential for teachers to develop the knowledge, skills, and dispositions required to use AAC that features core vocabulary to teach students with significant cognitive disabilities to use symbolic communication. Increases in observable behaviors provide evidence that teachers successfully learned to use aided language input strategies, while attributing meaning to non-symbolic behaviors and providing students with access to their own AAC systems with core vocabulary. Additionally, teachers reported increased levels of confidence in their abilities to use and teach core vocabulary and AAC in the classroom. Importantly, the findings also suggest that these changes in teacher behaviors contributed to increases in student communication, including the use of graphic symbols on AAC systems.

OUTCOMES AND BENEFITS

The main outcome of the current study is a replicable implementation model aimed at addressing the persistent problem of limited access to aided AAC systems and communication intervention faced by many students with significant cognitive disabilities. The components of the implementation model were evaluated and revised and provide a replicable approach for related lines of research and development in assistive technology. The promising results provide preliminary evidence of the beneficial impact of the implementation model on teachers' perceptions of the value and relevance of the use of aided AAC and targeted communication intervention, their knowledge and skills for delivering access to aided AAC

and foundational communication instruction, and observable changes in classroom practices and student access and use of aided AAC and core vocabulary to communicate.

DISCUSSION

The participatory action research study applied mixed methods to evaluate and refine an implementation model aimed at empowering classroom professionals to teach symbolic communication to their students with significant cognitive disabilities and complex communication needs. Specifically, the researchers sought to create an implementation model that increased the use of teaching practices positively associated with increased symbolic communication skills. The study supported the successful development of a sustainable implementation model (see http://project-core.com) and the mixed-methods evaluation provides important preliminary evidence that it was successful in improving teachers' knowledge and practices, as well as students' communication outcomes. Teachers with little confidence in the use of core vocabulary and AAC instruction prior to engagement in PD and the overall project made notable gains in the use of the targeted teaching practices.

These changes in teacher practices appear to have positively impacted their students' communication skills. This relatively large group of students with significant cognitive disabilities who had little to no conventional communication at the beginning of the school year made gains in their level of communication across multiple purposes: refusing, obtaining, and social interactions. Individual students may have benefited more from other communication interventions, but the universal approach described here allowed these teachers to improve the communication skills of large numbers of students in a relatively short period.

Students with significant cognitive disabilities are often faced with policies that call for them to demonstrate their ability to use an aided AAC device with voice output before they can receive one of their own (Center for Medicare and Medicaid Services, 2017). They also have limited time with professionals who can help select and teach them to use personalized vocabulary and AAC systems (ASHA, 2018). It should certainly be our collective goal to address both of these issues, but while we do, we must also work to ensure that all students have access to instruction that will help them communicate more successfully today and achieve maximal benefits when they do get access to appropriate technologies and highly qualified professionals in the future.

Ensuring that students have access to intensive and ongoing communication instruction is the long-term goal of the current series of investigations. By targeting teachers, we are maximizing the intensity and quantity of symbolic communication instruction that students will receive. The results of the current study suggest that special education teachers can develop the knowledge, skills, and dispositions required to teach communication using aided language input strategies and core vocabulary that can be integrated into naturally occurring activities throughout the day.

The core vocabulary selected for the current study was intended to provide teachers and their students with significant cognitive disabilities with access to a set of words and symbols that could be used to

communicate across the school day. In general, core vocabulary can be used to communicate for a broad range of purposes in a variety of contexts. In the current study, the use of the Universal Core vocabulary empowered teachers to target communication as part of their academic (e.g., shared reading) and non-academic (e.g., mealtime) routines. Prior research with students with significant cognitive disabilities has emphasized the use of personalized vocabulary (Romski et al., 2006) and often focused on teaching single communication purposes such as requesting (Davis et al., 2000; Frost & Bondy, 2002). The current study offers a new direction for this line of research by demonstrating the potential impact of an open-source, universal set of core words as an initial lexicon for students with significant cognitive disabilities that allows their teachers to demonstrate and support symbolic communication throughout the day. More research is certainly needed to make rigorous claims of causation; however, given a history of minimal to no gains in symbolic communication after several years of school for 55% (*n* = 39) of the student participants, including 32% (*n* = 23) in middle or high school, this preliminary evidence is encouraging.

Limitations and Future Directions

The findings are limited by the lack of a comparison group, the broad range of student disability and special education eligibility categories, the restrictive setting, and the risk of observer bias, given the lack of data collectors who were blind to the targeted intervention. The design aspects of the current study required partnership between the researchers and study participants and a willingness to actively support the shared development work; thus, the risk of researcher bias could not be removed from the process (Anderson & Shattuck, 2012). However, this study provided the research team with important information needed to create PD modules, self-reflection and observation tools, and other implementation supports that will add structure and control for future research aimed at evaluating the impact, scalability, and sustainability of the Project Core implementation model while more directly controlling for researcher bias.

The findings are also limited by the way the Communication Matrix was used. It is unusual for members of the research team to complete the Communication Matrix without consulting all members of the child's team, including families and caregivers outside of school. A number of factors contributed to the decision to use the assessment in this way. First and foremost, training the school teams to conduct the Communication Matrix would have interfered with the goals of the study because it may have led teachers to believe the goal was improved performance on the Communication Matrix rather than the successful development and evaluation of an implementation model that allowed them to teach symbolic communication. Other factors that influenced the decision included the large number of students enrolled and a desire to have the Communication Matrix completed in a consistent manner across all student participants as early as possible in the school year. Per the guidance offered by the developers of the Communication Matrix (Rowland, 2012), we did not attempt to engage in any sort of interrater reliability as the tool "does not lend itself to traditional measures of interrater reliability" (p. 3). In the end, this preliminary evaluation study revealed that teachers benefited from learning more about the Communication Matrix, and training for teachers on its use is now incorporated into the Project Core implementation model.

CONCLUSION

Students with significant cognitive disabilities and complex communication needs require intensive and repeated instruction to learn. While most special education teachers do not receive pre-service training on how to meet the communication needs of students with significant cognitive disabilities, they typically spend many more hours with their students each day than SLPs. The current study provides preliminary evidence that special education teachers can develop the knowledge, skills, and dispositions required to deliver symbolic communication intervention. The study also provides preliminary evidence that students with significant cognitive disabilities who have not developed conventional or symbolic forms of communication can continue to learn and develop as communicators as a result of their teachers' efforts. While the guidance of specialists like SLPs is important to realizing the full benefits of communication interventions such as the one described here, it is encouraging to find that teachers can move students toward conventional and symbolic communication as part of their everyday instruction.

DECLARATIONS

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