Competency-based interprofessional education enhances collaboration skills in special education and speech-language pathology students

Katherine Cullinan Holman[1]*, Kaitlyn P. Wilson[2], Greg Knollman[1] and Arlene Russell[3]

[1]Department of Special Education, Towson University, Towson, MD, United States, [2]Department of Speech-language Pathology & Audiology, Towson University, Towson, MD, United States, [3]Sigma Associates Incorporated, Minneapolis, MN, United States

Introduction: There is growing emphasis on the importance of interprofessional education and practice when supporting autistic students and their families. However, implementation of hands-on interprofessional, collaborative training models are limited in research and practice. This study examined the impact of a hands-on, competency-based interprofessional, supplemental training course (part of a two-year interprofessional training program, "Project LINC") for special education and speech-language pathology graduate students (n = 21). To determine the effectiveness of intentionally designed interprofessional collaborative learning strategies used during the course, this study addressed three main objectives: (1) to evaluate how the course affected students' progress toward meeting the Project LINC competencies; (2) to examine how students implemented collaboration strategies learned during the program; and (3) to identify what students gained from the clinical experience and how it contributed to their ability to collaborate effectively.

Methods: A mixed methods approach was used to evaluate the impact of a hands-on clinical interprofessional education (IPE) course on students' competencies and collaboration skills through quantitative self-ratings, paired t-tests, and effect size calculations, as well as qualitative analysis of students' reflections using reflective thematic analysis. Student survey data, simulation ratings, and written reflections were analyzed by trained coders to identify themes and ensure reliability in understanding students' collaborative development.

Results: The study found that students reported significant perceived gains across all Project LINC competencies after completing a hands-on clinical IPE course, with statistically significant improvements on all self-rated items and large effect sizes. In simulated interprofessional meetings, students rated themselves as highly proficient collaborators. Qualitative analysis of student reflections revealed that the course strengthened their collaborative actions, problem-solving skills, use of communication tools, and professional dispositions such as flexibility, empathy, and trust.

Discussion: The findings from this study point to key traits that can help students overcome real-world barriers to collaboration and build meaningful interprofessional partnerships. Implications and suggestions for practice are discussed.

Introduction

There is growing recognition of the need for interprofessional education (IPE) to support interprofessional practice (IPP) in serving autistic students and their families in the schools. Agencies governing fields like speech-language pathology (SLP) and special education recommend that education programs in both fields prepare future professionals to collaborate across disciplines through the inclusion of interprofessional education (ASHA, 2025; Council for Exceptional Children, 2020); however, there remains a critical gap in the inclusion of this type of pre-service and in-service preparation across most programs (Self et al., 2017; Pfeiffer et al., 2025). The need for effective interprofessional collaboration between special educators and SLPs has specifically been emphasized, with enhanced collaboration showing benefits for a variety of school-aged students in the literature (Bowers et al., 2024; Dobbs-Oates and Wachter Morris, 2016; McLeskey et al., 2017) and for autistic students in areas such as language and literacy (Archibald, 2017) and social skills (Howell et al., 2012; Ranjan et al., 2014). Autism is a heterogeneous condition that impacts multiple areas of development. Given the complexity of multiple areas of functioning affected in autistic students, one important competency is collaboration and the ability to work together as a team among school-based professionals (Beverly and Wooster, 2018; Paul and Wetherby, 2005; Summers et al., 2016). However, practicing school-based SLPs report low levels of IPP, with a lack of training in collaboration emerging as a predictive factor (Pfeiffer et al., 2019). Similar limitations are found in special education preparation programs, with pre-service special educators rarely trained using a collaborative, interprofessional model (Weiss et al., 2020).

IPE, IPEC competencies and effective preparation

The World Health Organization (WHO) defines IPE as a process that "occurs when two or more professions learn about, from and with each other to enable effective collaboration and improve health outcomes" (World Health Organization (WHO), 2010, p. 13). The Interprofessional Education Collaborative (IPEC) was formed in 2009 as a partnership between six national educational agencies to "promote and encourage constituent efforts that would advance substantive interprofessional learning experiences to help prepare future health professions" (Interprofessional Education Collaborative, 2023, p. 7). The organization has since expanded to 22 different associations and have developed a set competencies domains designed to guide the education of future health professionals, equipping them with the necessary knowledge, skills, values, and attitudes to work effectively in team. The IPEC core competencies are organized into four domains, what follows are the names of each domain, a definition, and examples of skills that fall under the domain: (a) Values and Ethics: emphasizing mutual respect and shared values among professionals from different disciplines (skills: *demonstrating empathy and cultural humility, valuing contributions of all team members, upholding confidentiality and ethical responsibilities, recognizing and addressing implicit bias*); (b) Roles and Responsibilities: understanding your own role and the roles of other professionals to effectively assess and address the needs of those you serve (skills: *clearly articulating your professional scope and responsibilities, recognizing and respecting others' roles and expertise,*

seeking clarification when roles overlap or are unclear, collaborating on role distribution based on client/student needs); (c) "Interprofessional Communication: using communication that supports a team approach, ensuring that all voices are heard and understood" (skills: *practicing active listening and open-ended questioning, using person-first or identity-first language as appropriate, adjusting communication for diverse audiences, including refraining from using jargon, and giving and receiving constructive feedback respectfully*); and (d) Teams and Teamwork: working effectively within an interprofessional team to deliver coordinated, high-quality care or services (skills: *participating in shared decision making, resolving conflicts collaboratively, supporting team consensus and shared leadership, reflecting on team performance for continuous improvement*). These competencies have been revised several times over the years (2016, 2023) and are beginning to be used beyond healthcare in schools and community settings to support building collaborative, person-centered support systems (Brashers et al., 2020, Price et al., 2023).

To improve instruction for students with disabilities in the classroom, the Individuals with Disabilities Education Act (U.S. Department of Education, 2004) and the Council of Exceptional Children (Council for Exceptional Children, 2020; McLeskey and Brownell, 2015) recommend high leverage practices, endorsing the use of co-teaching/collaborative teaming as best practice for preparation and professional development programs (Havnes, 2009; Jørgensen et al., 2008; McLeskey et al., 2017). High leverage practices (HLPs) were developed through a partnership with the Collaboration for Effective Educator Development, Accountability and Reform (CEEDAR) and the CEC to ensure that these sets of practices, when paired with evidence-based practices (EBPs), have a positive impact on the outcomes of students with autism (CEC and CEEDAR, 2015). The HLPs are organized around four aspects of practice, including collaboration. The CEEDAR center, in collaboration with educator preparation program faculty from across the country, has created effective practice opportunities referred to as practice-based learning opportunities (PLOs) (McDonald et al., 2013) that provide hands on practice, reflection, and feedback using necessary skills related to collaboration. The CEEDAR center highlights the synergy between HLPs and EBPs, advocating for their combined use to improve outcomes for students with disabilities, including those with autism. In a study by McKeithan et al. (2021), they emphasized the application of 12 instructional HLPs to support autistic students. The authors categorized these practices into three guiding principles: *planning with purpose, teaching for success, and actively engaging learners.* This approach aided educators in developing individualized, data-driven instructional strategies that enhanced academic and social-behavioral outcomes for students with autism in both traditional and remote settings. By embedding both HLPs and EBPs into training and preparation programs, educators can develop a comprehensive skills set to meet the needs of all learners (McCray et al., 2017).

Despite the development of these PLOs, hands-on experiences for pre-service special educators to learn in a collaborative, interprofessional manner with students from other disciplines are rare (Weiss et al., 2020) and limited in scope, and very few have been studied that focus on preparing key professional teams to provide effective interprofessional autism service delivery. In the limited number of studies investigating IPE models for multiple groups of pre- or early service professionals, most of the programs consist of brief trainings (Anderson, 2013; Gould et al., 2017) or the inclusion of one interprofessional practicum experience (Weiss et al., 2020).

Among this sample of studies, Anderson (2013) offered a two-hour training to education and social work students and focus group data showed students' interest in this type of training, but many gaps remained in participants' knowledge about other fields and processes after this very brief training. In 2017, Gould et al. examined the impact of an interdisciplinary, one-time case study exercise on graduate and undergraduate health profession students from 23 programs. They found that the students showed effective collaboration during the exercise, but lack of learning about the other professions after this brief event.

Need for interprofessional collaboration for autistic students

Collaborating in interprofessional teams is best practice for delivering services to autistic students and is especially important due to the myriad and complex co-occurring conditions that necessitate a team-based approach for this population (Khachadourian et al., 2023; Mutluer et al., 2022). The need for interprofessional problem solving and planning, as well as the delivery of collaborative services for autistic students and their families, is well established in the literature (ASHA, 2025; Bridges et al., 2011; Molteni et al., 2013; Prelock, 2006; Ravet, 2011). A lack of collaboration amongst professionals can cause disjointed goals, less effective service delivery and instruction, and confusion for families (Weiss et al., 2022). Specific examples of the need for IPP when serving autistic students include collaboration between the SLP and classroom teacher to successfully adopt and use Augmentative and Alternative Communication (AAC) systems in the classroom (Quinn et al., 2023); behavior analysts, occupational therapists, and SLPs working together to provide related services and evaluate progress (Whiting and Muirhead, 2019), and collaborating and planning evaluations and individualized education programs (IEPs) team meetings (Pfeiffer et al., 2025; Self et al., 2017). IPE is increasingly identified as a critical component of pre-service preparation that provides professionals with more confidence and skills to work together to provide more holistic and effective care and instruction to autistic children (Beverley and Wooster, 2018; Ravet, 2011, Tsilimingras et al., 2018). Weiss et al. (2020) investigated the impact of an intensive summer practicum for SLP and special education graduate students to address social communication skills for autistic children using a transdisciplinary team approach. This hands-on experience encouraged confidence and openness to work collaboratively, suggesting that these longer IPE experiences have the potential to increase collaboration in autism service delivery. Yet critiques highlight that while results like this program are encouraging, there is a noticeable lack of IPE curricula that are grounded in neurodiversity-affirming language and practices, which are essential for supporting autistic students in inclusive ways (Goncalves et al., 2023).

Impact of IPE training models

Overall, current international literature on IPE training models shows existing programs have varied duration, intensity of interactions, disciplines included in the IPE training program, and outcomes noted by participants. Most programs range from a mere half day to up to one semester (Curro et al., 2022; Cusack and O'Donoghue, 2012; Dobbs-Oates and Wachter Morris, 2016; Gould et al., 2017; Miolo and DeVore, 2017; Lieberman-Betz et al., 2023; Showstark et al., 2023) or include online modules only (e.g., Nagelli et al., 2024). Programs that engage students for a full calendar year and include significant course experiences (e.g., five three-credit hour experiences; Price et al., 2023) are limited in the literature. Participants in existing studies of IPE training models are generally undergraduate and graduate students, or pre-service professionals, with a wide range of healthcare and education professionals represented. Similarly, studies on existing IPE training models contain a wide range of participant pool sizes, with smaller programs ranging from 22 to 78 individuals (Curro et al., 2022; Lieberman-Betz et al., 2023; Miolo and DeVore, 2017; Price et al., 2023) and increasing to 92–289 for larger programs (Cusack and O'Donoghue, 2012; Gould et al., 2017; Showstark et al., 2023). A limited number of studies have specifically focused on IPE training focused on meeting the needs of autistic students. With this range of study contexts, it is difficult to determine the key ingredients; however, emerging evidence suggests sustained (i.e., at least one semester long) programs have significant impact on understanding of professions and collaborative skill when it comes to preparing interdisciplinary autism service teams (e.g., Weiss et al., 2020), as well as increasing understanding of autism and interprofessional collaboration across fields (Beverly and Wooster, 2018; Price et al., 2023) and other conditions (Miolo and DeVore, 2017).

The impact of studied IPE training models in the literature has been primarily evaluated through pre- and post-participation surveys (Curro et al., 2022; Gould et al., 2017; Showstark et al., 2023; Lieberman-Betz et al., 2023), written student reflections or evaluations (Dobbs-Oates and Wachter Morris, 2016; Lieberman-Betz et al., 2023; Miolo and DeVore, 2017), and group interviews at the conclusion of the programs (Lieberman-Betz et al., 2023). Some programs utilized existing questionnaires (e.g., ICCAS, Interprofessional Collaborative Competencies Attainment Survey, Archibald et al., 2014; ASK-Q, Autism Stigma and Knowledge Questionnaire, Harrison et al., 2017; IPAS, Interprofessional Attitudes Scale, Norris et al., 2015) prior, during, and after IPE experiences (Price et al., 2023; Showstark et al., 2023). As documented in this literature, the impact of existing IPE training models is varied.

Studied programs involving educational programs have yielded several noteworthy outcomes, as evidenced by participant feedback and progress documentation utilized within each program. Foundationally, IPE has provided a clear increase in knowledge and confidence related to (a) one's own discipline (Curro et al., 2022; Lieberman-Betz et al., 2023) and (b) self-perceived ability, preparedness, comfort, and value in working with other professions (Curro et al., 2022; Lieberman-Betz et al., 2023; Price et al., 2023). Additionally, some studied models have been shown to provide opportunity for clarification of roles and responsibilities of related services (Curro et al., 2022; Gould et al., 2017; Miolo and DeVore, 2017) and facilitated correction of profession-specific stereotypes or misunderstandings (Showstark et al., 2023).

Higher education training models that center interprofessional education (IPE) for students in education and health professions, particularly in early childhood contexts, have demonstrated positive impacts on interprofessional communication and collaboration by broadening participants' knowledge and perspectives

(Lieberman-Betz et al., 2023; Miolo and DeVore, 2017; Showstark et al., 2023). These IPE models have been shown to influence participants' attitudes toward and understanding of interprofessional teamwork, often leading to a more solidified appreciation for the collaborative process and increased respect for the roles of other professionals (Curro et al., 2022; Lieberman-Betz et al., 2023; Miolo and DeVore, 2017). As a result, participants report more positive attitudes, perceptions, and beliefs related to interprofessional practice (Curro et al., 2022; Gould et al., 2017; Lieberman-Betz et al., 2023; Showstark et al., 2023). Beyond attitudinal shifts, findings suggest that IPE-focused training contributes to the development of more holistic and person-centered services, ultimately benefiting clients and their families (Lieberman-Betz et al., 2023; Miolo and DeVore, 2017; Price et al., 2023).

Limitations to current IPE training model literature

Although training focused on IPE has been found to be beneficial, the literature base is small and is limited in several ways. First, most of the studied models are short in duration, which may reduce impact (Cordingley, 2015; Walter and Briggs, 2012). Additionally, despite the need for direct collaboration between special educators and SLPs within the school setting, this combination of disciplines is limited in the existing literature. Only a handful of the models in the educational literature utilized the IPEC core competencies of IPE (Dobbs-Oates and Wachter Morris, 2016; Miolo and DeVore, 2017; Price et al., 2023; Showstark et al., 2023), which are widely recognized and agreed upon competencies designed to improve healthcare and educational outcomes by delivering meaningful and relevant IPE (Interprofessional Education Collaborative, 2023). While several studies included some hands-on collaboration between the students, it was either through a consultative model (Miolo and DeVore, 2017), not systematically evaluated (Dobbs-Oates and Wachter Morris, 2016) or only focused on knowledge and attitudes (Price et al., 2023). This study contributes to the limited body of research on the preparation of school-based professionals by evaluating a sustained, competency-based, clinical IPE program focused on autism. The study specifically examines participants' perceived gains in both knowledge *and* their use of interprofessional collaboration skills.

Purpose of this study

This study evaluates a new IPE training model designed for special education and SLP graduate students. The goal of the model is to build knowledge of autism-related evidence, perspectives, and interprofessional collaboration skills that have been called for to enhance autism service delivery in the schools. Named "Project LINC" (Preparing school-based Leaders in autism through Interdisciplinary Networking and shared Competencies), this program addresses gaps in existing research by offering a sustained (two-year) training model that incorporates the IPEC core competencies as its foundation, combining both educational seminars and hands-on collaborative training experiences—the addition of implementation is a key component of the model that addresses a gap in the mainly didactic trainings common in the literature. In addition,

this training model brings together two key professions for autism service delivery in the schools and provides instruction and hands-on experience in the types of interprofessional collaboration (e.g., problem solving, planning) that have been called for in the literature (Molteni et al., 2013; Prelock, 2006). The focus of this paper is to determine the effectiveness of specific IPE strategies used during the hands-on clinical IPE course, which includes practical clinical work and content aimed at improving collaboration between special educators and SLPs. This research study has three main objectives: (1) to evaluate how the hands-on clinical IPE course affected students' progress toward meeting the Project LINC competencies; (2) to examine how students implemented collaboration strategies learned during the course; and (3) to identify what students gained from the clinical experience and how it contributed to their ability to collaborate effectively.

Methods

This study was approved by the Towson university institutional review board, and students consented to participate in the study. The data reported within this paper is part of a larger five-year project funded by the Office of Special Education Program (OSEP) Personal Preparation grant program. The first two authors were responsible for designing the curriculum, the hands-on interprofessional learning activities, and teaching the course examined in this study. This decision was made to capitalize on the authors' expertise in interprofessional collaboration and representation of both disciplines (special education and speech-language pathology). The authors' role during the summer course was restricted to the role of instructor. All data collection and analyses were completed by outside research partners or after the class had ended and final grades had been assigned so as not to influence student responses.

Project LINC training model

Project LINC is a two-year program that provides interprofessional, supplemental training for special education graduate students enrolled in the Teacher as Leader in Autism (TALA) M. Ed. program and SLP graduate students enrolled in the Speech-Language Pathology master's program at a regional mid-sized public university. The training model includes bringing both groups of students together for 2 years of monthly meetings focused on collaboration, IPP, evidence-based best practices, including neurodiversity-affirming practices for educating and serving autistic students and their families. The program intentionally designed opportunities for students to hear from autistic individuals and parents to learn about their unique lived experiences. A hands-on clinical collaboration course was developed that includes specific opportunities to collaborate based on the IPEC competencies.

To measure the impact of the Project LINC supplemental training program outcome of producing highly qualified professionals trained in IPP to effectively support autistic students and their families, a set of Project LINC supplemental competencies were developed. The supplemental competencies include specific *knowledge and skills* in three categories: (1) *Content* (competencies related to effective instructional and service delivery, including EBPs for autistic students,

including competencies such as: *knowledge of methods of assessment and data collection practices used across disciplines for autistic students* and *demonstration of fidelity in implementing specific EBPs for school-age autistic students*); (2) *Collaboration* (competencies related to effective collaboration, including sample competencies such as: *knowledge of effective culturally responsive and neurodiversity-affirming collaboration practices that build, enhance, and restore relationships and interactions with colleagues, additional adult supports, students and families* and *demonstration of fidelity in the use of specific collaboration practices and skills to successfully complete a group assignment, shared clinical experience, service-learning project, interdisciplinary professional development and/or action research project with students from a different discipline*), and (3) *Compassion* (competencies related to the dispositions of being a caring and empathetic partner to autistic individuals, parents and colleagues, including sample competencies such as: *knowledge and understanding of the va*r*ied lived experiences of autistic individuals and their families, including sociocultural influences on experiences* and *demonstration of critical thinking, including identification and disruption of biases*). These Highly Qualified Supplemental Competencies (Holman et al., 2021; see Supplementary materials for a full list of the competencies) were developed by the project directors and validated by the project

advisory board, which includes parents, professionals in the field from three different universities, autistic self-advocates, and local autism service providers and were integrated with the IPEC competencies (Interprofessional Education Collaborative, 2023) described above. The hands-on clinical IPE course that is the focus of the current study takes place in the summer between the first and second year of training and provides students the opportunity for intensive hands-on experience implementing knowledge gained about IPP through collaborative experiences described in detail below. See Figure 1 for the Project LINC competency-based interprofessional collaboration training model.

Participants

A total of 21 graduate students participated in this study. Participants included pre-service SLP graduate students (n = 9) and in-service graduate students in special education (n = 12). Special education graduate students were beginning their second year of a 36-credit program focused on best practices and effective instruction specifically for autistic students in the schools. They were also in-service educators working in schools at the time of participation.

FIGURE 1
Project LINC competency-based interprofessional collaboration training model.
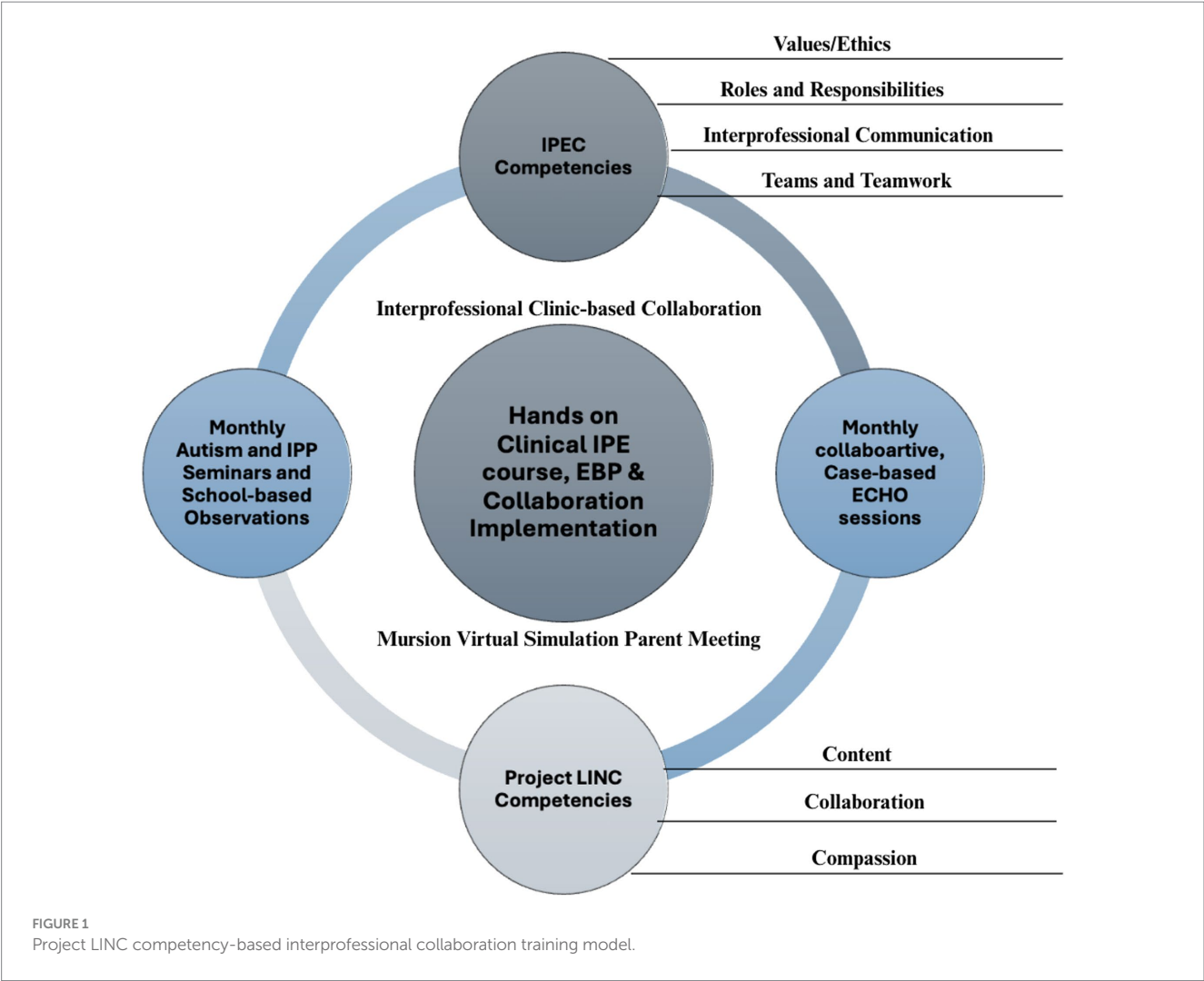
The SLP graduate students were beginning their second year of a two-year master's program in speech-language pathology and were not currently working in the schools beyond their clinical practicum placements. All participating students indicated interest in working with autistic individuals in their career, and all had experience interacting with autistic individuals in various capacities (e.g., classroom teacher, volunteer, friend, camp counselor) prior to participation. Of the nine SLP students, all identified as female and in their twenties. One SLP student identified as Black or African American, one as Black or African American and white, and seven as white. Of the twelve special education students, ten identified as female and two as male, most were in their twenties (n = 8), while two were in their thirties and one was in their fifties. Ten of the special education students identified as white, and two as Black or African American, with one identifying their ethnicity as Latinx. None of the participating students identified as having a disability. The range of years of experience for the special education students was between 1 and 15 years. The SLP students have yet to work in the field as a certified SLP.

Setting and general procedure

The summer hands-on clinical IPE course, *Interprofessional Practice & Clinical Experience*, was a three-credit, five-week, in person course designed specifically for Project LINC that included both synchronous and asynchronous learning. The goal of the course was to give students instruction and hands-on experience collaborating in service delivery for autistic students and their families in the schools. The course included classroom-based learning, hands-on collaboration in the on-campus speech and language clinic with autistic clients, and a practice-based collaborative learning opportunity using Mursion Simulation with a parent avatar. Students met synchronously every week for 3 h and asynchronously for four and a half hours, which included their collaborative clinic planning and in person collaborative clinic sessions. To ensure interprofessional collaboration, SLP graduate students were paired with either one or two special education graduate students (due to the higher number of special education students). The pairs completed all of the course activities together to promote and strengthen ongoing collaboration. In addition to the larger IPE learning activities described below, additional course activities included sharing their discipline's role and responsibilities, discussion of their results of the "The 4-Color Personality Test" that identified their communication and collaboration style, collaborating to present an overview of their autistic client in the clinic, and giving a final presentation that highlighted the collaboration strategies they used to successfully collaborate in the class. Course objectives included demonstrations of knowledge and skills related to: (a) interprofessional practice and collaboration strategies; (b) evidence-based practices (EBPs) for autism; (c) family-professional partnership and culturally responsive practices; and (d) effective collaboration with a parent of an autistic student in a "parent-teacher" conference.

To support the overarching goal of enhancing interprofessional practice, two targeted learning activities were intentionally designed using the IPEC competencies. These activities were structured to emulate the collaborative practices of participants' current and future professional settings, thereby promoting the transfer of skills acquired

through the Project LINC program to their future clinical and instructional work with autistic students and families. Research across various fields demonstrates that immersive, context-rich training environments can effectively mirror the conditions where skills will be applied, leading to improved performance and preparedness (Elendu et al., 2024). Further, in education specifically, there are several research studies affirming that simulation experiences are instrumental in equipping pre-service teachers with the necessary skills and self-efficacy for effective classroom practice, especially when coupled with individual and collaborative reflection (Dittrich et al., 2022; Samuelsson et al., 2022). The Project LINC supplemental competencies were integrated with the IPEC Core Competencies for IPE (Interprofessional Education Collaborative, 2023) and the CEC and CEEDAR (2015) High Leverage Practices (HLP) in Special Education for Collaboration when designing both IPE learning activities (see Supplementary materials for table of integrated competencies). Below we describe in detail two primary hands-on interprofessional learning activities from the course, both of which are examined in this article: Interprofessional clinic-based collaboration and the Mursion virtual simulation meeting.

Interprofessional clinic-based collaboration

A priority of this hands-on clinical IPE course was to provide the opportunity for the special education and SLP graduate students to practice implementing the collaboration and IPP strategies that they had learned the previous semester in the monthly seminars. As previously stated, special education students were paired with an SLP graduate student to support their clinical practice with an autistic client. The first partner activity was for the SLP student to meet with the special education student and share about their client, discuss any EBPs they have used, and collaboratively decide what EBP might be beneficial to implement with the client. Since most of the special education students had just completed a three-credit course on EBPs for students with autism, they were able to support this discussion and knew where to reference EBPs for autism (e.g., National Clearinghouse on Autism and Evidence-based Practices, Affirm Modules, etc.), while the SLP graduate students were completing an AAC course concurrently and were able to take the lead in offering information about functional communication and the use of AAC for clients. After this initial collaborative meeting, the groups worked together to develop a brief presentation introducing their client, the chosen EBP, information on what the EBP is, and why they chose it based on the profile of the client. This activity alone encompassed all four of the IPEC competencies: Values & Ethics (*valuing contributions of all team members*), Roles & Responsibilities (*recognizing and respecting others' roles and expertise, clarifying roles*), Interprofessional Communication (*practicing active listening and open-ended questioning*), and Teams and Teamwork (*participating in shared decision-making and shared leadership*).

To provide the collaborative teams through all three necessary stages of collaboration, the Interprofessional Practice Cycle Form was developed (see Supplementary materials for a copy). The form required the interprofessional partners to complete all three sections as part of their collaboration: (1) pre-clinic session planning; (2) clinic implementation, which included the identified EBP, EBP implementation feedback, and session data collected; and (3) post-session reflection and planning for the next session based on the collaborative discussion of how the session went and what they want to do differently based on the data collected. Students had to complete

the Interprofessional Practice Cycle form for all scheduled collaborative clinic sessions during the class's asynchronous portion. This requirement mimicked the time, commitment, and communication that is often required for successful collaboration in the school setting.

Mursion virtual simulation parent meeting

Mursion is a mixed-reality simulation widely used in fields outside of education, such as the military and healthcare (McGaghie et al., 2010) and is increasingly being applied in teacher preparation. It creates a realistic virtual environment where students can practice applying their knowledge and skills by interacting with "live" avatars (Driver et al., 2018). These education simulations give students the opportunity to practice decision-making, communication, instructional strategies, and collaboration in scenarios that demand real-time responses to the avatars' unpredictable behavior—helping to prepare them for actual classroom situations (Dieker et al., 2014). This specific Mursion experience addresses the HLP of Collaboration and is one of the PLO's designed through CEEDAR that provides students with four sequential activities to develop collaboration skills: (a) prerequisite knowledge, (b) collaborative planning, including role-play practice, (c) implementation, and (d) self-reflection (Driver et al., 2020). The simulations also offer immediate feedback on student performance. Research shows that this kind of learning significantly enhances students' knowledge and teaching abilities (Dawson and Lignugaris-Kraft, 2017; Garland et al., 2012; Storey and Cox, 2015; Vasquez et al., 2017).

A unique Mursion simulation script was developed to provide the special education and SLP students with a structured opportunity to practice and demonstrate their communication and collaboration skills in a realistic setting related to autism and EBPs. The simulation featured a live, interactive parent avatar, representing a single, African American father of a first-grade student with autism. The objective of the simulation was to replicate a parent-teacher conference in which the professionals would discuss the child's communication needs and introduce the possibility of exploring an AAC device to support his expressive language development. Prior to the simulation, students were required to collaborate to co-develop a meeting agenda and plan how they would approach the conversation. During the simulation they were expected to jointly facilitate the meeting, actively collaborate with each other and the parent avatar to identify parent priorities, share information about student progress and the use of an AAC to support communication, and plan with the father for how to proceed based on the discussion. After the simulation, students watched the video of their team's Mursion meeting and reflected on their communication and collaboration skills during the meeting.

To enhance the authenticity of the experience, the simulation used a structured guide to track specific communication and collaboration skills. Student actions were evaluated in real time as either "hits" (effective application of skills) or "misses" (ineffective or absent use of skills). When a "miss" occurred—such as failing to invite the parent's input or dominating the conversation—the parent avatar would respond accordingly. For instance, if students simply conveyed information without engaging the parent in a two-way dialogue, the father avatar would emotionally withdraw and contribute less to the conversation. This specific simulation scenario included 10 predefined "hits" and "misses," allowing for formative feedback on student performance. The responsive nature of the avatar and the dynamic unfolding of the interaction provided students with a more realistic

and impactful learning experience than traditional role-play or static case studies, reinforcing the critical importance of respectful, family-centered collaboration in educational and clinical contexts. This performance-based learning opportunity allowed students to demonstrate their understanding of EBPs and apply core communication and collaboration competencies in a realistic, emotionally responsive setting. Again, this intentionally designed IPE learning activity provided multiple opportunities to not only practice the IPEC competencies but also reflect on their performance.

Measurement and data collection procedures

Highly qualified supplemental competencies questionnaire

To measure how the hands-on clinical IPE course affected students' progress toward meeting the Project LINC competencies, the Project LINC Highly Qualified Supplemental Training Checklist (HQSC) questionnaire was created by this research team (see Supplementary materials). The HQSC is a 20-item self-assessment survey that includes 15 retrospective knowledge questions related to the Project LINC competencies and five feedback questions related to the summer course experience. Upon conclusion of the summer class, students were asked to retrospectively rate their knowledge and demonstration of skills for each competency on a 5-point scale, ranging from not at all knowledgeable/proficient (1) to extremely knowledgeable/proficient (5) from the beginning of the summer class to the end. Sample questions included, "Knowledge of core areas of strength/need and cultural considerations for students with autism and their families in the PK-12 setting" (knowledge-based) and "Demonstration of fidelity in the use of specific collaboration practices and skills to successfully complete a group/partner assignment, shared clinical experience, and/or an interdisciplinary professional development with students from a different discipline" (skill-based). A final question asked about the level of agreement with how the hands-on interdisciplinary training activities in the course impacted their understanding of the importance of collaboration for working with autistic students and families. This used the same 1–5 scale for level of agreement. Each "before" and "after" response is assigned a numerical value based on the scale above.

Communication and collaboration rubric and reflection form

CEEDAR's Communication and Collaboration Rubric and Reflection Form (Driver et al., 2018) was adapted to include key IPEC competencies and used to guide reflection of students' implementation of their communication and collaboration skills during their Mursion Virtual Simulation meeting (see Supplementary material for a copy of the rubric). Each Mursion meeting was recorded, and the videos were scored by the students using the Communication and Collaboration Rubric and Reflection Form. Students utilized the rubric to rate and reflect on their individual and team's (their partner SLP or special education student) use of interprofessional communication and collaboration skills during the Mursion meeting. The rubric includes ten competency-based questions that were rated on a four-point scale (Ineffective, 1; Needs Development, 2; Proficient, 3; Exemplary, 4) with specific descriptions for each rating. Sample rubric items

included: "*How effectively did you collaborate with each member of your team?*" To score "exemplary," the observed collaboration in the video needed to match this description: "*We demonstrated strong collaboration amongst each other and with the parent. We took turns sharing information, checking for understanding, asking questions, and inviting input. We use collaborative language (e.g., 'we are in this together' or 'we are a team'). We each contributed ideas, information that helps us to develop a plan together. The plan was summarized, including everyone's roles and responsibilities and we ensured that everyone felt comfortable and was in agreement with the plan before closing the meeting.*" The overall score was computed by adding up the total score for each line of the rubric. There were 10 lines on the rubric for an overall total of 40 points possible. After completing the rubric rating portion, they completed written reflections answering the five questions at the bottom of the form related to their communication and collaboration during the meeting: "*(1) What was your overall rubric score using the Communication and Collaboration Rubric (above)? What was the highlight/strength of this meeting? What is the one area of the rubric that you would like to improve upon?; (2) Do you believe the conversation aligned with the purpose and desired outcomes of the meeting? Why or why not? If you answered no, what would you do differently in the future?; (3) Do you believe the lesson promoted the parent's engagement and participation in the meeting? If you answered yes, discuss specific examples that promoted Mr. Johnson's engagement. If you answered no, what would you do differently in the future?; (4) During this simulated meeting, you were asked to share information and solicit input from Mr. Johnson related to the introduction of an AAC, while simultaneously building and strengthening a trusting relationship. Do you believe this was done successfully? Why or why not? Discuss specific examples in your response; and (5) What would you do differently as a result of this experience? What do you need to learn more about to deepen your understanding of high-leverage practices and effective collaboration? Name one specific next step that you will do to make this happen.*"

Final reflections

Students were asked to complete a written final individual reflection at the end of the course that included their insights on how they felt their collaboration with their partner/team (e.g., SLP students and special educators) went throughout the course. The following questions were used as prompts: *What went well? Name three specific examples of successful collaboration with your partner across the course (e.g., related to the EBP presentations, clinic partnership, Mursion Simulation)?; What was one barrier that impacted your collaboration and what strategies did you use to overcome this barrier?; What is one key take-away from this collaborative experience and how will it influence your future interprofessional collaborations?*

Research design and data analysis

A mixed methods approach was used to evaluate the data and address the three research objectives. To examine the impact of the hands-on clinical IPE course experience on students' progress towards the Project LINC competencies, student numerical self-ratings on a survey (HQSC) designed to reflect those competencies was used. Data consisted of students' retrospective pre-summer class estimate of their knowledge and skills and a current/post-class estimate of knowledge

and skills on 15 different items rated on a 5-point scale related to the Project LINC competencies. The self-rating data were analyzed descriptively and inferentially, with retrospective pre-class ratings compared with post-class ratings using paired *t*-tests. Effect sizes were computed for the differences using Cohen's d for repeated measures (Lakens, 2013). Descriptive statistics and narrative data analyses were used to analyze the remaining questions on the HQSC.

To examine students' implementation of collaboration strategies taught in the course, students' numerical self-ratings of collaboration during the simulated interdisciplinary (i.e., SLP and special education students paired) Mursion parent meeting were collected on the Communication and Collaboration Rubric and Reflection form. Data from this form was analyzed using both descriptive statistics and qualitative analyses. To examine the specific communication and collaboration behaviors students observed being implemented in the Mursion meeting simulation recording, the rubric ratings were analyzed to identify the mean rating for each item (or line) of the rubric. The self-ratings were then ranked in order of highest mean rating to lowest. The five reflection questions at the bottom of the Communication and Collaboration rubric were closely tied to the specific skills in the rubric. To analyze student responses to the five reflective questions, a frequency count of "mentions" of these skills and behaviors was conducted to identify perceived strengths, areas for improvement, and which skills they want to enhance in their future practice.

Finally, qualitative coding methods were employed to identify themes in students post-course written reflections on how the course contributed to their ability to collaborate effectively. The narratives were analyzed using reflexive thematic analysis (Braun and Clarke, 2019). Adopting a phenomenological approach, the researchers sought to understand the experiences of students participating in the hands-on clinical IPE course and how it influenced their collaborative mindset and skills. After receiving training from the first two authors and completing a qualitative coding course, two doctoral students and the first author independently reviewed the reflections. All coders began by reading the reflections multiple times to gain an overview before analyzing and interpreting the data. Next, they identified meaningful units within the written reflections and labeled these with a code. They coded 10 transcripts separately, then met to discuss discrepancies and reach consensus on their codes. Following this consensus meeting, they independently coded the remaining narratives. The three coders then used their codes to develop themes and sub-themes (skills/dispositions) related to the research questions. The two doctoral students and the first two authors reconvened to review, refine, revise, and finalize the themes to best capture the meaning of the students' post-course experiences and ensure trustworthiness of the results. A final step in this analysis was to identify the associated IPEC competencies for each theme and set of skills/dispositions.

Results

HQSC self-reported questionnaire

The impact of the hands-on clinical IPE course experience on students' perceived progress towards the Project LINC competencies was examined using the self-assessment survey. Seventeen participants completed the self-ratings on the HQSC questionnaire with no missing data from these participants. The remaining four participants

TABLE 1 Item means and standard deviations by time frame.

	Retrospective pre-class (*n* = 17)		Current/post-class (*n* = 17)	
	Mean	SD	Mean	SD
C1A Knowledge of core areas of strength need and cultural considerations for students with autism and their families in the PK-12 setting.	1.5	0.6	2.9	0.7
C1B Knowledge of methods of assessment and data collection practices for students with autism.	2.1	0.9	3.0	0.7
C1C Demonstration of research literacy skills and knowledge of evidence-based practices for student with autism.	1.7	1.1	3.1	0.9
C1D Demonstration of fidelity in implementing a specific evidence-based practice with an autistic individual.	1.5	1.5	2.9	0.9
C2A Knowledge of the importance of interdisciplinary practice interprofessional practice for effectively instructing and serving students with autism.	1.7	0.9	3.6	0.5
C2B Knowledge of effective culturally responsive collaboration practices that build, enhance, and restore relationships and interactions with colleagues, additional adult supports, self-advocates, and families.	1.5	0.8	3.2	0.7
C2C Demonstration of fidelity in the use of specific collaboration practices and skills to successfully complete a group/partner assignment, shared clinical experience, and/or an interdisciplinary professional development with students from a different discipline.	1.6	0.8	3.6	0.5
C3A Knowledge and understanding of the varied lived experiences of autistic individuals and their families, including sociocultural influences or experiences.	1.8	0.9	3.3	0.7
C3B1 Knowledge of the importance of presuming competence of all autistic students and their families.	2.6	1.1	3.6	0.5
C3B2 Knowledge of the importance of advocating with autistic students and their families.	2.7	1.2	3.7	0.5
C3B3 Knowledge of the importance of building self-determination of autistic students.	2.1	1.2	2.8	1.0
C3C Demonstration of partnership practices (communication, respect, equity, commitment, advocacy, and trust) when interacting with families.	1.9	1.1	3.4	0.9
C3D Demonstration of advocacy and instruction related to the importance of presuming competence.	1.9	0.9	3.1	0.8
C3E Demonstration of critical thinking, including identification and disruption of biases.	1.8	0.8	2.9	0.9

chose not to complete this questionnaire, as it was voluntary. Table 1 shows that item means (possible values: 1–5) increased between participants' retrospective pre-class rating and their post-class ratings. Responses were not overly variable. The maximum standard deviation to expect on a 5-point scale would be 2.0 and none of the items were that large, ranging from 0.5 to 1.5.

Participants' retrospective pre-class ratings were compared with their post-class ratings using paired t-tests. The results are shown in Table 2. All paired comparisons resulted in statistically significant differences. Exact *p*-values are reported in the "p" column. All p-values are less than 0.05. However, because there were fourteen comparisons, concerns about Type I error rate inflation were important to consider. We note that all p-values are also less than a Bonferonni-adjusted significance level of 0.05/14 = 0.003. Additionally, we opted to use a False Discovery Rate (FDR; Benjamini and Hochberg, 1995) adjustment of p-values. FDR adjusted p-values were computed and compared against a FDR of 5%, with all differences remaining statistically significant. The FDR adjusted p-values are all less than 0.05 (i.e., 5% FDR). On average, participants reported statistically significant differences (gains) for all items. All effect sizes exceed 0.5, eleven exceed 1.0, and three exceed 2.0, indicating large effects for all items based on established interpretation guidelines (Lakens, 2013).

On a final item asking students to report whether the hands-on clinical IPE course was beneficial and increased their confidence with interprofessional collaboration, 100% reported that it was.

Mursion meeting ratings

Students were asked to watch their video recording of their Mursion simulation meeting and rate their performance using the Communication and Collaboration Rubric and Reflection Form. Descriptive analyses of the rubric ratings were conducted to identify the range in scores. Student's overall score on the rubric form ranged from 27 to 39 out of 40, indicating students observed relatively high proficiency in their skills. To examine the specific knowledge, skills, and behaviors students observed in their simulation, the rubric rating scores for each line of the form were analyzed. Items for which students rated themselves highest were demonstrating respect for unique cultures (Mean = 3.74, item #10), effective collaboration (Mean = 3.66, item #1) and creating space for caregiver questions and clarifications (Mean = 3.66, item #3). Students rated themselves lower in areas related to communication: utilizing responsive listening (Mean = 3.16, item #2), using effective turn taking (Mean = 3.26, item #4), and using understandable language (Mean = 3.26, item #6). Table 3 provides the questions/rubric line item, the means and standard deviations from highest to lowest.

Students were given the opportunity to review their simulation experiences and expand on their self-ratings in a written reflection. Across the five reflection prompts, students were asked to note strengths and areas for improvement, the alignment of their conversation with the desired meeting outcome, their promotion of parent engagement, building of trust, and how they might deepen

TABLE 2 Mean differences, confidence intervals for the mean differences, and paired *t*-test significance test results (for 17 responding participants).

Item	Mean difference	SD	95% CI lower limit	95% CI upper limit	t	df	p	Significance level (FDR)	Significant difference?[a]	r	Cohen's d_{RM}[b]
C1A.	1.47	0.51	1.21	1.74	11.79	16	2.67E-09	3.741276E-08	TRUE	0.68	2.23
C1B.	0.94	0.56	0.66	1.23	6.98	16	3.09E-06	5.401550E-06	TRUE	0.79	1.10
C1C.	1.41	0.71	1.05	1.78	8.17	16	4.2E-07	8.406940E-07	TRUE	0.75	1.36
C1D.	1.35	0.86	0.91	1.80	6.47	16	7.69E-06	1.076939E-05	TRUE	0.87	0.82
C2A.	1.94	0.97	1.44	2.44	8.28	16	3.53E-07	8.231393E-07	TRUE	0.17	2.62
C2B.	1.71	0.77	1.31	2.10	9.11	16	9.83E-08	3.439328E-07	TRUE	0.46	2.27
C2C.	2.06	0.83	1.63	2.48	10.27	16	1.91E-08	1.334620E-07	TRUE	0.24	3.04
C3A.	1.53	0.72	1.16	1.90	8.79	16	1.6E-07	4.482212E-07	TRUE	0.62	1.85
C3B1.	1.00	0.87	0.56	1.45	4.76	16	0.000213	2.289442E-04	TRUE	0.59	1.01
C3B2.	1.00	0.94	0.52	1.48	4.41	16	0.00044	4.398750E-04	TRUE	0.63	0.89
C3B3.	0.71	0.59	0.40	1.01	4.95	16	0.000144	1.838849E-04	TRUE	0.87	0.61
C3C.	1.47	0.62	1.15	1.79	9.71	16	4.11E-08	1.919265E-07	TRUE	0.84	1.39
C3D.	1.18	1.02	0.66	1.70	4.78	16	0.000204	2.289442E-04	TRUE	.28	1.38
C3E.	1.12	0.70	0.76	1.48	6.62	16	5.94E-06	9.246456E-06	TRUE	0.67	1.31

[a]Decisions on statistical significance are made using FDR (False Discovery Rate).
[b]Cohen's d_{RM} is an effect size for repeated measures, $d_{RM} = (postMN − retropreMN)/sqrt(postSD^2 + retropreSD^2 − 2 \times r \times postSD \times retropreSD) \times sqrt(2(1 − r))$.

TABLE 3 Means and standard deviations of student ratings of communication and collaboration skills in the Mursion meeting simulation.

Rubric item	Mean	Standard deviation
Q10: Demonstrating Respect for Unique Cultures	3.74	0.47
Q1: Effective Collaboration	3.66	0.50
Q3: Creating Space for Caregiver Questions and Clarification	3.66	0.58
Q5: Using Effective Body Language	3.63	0.50
Q8: Understanding Others' Perspectives	3.63	0.50
Q9: Sharing Roles/Responsibilities	3.61	0.53
Q7: Building Rapport	3.50	0.71
Q4: Using Effective Turn-Taking	3.26	0.57
Q6: Using Understandable Language.	3.26	0.55
Q2: Responsive Listening	3.16	0.59

their understanding of effective collaboration. These prompts were closely tied to rubric rated items and solicited responses about specific communication and collaboration skills (e.g., using active listening, clearly explaining the device). Strengths observed by students followed by the number of students who identified each include using active listening (13), building rapport and trust (12), and encouraging care-giver input (12). The most noted areas for improvement were avoiding jargon (10) and using paraphrasing (9). All of the students agreed that the *conversation aligned well with the meeting's purpose* and desired outcomes. Most noted that the desired outcome was to have effective collaboration with the parent, and to ensure parent's insights and priorities were incorporated (17). One student noted that the lack of "a proper summary can leave the meeting feeling disjointed and incomplete" and committed to summarizing outcomes and next steps at the end of the meeting as a regular practice moving forward. Almost all of the students indicated that their team (typically one or two special education students and one speech-language pathology student) successfully *engaged the parent* (20). One noted that that this was done more as the meeting progressed, and another admitting that it was "hard to read" the parent's engagement at times. Skills used to foster the collaborative environment were using positive body language, asking questions, and checking for understanding. Almost all (19) of the students reflected that they successfully introduced an AAC device to the parent while *building a trusting relationship.* This was done by clearly stating the meeting's purpose and soliciting input on priorities and concerns. They shared classroom observations and discussed behaviors observed at home. By focusing on open-ended questions and frequent check-ins and also emphasizing a commitment to the student's well-being, this ultimately fostered trust and collaboration within the Mursion meeting. Two Students noted that there was room for improvement in their skills in building trust. One Student specifically noted: *We did not fully address the parent's initial concerns or provide enough detail on the device's use. This left some uncertainty about its implementation.* Another reflected: *We could have been clearer about the device's functionality and addressed his worries more effectively.* Upon reflecting on what they might do differently because of their experience through the Mursion meeting, students identified areas for improvement, such as speaking slower, avoiding jargon, and allowing pauses. To enhance skills, they would take deep breaths before meetings and practice explaining AAC device concepts clearly. Regarding specific next steps, they plan to engage in more collaboration to build confidence and address challenges and engage in discussion so they can learn from their peers. They wrote that emphasizing active listening, reducing interruptions, and encouraging parent input will foster better collaboration. They will also practice presenting confidently, using positive reinforcement, and incorporating effective strategies

to create a supportive, inclusive environment for parents and team members.

Final written reflections

To answer the question what did student's gain through participating in the IPE activities in the summer hands-on clinical IPE course and how did this contribute to their ability to collaborate effectively, all 21 of the student's final narrative reflections were coded. Four major themes were developed from the student's reflections: (1) collaborative actions; (2) barriers and overcoming barriers; (3) collaborative skills & tools; and (4) collaborative dispositions. The associated IPEC and Project LINC competencies related to the themes and sub-themes are listed in Table 4.

Collaborative actions

The students' reflections included many different collaborative actions that they engaged in throughout the summer course. Collaborative actions are what you do to successfully collaborate, and students indicated they engaged in these collaborative actions to successfully complete all the learning activities, including the Mursion meeting and Clinic collaboration for this course. Collaborative actions identified in the student's reflections included sharing expertise, determining roles, co-planning, co-creating materials, co-treating (e.g., identifying targets, collecting data, observing and co-facilitating the parent meeting), and reflecting and revising (e.g., providing feedback, sharing data, analyzing data together and making data-based decisions). One student talked about the specific ways they collaborated to create materials and share knowledge to benefit their shared client:

> "Materials: We collaborated well when creating the materials and selecting the best EBP to use to target goals. G trusted that I knew my client well and that a social narrative would be appropriate. He brought his knowledge of power cards, and together, we decided on the narrative we would use and which characters to use on the power cards. We combined what we each knew well to offer a dynamic EBP that ended up being successful for the client."

Another student talked about a variety of collaborative actions that they engaged in and how these helped their collaboration to be successful and beneficial for her client:

> "We were also successful in collaborating in our clinical partnership. S16 and I were able to devise an easy checklist for the FBA [functional behavior assessment] that would allow her to take data but also provided a quick and easy way for me to attempt to take data on my own. She was also able to give suggestions on how to better help the client during the partnerships. For example, she helped me realize the frequency that my client eloped from a designated area, instead of just the classroom. This awareness helped us to edit our FBA and provided me with additional information to include in my progress report to aid future clinicians. S16 also helped when my client was fixated on a fidget toy during circle time and no longer participating. She suggested using an 'all done box' and having the client put the fidget in there on his own. This was extremely helpful as my client felt he had some control over the situation and was immediately participating again."

Barriers and overcoming barriers

Students repeatedly identified the same barriers of time and conflicting schedules that made it challenging to successfully collaborate with their partner from the other discipline. Yet they all persevered through these barriers and identified specific collaborative skills, tools and dispositions that enabled them to successfully collaborate to complete the IPE learning activities. One student discussed some of the barriers they faced and how they overcame them:

> "Another example of successful communication and collaboration was simply finding time to meet to plan, create presentations, and complete group assignments when we all have very different and very busy schedules. The first thing we did was create a group chat, then each time an assignment needed to be completed or talked about two were able to coordinate a meeting time on Google Meet. This enabled us to easily communicate and collaborate throughout the class and lead to successful completion of all assignments and responsibilities."

Another student commented:

> "'One gain was combatting the barrier of time by using different communication modalities to connect.' During Week 2, when completing the IPP Cycle #1 document, my partner and I were unable to meet to complete the reflection simultaneously. It was during this week that we realized that our collaboration could maintain success by digitally communicating via shared documents. I was able to read my partner's responses once they were entered which furthered my reflection."

Collaborative skills and tools

Students identified very specific collaborative skills and tools that they used to overcome barriers they faced when collaborating. Some of the skills that were identified were strong and open communication, including active listening, sharing knowledge, information and expertise, dividing up responsibilities, and valuing other's expertise. Students also identified a variety of communication tools that helped them to successfully collaborate including email, text, phone conversations, shared documents (e.g., Google docs©), and virtual meeting spaces such as FaceTime©, and Google meet©/Zoom©. One student described specific activities and examples of how they worked hard to communicate with one another and how this positively impacted their collaboration:

> "We each took the time to listen to each other's opinions and suggestions. We were respectful of how we communicated but also passionate about our individual stake in the matter. I believe that the color theory activity we participated in at the start of class set us up for success. During this activity we focused on our individual strengths as well as our areas of opportunities, and it was during this moment where S10 and I outlined the type of working partnership we would like to have. One activity that demonstrated our listening skills was the Mursion simulation. During the pre-planning stage we had in-depth conversations about our students and spoke from our individual expertise. We listened keenly to the other, adding as needed and refuting what would and would not work for our students and families. Additionally, we practiced after we outlined our plan, spoke of any

TABLE 4 Qualitative themes, collaborative skills and associated IPEC and Project LINC competencies.

Qualitative theme	Qualitative collaborative skills	Associated IPEC and Project LINC competencies
Collaborative actions	• Sharing expertise • Determining roles • Co-planning • Co-creating materials • Co-treating (e.g., *identifying targets, collecting data, observing, and co-facilitating the parent meeting*) • Reflecting and revising	*IPEC competencies:* Value & ethics (*valuing contributions of all team members*) Roles & responsibilities (*collaborating on role distribution*) Teams & teamwork (*participating in shared decision-making, supporting team consensus and shared leadership*) *LINC competencies:* Content (*knowledge and skills related to autism*) Collaboration (*knowledge and skills related to collaborative skills and practices*)
Barriers and overcoming barriers	• Time • Conflicting schedules	*IPEC competencies:* Roles & responsibilities (*collaborating on role distribution*) Teams and teamwork (*resolving conflicts collaboratively*)
Collaborative skills and tools	Collaborative skills: • Strong and open communication, including active listening • Sharing knowledge, information and expertise • Dividing up responsibilities • Valuing other's expertise Collaborative tools: • Email • Text • Phone conversations • Shared documents • Virtual meeting spaces	Value & ethics (*valuing contributions of all team members*) Roles & responsibilities (*recognizing and respecting others' roles and responsibilities, collaborating on role distribution*) Interpersonal Communication (*practice active listening*) Teams and teamwork (*participating in shared decision-making*) LINC Competencies: Collaboration (*knowledge and skills related to collaborative skills and practices*)
Collaborative dispositions or attitudes	• Flexibility • Respect • Willingness to contribute • Vulnerability or transparency • Trust • Grace and empathy • Being student-centered • Valuing collaboration • Motivation to collaborate	*IPEC competencies:* Value & ethics (*demonstrating empathy, valuing contributions of all team members, upholding confidentiality and ethical responsibilities*) *LINC competencies:* Compassion (*knowledge and skills related to dispositions that support the understanding of others lived experiences and partnership practices*)

hiccups that may occur, and communicated how we could overcome those hiccups on the day of the simulation. I believe that if we had not taken the time to listen and establish communication processes from the start of class, our working relationship and some of our projects would not have been successful."

Another student shared below about her realization that prior to the summer course she had not realized how ineffective her previous collaborative relationships had been and how much this experience of working together to overcome barriers and complete their assignments allowed them to be much more successful:

"Prior to beginning this course, I was confident in my ability to collaborate with school-based professionals in my school community. Throughout my 5 years as a special educator, I have worked collaboratively with other special educators, administrators, occupational therapists, speech and language pathologists (SLP), and Board-Certified Behavior Analysts. With these experiences in mind, I came into this course expecting an experience similar to my daily life as a special educator. Reflecting

on the opportunities that I have had this summer, I must say that I have not been collaborating with my coworkers as proficiently as I did for the assignments in this course. In the past, collaboration between our SLP and myself involved sharing our drafted IEP goals, the SLP sharing visual supports and newly created communication icons, and me sharing behavior interventions/supports for the SLP to utilize in her sessions with my students. While we were working collaboratively, communicating effectively, and sharing interventions to be used in both academic and speech therapy settings, we were doing all the work separately and bringing finished products together. Preparing for the clinic sessions and other coursework forced S11 and I to work together from start to finish. We worked together in preparation for the IPP cycles to plan an intervention, create materials, implement the intervention, reflect on the sessions, and analyze the data. Conflicting schedules created a major barrier for us, but through effective communication, collaboration on online documents, and shared knowledge gained through our individual professional experiences, we were able to come together and be successful in our clinic sessions and collaborative assignments."

Collaborative dispositions

Beyond collaborative skills and tools, many students discussed specific characteristics or dispositions that were necessary for their collaborative relationships to be successful. Dispositions can be defined as, "behaviors, attitudes, and habits of the mind that shape a person's learning and development over time. They are important for lifelong learning because they enable learners to approach new challenges with curiosity, flexibility, and perseverance." (MDE, 2025). Some of the most frequently stated dispositions and attitudes were flexibility, respect, willingness to contribute, vulnerability or transparency, trust, grace and empathy, being child-student centered, valuing collaboration and motivation to collaborate. While collaboration skills are certainly necessary, many students discussed that they learned that it was the dispositions that enabled them to be truly successful collaborators:

> "These strategies created a sense of respect in our partnership and understanding of the other person and we were able to successfully work together to, not just complete the projects, but to complete them effectively, collaboratively, and in a way that made us both comfortable and able to be proud of that work. I really feel like the respect and understanding that we had for one other led to our very successful partnership. Though not necessarily a strategy, it was a mindset that allowed us to work at our pace while trusting that the other partner would contribute when they were able."

Another student talked about how they learned the importance of shared responsibility and trusting and valuing their collaborators expertise:

> "My biggest takeaway from the collaborative experience really is that true, successful partnership must have trust, respect, and understanding from all parties involved. In my experience in the schoolhouse, by nature, educators or school-based professionals tend to be 'control freaks,' for lack of a better term, and we really only trust ourselves to do the work in the way we want it done, on the timeline we want it done, and in a format that works for us. This really taught me to trust and to listen to the other professionals at the table and that is something that I want to take with me into my schoolhouse this year to really encourage my interprofessional collaborations. I want to recognize that my SLPs, OTs, PTs, SELs, counselors, general educators, parents, etc. have a unique set of skills, knowledge, and experiences that are different from mine but equally valuable."

Lastly, another student shared about how both their collaboration skills and dispositions helped them to overcome the barrier of conflicting schedules and successfully collaborate:

> "One barrier that impacted our collaboration included our differing schedules in terms of work and school requirements. To overcome this barrier, we made sure to have an open and transparent line of consistent communication. Specifically, we effectively divided our roles and responsibilities to ensure that we are on the same page. Furthermore, we granted each other grace and flexibility in terms of competing work assignments. For instance, if we were unable to input our information into the interprofessional practice reflection until a certain date,

we provided each other consistent updates to coordinate our collaborative work. This barrier reflects collaboration within the professional environments, as we will have differing roles and responsibilities related to our specific disciplines. However, utilizing strategies such as open lines of communication and an understanding of our expectations, has positively aided our ability to successfully collaborate."

Discussion

Interprofessional education has been defined as occurring when two or more professions learn together with the goal of fostering collaborative practice that will benefit students and families (Dale et al., 2021). High quality IPE promotes a realistic pathway to interprofessional practice (ASHA, 2025; Brandel and Loeb, 2011; Pollard et al., 2012), which has demonstrated to have a positive impact on student outcomes, particularly autistic students whose needs typically cover multiple domains (ASHA, 2025; Bridges et al., 2011; Molteni et al., 2013; Prelock, 2006; Ravet, 2011). The Interprofessional Education Collaborative, a consortium of partners and programs from around the world committed to strengthening the quality of IPE have defined high-quality programmatic IPE as, "IPE that is integrated into curricula and spans its entire length, from early didactic IPE experiences to advanced clinical IPE experiences, which collectively results in meaningful outcomes" (Zorek et al., 2022, p. 2). Therefore, high quality IPE requires integration, longevity, and meaningful hands-on practice that is grounded in both interprofessional collaborative competencies and realistic challenges that support the implementation of interprofessional collaboration in the field.

This study focused on data from a competency-based hands-on clinical course and how this experience impacted students' advancement in the Project LINC (autism-focused) competencies and their successful use of interprofessional collaboration skills. The overall results showed that students' self-reported changes were significant related to progress towards the Project LINC competencies. They rated their implementation of interprofessional collaboration skills as proficient to exemplary upon completion of the hands-on IPE course. Meaning, students' ratings of their use of communication and collaboration skills during the Mursion meeting was fully satisfactory with some evidence of such high-level skills that they could serve as a model of excellence. Students reported that the hands-on clinical course was beneficial to increasing their confidence for interprofessional collaboration because of the authentic and meaningful opportunities to practice collaborating and overcoming barriers together while addressing the unique challenges, EBPs, and instructional strategies for teaching autistic students in the schools.

In addressing the first objective to evaluate how the hands-on clinical IPE course affected students' progress toward meeting the Project LINC competencies, results showed significant positive changes in students' mean self-ratings on all the items on the retrospective pre-post assessment. The Highly Qualified Supplemental Competencies (HQSC) questionnaire included students' ratings of their self-perceptions of both knowledge and demonstration (or application) of knowledge and was designed to reflect growth during the summer hands-on clinical IPE course. Student ratings showed improved knowledge about, and demonstration of, skills aligned with the Project LINC competencies, with large effect sizes indicating

showing the practical significance of these findings. More than 70% of the students reported that the course was beneficial and increased their confidence with interprofessional collaboration, enhancing student self-efficacy.

As indicated in the Results section, students reported gains on all items of the HQSC questionnaire, showing a significant effect of the course content on these key competencies related to autism, evidence-based practices, and collaboration. Notably, and as evident in Table 1, students' greatest reported increases were on the four questionnaire items specifically related to collaboration and partnership-related knowledge and skills. Specifically, students' reported understanding of the importance of inter-professional practice for effectively instructing and serving autistic students and their perceived use of collaboration practices and skills for successful demonstration of IPP increased greater than 1.5 points following participation in the course. In addition, students reported a greater than 1.5-point increase in their knowledge about effective culturally responsive collaboration practices for use with colleagues, professionals, and families and their use of partnership practices (e.g., respect, equity, advocacy) when interacting with families.

The findings regarding increased self-perceived knowledge and application of interprofessional collaboration competencies addressed in the course align with those from a meta-analysis of IPE training in healthcare (Guraya and Barr, 2018). Guraya and Barr (2018) found that many forms of IPE intervention improved students' knowledge, skills, and attitudes related to collaboration. However, the findings from the current study add to the existing literature by sharing the impact of a hands-on IPE course experience, compared to recent reports of IPE modules that did not include simulated or actual autism service delivery or family collaboration (e.g., Nagelli et al., 2024; Velladath et al., 2024). The current study demonstrates significant effects of an IPE course on participants' self-reported autism-related knowledge and skills, as well as collaboration knowledge and skills—findings consistent with prior research (e.g., Beverly and Wooster, 2018). Notably, Project LINC participants engaged in shared decision-making and co-treatment experiences, which may enhance their likelihood of engaging in future school-based collaborative practices. This aligns with findings from Brandel and Loeb (2011), whose survey of 1,897 public school SLPs indicated that those with classroom-based IPE experiences alongside educators in graduate school were more likely to implement collaborative interprofessional interventions in the schools.

Prior interprofessional training models that center around interprofessional communication and collaboration note the importance of offering opportunities to expand participant perspectives (Lieberman-Betz et al., 2023; Miolo and DeVore, 2017; Showstark et al., 2023). Findings from this study similarly highlight how opportunities for students to practice interprofessional collaboration through simulated parent conferences were viewed as important to emphasizing shared responsibility and opportunities to consider multiple perspectives. For example, individual students rated themselves as proficient to exemplary in their demonstration of collaboration skills during the Mursion simulation meeting with the parent avatar. Important to the process of completing the simulation was not only the practice of engaging in a collaborative parent conference experience but requiring students to design a meeting that offered multiple opportunities for input from students and the parent avatar alike and reflect upon their experience. As noted in the review

of student written reflection of the experience, students indicated the opportunities offered ways to share their expertise, collaborate on how to determine the roles of everyone involved on the team, along with the importance of enhancing co-planning and co-leading the creation of materials and supports for students and families. Student self-ratings and written reflections indicated that the hands-on practice and experiences collaborating were meaningful and had a positive impact on their successful interprofessional collaboration. Hands-on practice offered students space to practice and reflect upon the necessary skills and dispositions to complete collaborative actions successfully. Student reflections indicated their use of these skills were complimentary in fostering collaboration and supporting the parent.

The Mursion simulation was also a way to highlight opportunities for students to engage in practices aligned with the Project LINC Highly Qualified Supplemental Competencies, such as interprofessional instruction that supports autistic students. In this way, students engaged in the use of a simulation activity to practice not only how they would explain the importance of incorporating evidence-based supports such as AAC to aid communication, but also how professionals across disciplines could work together to strengthen their explanation of the benefits and aims for incorporating the supports in practice, while also leaving intentional opportunities throughout the conversation for parental input. These opportunities were only further enhanced when paired with designated time for critical self-reflection on the process of how each member of the team contributed as a collaborative contributor based on their knowledge and valued expertise. Responses to the self-ratings and reflection probes indicate that students saw their team as proficient in effectively collaborating and communicating interprofessionally and with the parent.

Students' final written reflections were analyzed, and several important themes emerged from the data, including the need for *collaborative skills and tools, collaborative dispositions* and the opportunity to engage in *collaborative actions* to *overcome barriers* and successfully collaborate. The theme of collaborative skills and tools included all the expected skills needed for successful collaboration such as communication, valuing others' expertise and sharing responsibilities, which was associated with all four IPEC competencies: Value & Ethics, Roles & Responsibilities, Interpersonal Communication and Teams & Teamwork (Interprofessional Education Collaborative, 2023) and two of the Project LINC competencies. The theme of collaborative actions included different ways students collaborate with others, for example, co-teaching and co-planning was expected given the literature on IPP (Bridges et al., 2011) and the IPEC competencies (Interprofessional Education Collaborative, 2023). These actions were also associated with the Project LINC competencies of Content and Collaboration, corroborating that it is not enough to only know how to collaborate if you do not have strong knowledge and skills related to effective instruction and services delivery in the content area or population (in this case autism) as well (Pfeiffer et al., 2019, 2025). However, students' strong emphasis on the importance of partner traits such as trust, flexibility, and vulnerability—as outlined in the Values and Ethics domain of the IPEC competencies (Interprofessional Education Collaborative, 2023)—suggests that these qualities may not have been recognized as critical to successful collaboration without firsthand experiences. Through these hands-on IPE experiences in Project LINC, students encountered situations where

such relational attributes were as essential as technical collaborative skills in navigating and overcoming barriers to effective teamwork. Overall, a central finding emerged from these final reflections: the collaborative, hands-on IPE activities, particularly the Mursion simulation and autistic clinic-based collaboration, offered valuable practice that significantly enhanced students' ability to collaborate effectively. Using the IPEC core competencies (Interprofessional Education Collaborative, 2023) as a framework, we suggest that effective IPE related to serving autistic students in the schools encompasses the integration of these four key competencies: (a) fostering mutual respect and shared values with professionals from other fields; (b) understanding the roles and responsibilities of both one's own profession and others to enhances student outcomes; (c) promoting effective communication among students, families, communities, and professionals for effective student outcomes; and (d) cultivating relationships that support team development and collaboration to plan, deliver, and assess timely, efficient, and equitable education and policies.

The course requirement to collaborate and complete the IPE learning activities within the context of students' other professional and personal responsibilities, provided realistic barriers, such as time constraints and conflicting schedules. These challenges required students to apply collaborative skills, tools, and dispositions to overcome obstacles, implement collaborative actions, and be successful working together to meet the course learning outcomes. Based on the student's reflections, we created a visual representation of what is needed for successful preparation of students for interprofessional collaboration (Figure 2). The image represents how different aspects of successful collaboration come together in a complex and dynamic process, where collaborative skills and tools and personal dispositions are all necessary to overcome barriers and achieve success in interprofessional practice. Beginning in the outer-most circle of the visual is the opportunity to engage in intentionally designed, competency-based hands-on interprofessional experiences. These experiences allow students to practice using collaborative skills, tools, and demonstrate the right attitudes to overcome barriers and
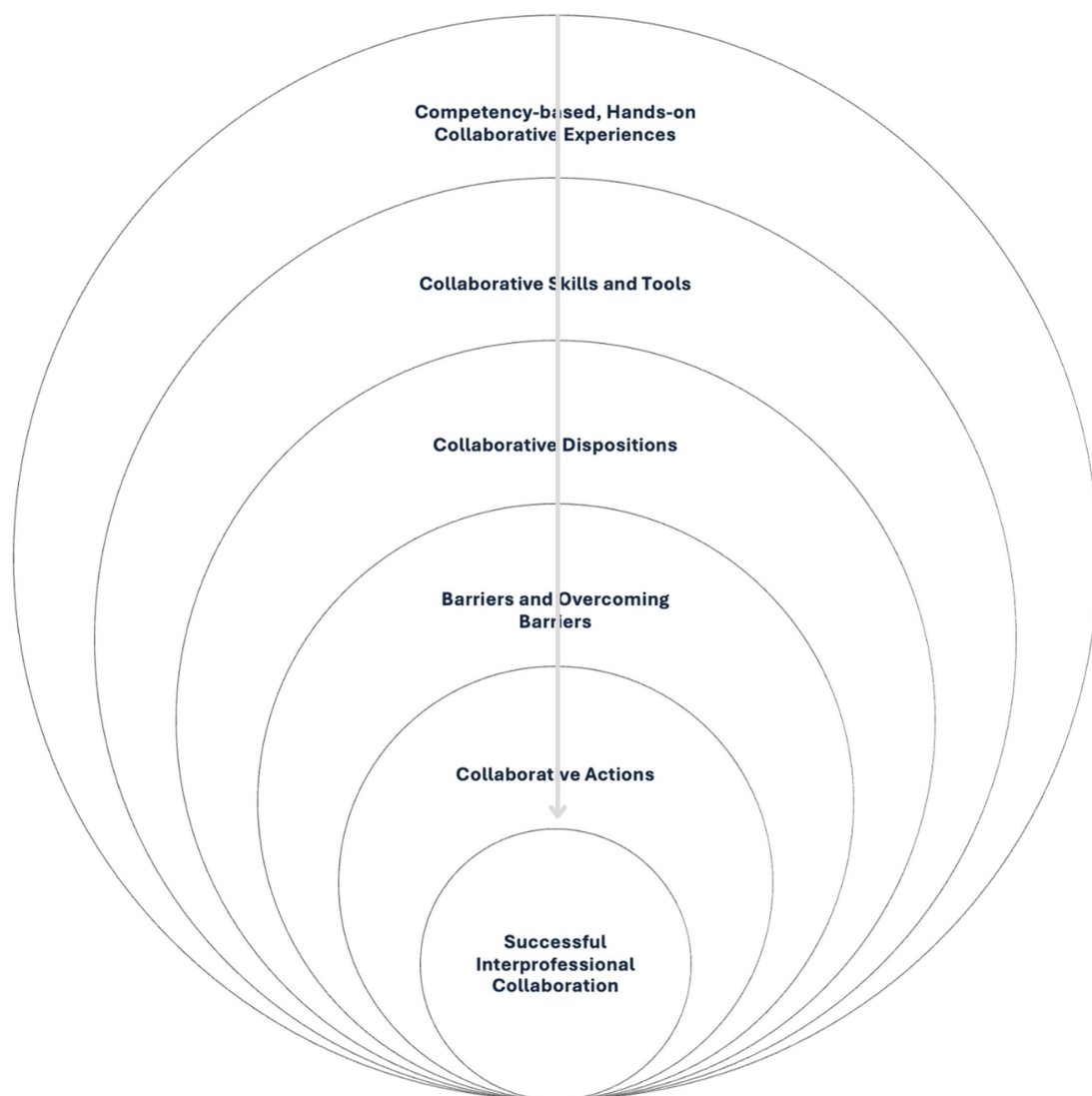

FIGURE 2
Effective preparation of students for successful interprofessional collaboration.

successfully complete collaborative actions. The interconnected circles in the diagram represent the various necessary components of collaboration, with an arrow running through the center to emphasize that all these elements must work together for collaboration to be successful. Without hands-on IPE, there is limited opportunity to bridge the gap between theory and practice (Glennen, 2017; Olswang and Prelock, 2015). It is one thing to learn about interprofessional practice in a textbook or seminar, but it is another to experience the barriers and overcome them within hands-on collaborative experiences. Getting to experience the dynamics of how professionals from different disciplines approach challenges, share knowledge, work together, and problem-solve more authentically equips students to be more motivated, confident, and prepared to successfully engage in interprofessional practice in the schools.

Conclusions, limitations, and future research

Findings from this study both corroborate and extend existing research on the importance of intentionally designed, competency-based interprofessional education (IPE) activities that go beyond isolated workshops or standalone events (Price et al., 2023). The inclusion of hands-on collaborative learning experiences specifically the clinic-based collaboration and Mursion simulation activities, offered students meaningful opportunities for implementation practice and structured self-reflection. These experiences fostered increased self-awareness regarding students' strengths and areas for growth, while also emphasizing the positive influence of collaboration on their interactions with the parent avatar and their peers.

Students reported increased confidence and self-efficacy as a result of multiple opportunities to practice interprofessional collaboration, apply autism-specific and evidence-based knowledge, and work through barriers to effective teamwork. Their self-ratings from the Mursion simulation further confirmed growth in communication and collaboration skills. Importantly, analysis of students' final written reflections revealed that when faced with realistic barriers mirroring school-based challenges, dispositional qualities—such as trust, flexibility, vulnerability, and grace—were regarded as equally essential as technical skills like communication and role-sharing for achieving successful collaboration. Overall, the competency-based IPE activities implemented in this study provided meaningful, realistic, and impactful preparation for interprofessional collaboration in school settings.

This study has several limitations that should be considered when interpreting the findings. First, the sample size was relatively small, and participant diversity was limited, which restricts the generalizability of the results. Additionally, the absence of a formal comparison group prevents clear attribution of observed outcomes specifically to the Project LINC training program. To enhance both the validity and generalizability of future research, larger-scale studies with more diverse participant samples are recommended. The inclusion of a comparison group consisting of speech-language pathology and special education graduate students who did not participate in Project LINC would provide important insight into the program's unique impact on interprofessional collaboration knowledge and skills.

The decision to utilize a retrospective pre-post design rather than a traditional pretest-posttest format was intentional. Traditional

pretest measures are vulnerable to response shift bias, wherein participants may overestimate their initial knowledge or skills due to limited awareness of program goals and content (Pratt et al., 2000). Retrospective pre-post designs help mitigate this issue by allowing participants to assess both their pre- and post-training competencies within the same cognitive frame of reference, reducing pretest sensitivity and improving internal validity (Howard, 1980; Rockwell and Krohn, 1989). This approach is particularly well-suited to fields like interprofessional collaboration, where early misunderstandings of key concepts are common (Mitchell et al., 2020). Nevertheless, future research should consider incorporating both retrospective and traditional pre-post designs to compare results and further validate findings.

Another limitation of this study is the absence of pre-training data on the Communication and Collaboration rubric used during the Mursion simulation meetings. Without baseline measures, it is challenging to quantify growth in observed collaboration behaviors over time. Future studies should incorporate an initial Mursion simulation as a pre-intervention assessment, allowing for direct comparisons and a clearer understanding of behavioral change resulting from the IPE experience.

Additionally, this study did not employ validated instruments to directly assess IPEC-aligned and Project LINC-specific competencies. While self-reported measures provided valuable insight into participants' perceived confidence and skill development, the integration of standardized instruments such as the Interprofessional Attitudes Scale (Norris et al., 2015) and the Interprofessional Collaborative Competency Attainment Scale-Revised (Schmitz et al., 2017) would improve measurement rigor. Triangulating self-report data with observational assessments conducted by trained raters using validated checklists, aligned with both the IPEC framework and the Mursion Communication and Collaboration rubric, would enhance the reliability and depth of future findings.

Future research should also examine how variations in the duration, structure, and delivery format of interprofessional education influence student outcomes. Investigating the effectiveness of immersive, hands-on models—such as the one implemented in this study—can offer critical insights into best practices for IPE design and implementation. Another important next step in this project is to evaluate the real-world application of IPP in school settings following participation in the IPE program, including its direct impact on outcomes for autistic students. These lines of inquiry would support the refinement and integration of IPP-focused content and hands-on experiences into both pre-service and in-service professional development programs across educational contexts.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors upon request, without undue reservation.

Ethics statement

The studies involving humans were approved by Towson University's Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements.

The participants provided their written informed consent to participate in this study.

Author contributions

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Conflict of interest

AR was employed by Sigma Associates Incorporated.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2025.1581257/full#supplementary-material

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