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# Transitioning to a virtual reality-infused curriculum in clinical sciences education: a road map

**Richard Kalunga[1], Carmen Ana Ramos-Pizarro[1], Fatma Elshobokshy[2], Tiffany Gurley-Nettles[1]**
[1]Speech-Language Pathology Program, College of Arts and Sciences, University of the District of Columbia, Washington DC, United States
[2]Center for the Advancement of Learning, University of the District of Columbia, Washington DC, United States

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**ABSTRACT**

The integration of virtual reality (VR) into clinical sciences education offers transformative potential for enhancing experiential learning and clinical training. This paper presents a comprehensive framework for integrating VR into clinical sciences education, using a case study from a speech-language pathology (SLP) program. It provides a roadmap for aligning VR integration with program and institutional goals, ensuring sustainability, and fostering stakeholder collaboration. Key components of the integration process are identified, and a case study on the implementation of the Bodyswaps VR platform for training active listening skills in SLP students is presented to illustrate the practical application and benefits of VR in clinical education. Preliminary findings indicate that VR integration increased student engagement and self-efficacy and improved clinical competencies. This paper concludes with reflections on the challenges and future directions of VR adoption in higher education. The roadmap presented serves as a scalable model for other programs seeking to leverage VR to enhance educational outcomes, boost student engagement, and prepare students for a technologically advanced workforce.



***Corresponding Author:***

Richard Kalunga
Speech-Language Pathology Program, College of Arts and Sciences, University of the District of Columbia
4200 Connecticut Avenue, NW, Washington, DC 20008, United States
Email: rkalunga@udc.edu

## 1. INTRODUCTION

The development of immersive technologies has progressed significantly, and they have become more accessible in various aspects of life, including leisure and the workplace. Immersive technologies blur the line between the real and virtual worlds, allowing users to feel fully immersed in their experiences [1]. They extend reality or create a new reality by leveraging the 360 space to allow users to see content in any direction. Some immersive technologies extend reality by overlaying digital images on a user's environment, whereas others create a new reality by completely shutting the user out from the rest of the world and immersing them in a digital environment [2]. Immersive technologies encompass virtual reality (VR), augmented reality (AR), mixed reality (MR), and extended reality (XR) [1]. Immersive technologies offer the benefits of "immersion" and "presence". Immersion can be objectively measured using the technological affordances of a medium. Media are more immersive when the user can experience the sensation of being in another place owing to various elements, such as visual quality and auditory design [3]. Features such as audio and visual quality, frame rate, stereoscopy, and field of view can impact the extent to which a system is immersive [4]–[6]. In contrast, presence is the subjective, psychological experience of being in a virtual environment (VE) [7], [8]. It focuses on how effectively the VE can make individuals forget about the real world. Technological advances leading to enhanced immersion and presence have opened the door to various educational and clinical use cases for VR. The psychological presence of 'being' in a created artificial mediated environment that harnesses an all-inclusive sensory illusion of being present in another environment presents unique learning and clinical opportunities. The academic and clinical use of three-dimensional VR renderings of environments that incorporate visual, auditory, tactile, and/or kinesthetic elements can lead to improved educational and clinical outcomes through increased engagement, enriched learning and clinical experiences, improved understanding, and enhanced knowledge retention. This is supported by research in healthcare [9], [10], education [11], [12], and crisis management [13], [14].

Work with graduate students in speech-language pathology (SLP) [15] showed the benefit of VR in helping learners thread the connections between experiences and knowledge, identifying the following learning benefits: i) allowing students to test real-world lessons in low-risk situations; ii) helping students visualize difficult and abstract concepts; iii) increasing student motivation to learn; iv) allowing more personalized learning; and v) providing students with the technical skills to excel in a changing technological workforce. The use of VR in rehabilitation for communication disorders is becoming increasingly widespread, with VR offering benefits over traditional clinical methods because of the ability to manipulate "real-world" task complexity and scaffold communication supports in ways that cannot be easily replicated in clinical settings [16]–[18]. VR has been used to train social communication skills in children with autism and to observe stuttering behaviors [19], [20]. In these studies, VR achieved comparable or better outcomes than non-VR communication tasks [21], [22]. VR has been used in the treatment of communication disorders following acquired brain injury, such as post-stroke aphasia, with some participants demonstrating gains in measures of functional communication, vocabulary, engagement, and verbal output [23]. For pre-service clinicians, VR offers the opportunity to practice clinical skills risk-free under controlled conditions, thereby preserving patient safety.

Although the benefits of VR in an experiential field such as SLP are documented, evidence on effective curriculum-wide implementation procedures is limited, slowing the rate of adoption. This trial provides a framework for successfully integrating VR into clinical sciences education. The SLP program, characterized by its dual academic and clinical components, presented a unique opportunity to develop a template for effectively embedding VR into the curriculum. This template can serve as a model for the successful implementation of VR into university programs across various disciplines.

## 2. METHOD

A plan was developed in collaboration with the university's center for advancement of learning (CAL) for the program-wide implementation of VR into the SLP curriculum. It focused on attaining synergistic integration, sustainability, responsiveness to changing program and student needs, enhancing student learning and clinical competency, pedagogical evidence, and garnering the support of faculty and students. VR use was thoughtfully embedded as a learning modality, along with existing ones, in a test course before more widespread implementation in the full SLP curriculum.

A template was developed to embed VR into course instruction. A use case example of its deployment was trialed in an SLP graduate students' pre-service training. Pre-service training is designed to provide maximum scaffolding in the early stages when students have minimal to little exposure to the field and reduce support as students gain increased knowledge and master clinical competencies. One of the main challenges at this stage of training is providing students with active learning activities that are low-stakes and formative in nature, while allowing them to practice critical competencies in a safe environment that does not involve patients. VR meets this challenge by allowing student clinicians to master basic knowledge and clinical competencies through controlled, well-scripted activities.

This case study targeted clinical soft skills. Soft skills are non-technical skills such as communication, teamwork, and emotional intelligence, which are crucial for effective patient care and building strong relationships. Soft skills training is an important part of pre-service training, as these skills are increasingly recognized as vital for healthcare professionals, contributing to improved patient satisfaction and enhanced teamwork. While the development of communication skills when interacting with patients and their caregivers has been identified as an essential clinical competency by the American Speech-Language-Hearing Association (ASHA), the professional association for speech-language pathologists, there is limited information available on how best to train these skills within graduate school clinical program curricula [24]. To provide experience and help master this critical competency, a VR-facilitated learning module was implemented as part of the students' Level 1 clinical practicum training at the UDC SLP clinical program. The Bodyswaps VR application was selected for this module after considering the module student learning objectives and consulting with CAL. Bodyswaps is a training platform that provides learners with VR experiences to assist them in mastering soft skills as in Figure 1. While the target audience of this VR app is general and more focused on the business world, the communication skills presented align well with those expected of SLP students in clinical settings, specifically in their interactions with clients and caregivers.


Figure 1. Bodyswaps active listening screengrab

The program was implemented in two phases, beginning with a program-wide immersive technologies module. This module introduced students to the use of immersive technologies in education and clinical practice. The module is part of the initiative by the SLP program to systematically and comprehensively integrate immersive technologies into the SLP curriculum and is a requirement for all incoming students. It is integrated into the learning management system (LMS) and contains online asynchronous and face-to-face components. It provided students with the knowledge and skills to effectively interact with VR technologies, helping to combat any negative perceptions of the technologies and reduce user frustration. As part of the module, students were: i) introduced to the use of immersive technologies in education and clinical practice; ii) provided hands-on experience using various immersive technology hardware and software with educational and clinical applications; iii) explored VR resources designed for use in the field of SLP and others which, though not specifically designed for the field, could be used with adaptation; iv) identified barriers to the academic adoption of VR platforms, and v) appraised the clinical effectiveness of VR-based therapies.

Phase two involved students completing the Bodyswaps VR-facilitated learning module deployed on the Blackboard LMS. The learning module was structured in ways that allowed better alignment of the Bodyswaps app to the SLP field and assisted students in making needed clinical connections. Students completed the module as they progressed through the VR experience. Blackboard forced sequence navigation was employed to effectively manage the learning environment and promote systematic pacing of the VR experience. This required learners to satisfactorily complete a "test your knowledge" quiz before the system unlocked the next section in the module. Following best practices in the deployment of VR simulation activities, the learning experience included the following three phases: pre-brief, simulation, and debrief [25].

- The pre-brief phase provided learners with activity objectives and background articles on the importance of soft skills, specifically active listening. Articles were presented via "hypothesis", a web-based social annotation tool, to encourage active interaction of learners with article content and other learners. As part of setting the stage for the VR experience, the concept of suspension of disbelief was discussed and emphasized. Quality simulation-based learning activities rely on mimicking real life by requiring learners to accept the simulation's environmental, conceptual, and psychological features as real. Successfully achieving suspension of disbelief was critical to achieving the highest engagement from learners [26].
- The simulation phase introduced the active listening module of the Bodyswaps VR platform, a fully immersive VR interface designed to be completed as the learner paused at specific points during the VR activity. The module guided the students in the learning about active listening skills and provided opportunities for making clinical connections to the SLP field via critical thinking questions. The VR module presented a scenario in which two colleagues (Dave and Amy), discussed a work issue in a VR simulation. Students were expected to engage in active listening exercises and analyze Dave and Amy's conversations to identify the use of best practices in active listening. They were then asked to put those skills into practice by assuming Amy's role and recording themselves responding to Dave's concerns, summarizing his feelings, and experiencing the impact of their words through a body swap, in this case, switching to assume the VR avatar's perspective.

- The VR experience was debriefed in stages via formative quizzes that guided students in self-reflection and making clinical connections to the application of target skills in SLP clinical communication contexts.

Upon completion of the module, students underwent summative assessment. To demonstrate mastery of target active listening skills, students were asked to write a script or dialogue between an SLP and a caregiver that demonstrated best practices in active listening and record a live low-fidelity role-play with a standardized participant assuming the role of caregiver for later review with the instructor. Students selected between two different communication scenarios: i) a parent describing to an SLP the lack of services to meet their child's needs and ii) a caregiver upset about the constant changes in clinicians at the SLP Clinic.

## 3. RESULTS AND DISCUSSION

The work undertaken by the SLP program and the Center for the Advancement of Learning (CAL) identified five necessary components for the successful integration of VR into a program: i) clearly defined goals and objectives; ii) alignment of VR initiative goals and objectives with program, college, and university goals, objectives, and priorities; iii) extensive curriculum review to determine VR-compatible subject matter and sequence for VR integration; iv) faculty readiness and training to implement VR in course activities; and v) stakeholder-informed implementation guided by data from surveys and focus groups. These essential components of program VR integration, as illustrated in Figure 2, align with the general principles of educational innovation.

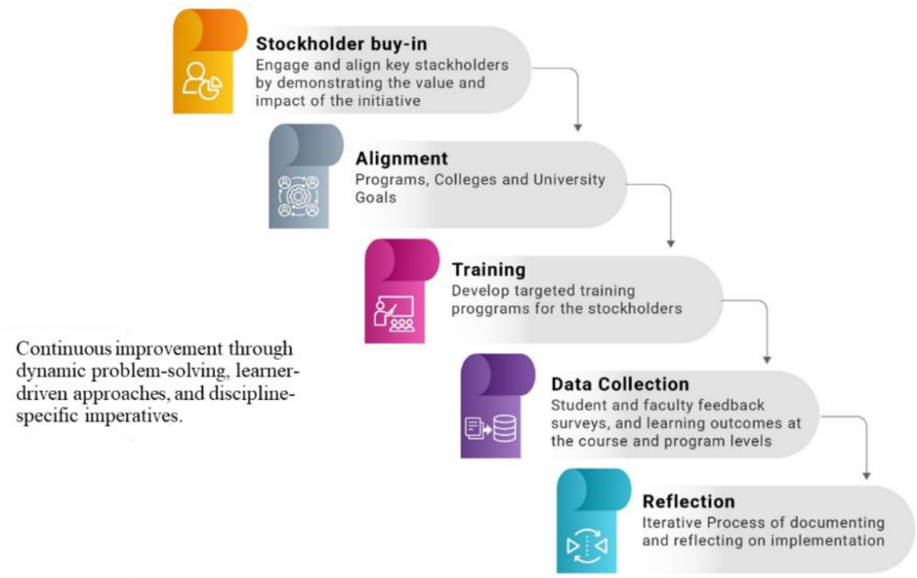


Figure 2. Program VR integration components

Research supports the importance of defining clear and collaboratively developed goals and objectives as foundational steps in integrating VR into higher education. These objectives serve as critical anchors for securing institutional buy-in and ensuring successful implementation. When shaped through input from key stakeholders, including program faculty, instructional designers, and technology leaders, they help the initiative gain both legitimacy and strategic direction, enhancing operational clarity throughout the implementation process. Importantly, objectives should be directly mapped to measurable learning outcomes and grounded in constructivist and experiential learning theories, which align closely with VR's capacity to foster immersive engagement and deep conceptual understanding [27]. By explicitly articulating how VR enhances student engagement and skill acquisition, programs can more effectively justify the selection and customization of VR assets, facilitating cross-content alignment and promoting sustainable adoption at scale.

Aligning VR initiative goals with program, college, and broader university missions is supported in the literature [28] as being essential for generating meaningful, system-wide impact and sustained commitment. When VR implementation is strategically linked to broader priorities, such as workforce readiness, cultural competence, and lifelong learning, it not only enhances the initiative's relevance but also helps secure critical resources and facilitates cross-departmental collaboration. Well-aligned initiatives are more likely to receive sustained administrative and faculty support because they demonstrate coherence with accreditation standards, institutional strategic plans, and evolving higher education imperatives.

The study identified comprehensive curriculum review and intentional course sequencing as pivotal for the successful integration of VR technology. This process should prioritize interdisciplinary curriculum innovation that embraces digital transformation and supports the adoption of emerging technologies. By leveraging immersive simulations and experiential pedagogies, programs can enhance both engagement and learning outcomes of students. Comparative research on VR adoption affirms these findings [29], highlighting that faculty-led curriculum reviews are essential for identifying content best suited for VR enhancement and for determining the optimal sequence for phased implementation. Such strategic planning not only improves instructional coherence but also maximizes the adaptability and pedagogical impact of VR integration.

Faculty training and ongoing professional development emerged as essential pillars for effective VR integration, enabling instructors to confidently leverage both the technical capabilities and pedagogical potential of VR technologies. Systematic reviews and case studies [30] show that faculty development is most effective when designed as collaborative, iterative, and contextually relevant, combining hands-on technical support with mentorship in immersive instructional design. These elements were evident in the study training which, fostered active collaboration between faculty, instructional designers, and technology experts. This partnership not only encouraged innovation but also mitigated resistance and accelerated the overall adoption process of the new technology. It was also important that ongoing faculty development was embedded in the institutional strategy to ensure that pedagogical best practices for VR were consistently reinforced and aligned with evolving technologies.

Robust data collection and formative feedback mechanisms were identified as integral to a responsive and effective VR integration framework. Ongoing feedback via qualitative focus groups, targeted surveys, and LMS-integrated analytics yields actionable insights that drive continuous curricular refinement, inform technology optimization, and deepen stakeholder engagement. This is supported by research [31], which shows that activity-oriented focus groups and faculty-driven scenario discussions effectively capture authentic user experience and pedagogical needs. These feedback loops enabled iterative improvements that enhanced the educational value of VR and ensured alignment with learning objectives and user expectations.

Stakeholder engagement and collaboration emerged as hallmark features of successful and sustainable VR integration. Early and sustained involvement of key stakeholder groups, including faculty, students, instructional designers, and institutional leadership, was intentionally designed to foster buy-in, align interests, and cultivate a shared sense of ownership of the project. These collaborations facilitated agile problem-solving across all project phases, including ideation, planning, implementation, and evaluation, ensuring that the initiative remained responsive to emerging needs and challenges. This approach is supported by social constructivist theory and stakeholder-oriented frameworks, which emphasize participatory design and shared purpose as essential conditions for enduring educational innovation [32].

In this study, the primary stakeholders included CAL, academic and clinical faculty from the SLP program, and the graduate students. CAL, as the university division responsible for advancing learner-centered, inclusive, and innovative instructional design, played a pivotal role as both a thought partner and implementation driver. Aligning the VR initiative with the strategic goals of CAL, the SLP program, and the broader university was critical to securing the financial, technological, and human resources necessary for the project's success. It was also essential that student engagement be prioritized equally. By clearly communicating the pedagogical rationale and anticipated benefits of VR integration, the initiative positioned VR as an enhancement rather than a replacement for traditional student learning experiences. Actively involving students in the design, testing, and refinement phases helped ensure that learner needs were addressed and that the technology served to deepen, rather than complicate, their educational experience. Finally, the initiative drew on the diverse expertise of its stakeholders to inform VR asset selection, instructional alignment, and user experience design. Given the inherent complexity and rapid evolution of VR technologies, a dynamic collaborative model is essential for identifying and resolving technical and pedagogical challenges in real-time. This adaptability ultimately strengthens the quality, relevance, and impact of VR initiatives.

Preliminary outcomes from the use case revealed measurable gains in student self-efficacy related to active listening skills following completion of the Bodyswaps module. These findings align with a growing body of research demonstrating the efficacy of VR in enhancing learner confidence and the acquisition of non-technical or soft skills [10], [14]. Students not only reported improved confidence but also demonstrated practical application of active listening during caregiver interviews embedded within formative assessments and semester-end summative simulations. Their ability to effectively transfer skills practiced in the VE to authentic, real-world clinical scenarios underscores the pedagogical power of well-designed VR interventions, a finding supported by prior studies on VR's impact on social communication skills development [21], [22].

These results further substantiate the value of VR learning environments in cultivating both self-efficacy and skill mastery by offering low-risk, repeatable opportunities to engage in complex tasks. By enabling students to practice critical competencies in a controlled immersive setting, VR facilitates a smoother transition from theoretical classroom instruction to applied clinical practice. Collectively, the evidence positions VR as a scalable, high-impact pedagogical strategy that supports workforce preparedness and bridges the gap between academic learning and professional competency.

Moreover, the structured pre-brief-simulation-debrief cycle employed in this study aligns closely with best practices in healthcare simulation, emphasizing the importance of pedagogical scaffolding to support knowledge retention and skill acquisition [25]. This framework, comprising preparatory theoretical grounding, immersive experiential engagement, and post-experience reflection, has been shown to enhance cognitive integration and learner outcomes. In this implementation, students participated in collaborative annotation using the Hypothesis platform, engaged in immersive practice through the Bodyswaps VR module, and completed structured reflective exercises. This multifaceted approach promotes deep learning and is firmly rooted in social constructivist educational theory, which holds that learners construct meaning through active engagement and social interaction [27].

Thus, the VR-infused curriculum presented here is not only demonstrably effective in improving clinical competencies but is also grounded in robust pedagogical theory. It reinforces active learning, cultivates critical reflection, and bridges theory with practice, which are hallmarks of high-impact instructional design in professional education.

The deployment of the VR experience through the Blackboard LMS was positively received by students, who highlighted its accessibility, ease of navigation, and integration with course assessments. Embedding the VR module within the existing LMS infrastructure enhanced the overall learning experience by providing asynchronous access, consistent content organization, and seamless transitions between immersive and non-immersive components. This strategic integration helps reduce cognitive load and improve usability, which are critical factors for successful immersive learning [12].

Notably, although Bodyswaps was originally developed for professional development in business contexts, its strategic adaptation for SLP training proved to be effective. This outcome reinforces findings that show that generic VR interventions, when thoughtfully scaffolded, can be successfully repurposed to meet discipline-specific learning objectives [19]. The significance of this finding lies in its broader applicability: academic programs with limited access to custom-built VR applications can still achieve meaningful outcomes by creatively leveraging existing tools through innovative instructional design and seamless LMS integration. This approach aligns with the established best practices in simulation-based learning within communication sciences, which emphasize flexibility, contextual relevance, and pedagogical alignment [26]. It affirms that the educational value of VR lies not solely in content specificity but in the intentional structuring of learning experiences that guide students through realistic, immersive scenarios tied to their professional training.

Overall, this study reinforces the growing body of evidence that VR-facilitated learning environments, when pedagogically grounded and technically supported, can significantly improve student learning outcomes, including soft skills acquisition. It adds to the literature by providing a replicable, scalable model that demonstrates how generic VR platforms, such as Bodyswaps can be embedded in discipline-specific curricula with meaningful results.

Although the findings of this study are encouraging, several limitations warrant careful consideration. One notable challenge involved intermittent transitions out of the VR environment for debriefing activities, which may have disrupted the experiential flow and diminished the sense of presence, a critical factor in immersive learning effectiveness [8]. To preserve immersion and optimize learning outcomes, future implementations should consider restructuring debriefing activities to occur post-immersion or explore the integration of reflective prompts directly into the VR environment.

Additionally, further investigation is needed to determine the optimal sequencing of experiential learning activities. Specifically, it remains unclear whether students benefit more from engaging in low-fidelity role-play exercises prior to VR exposure or whether the VR experience alone provides sufficient preparation for real-world clinical interactions. Emerging evidence [18] suggests that hybrid sequencing, which blends traditional role-play with immersive simulations, may offer the most effective pathway for skill transfer. Future research should empirically explore these instructional design variables to establish best practices for maximizing learning in VR-enhanced curricula.

## 4. CONCLUSION

VR can significantly enhance the educational experience of pre-service clinicians in graduate SLP programs and other disciplines. These cutting-edge technologies offer an engaging and innovative approach for students to acquire both scientific knowledge and non-technical or soft skills, which are often difficult to train effectively. Despite their advantages, VR technologies have not been widely adopted in higher education, in part because of limited foundational research on theories relating to VR adoption as a learning strategy.

Additionally, few publications detail how to best integrate VR-based instruction into academic and clinical curricula. This creates a potential barrier to adoption, as educators seek supportive evidence for VR use in the classroom, and institutions seek funding justification. Establishing strong learning theory bases for classroom VR use, supported by data on its validity, is essential to breaking down this barrier. Although challenges remain in implementing VR in higher education, interest in its use is prevalent and growing. Successful curricular higher education adoption of VR will require curriculum integration trials and continued collaboration between institutions and VR developers. The noted barriers to VR adoption do not diminish the value of its use; rather, they provide an opportunity for significantly consequential work in this space that advances VR's value in higher education. The novelty of this study lies in its comprehensive and practical approach to integrating VR into clinical sciences education. It underscores the potential of VR-facilitated training for soft skills acquisition and presents a structured framework that can be adapted by other educational programs. This study significantly enriches the expanding body of research on immersive technologies in education, offering valuable insights for educators and institutions seeking to enhance their curricula with the use of VR.

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Richard Kalunga | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | | |
| Carmen Ana Ramos-Pizarro | | ✓ | | | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | |
| Fatma Elshobokshy | ✓ | | ✓ | | | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ |
| Tiffany Gurley-Nettles | ✓ | | | | | ✓ | ✓ | | ✓ | ✓ | | | | |

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
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R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

## CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The authors state no conflict of interest.

## DATA AVAILABILITY

The authors confirm that the data supporting the findings of this study are available within the article.

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## BIOGRAPHIES OF AUTHORS

**Richard Kalunga** is an academic coordinator and associate professor of speech-language pathology. He received his PhD from Howard University in communication sciences and disorders, MS in speech-language pathology from the University of the District of Columbia, and BS in mechanical engineering from the University of Manchester Institute of Science and Technology. His work in digital transformation in teaching and learning, including the use of extended reality (virtual reality, augmented reality, and mixed reality), is focused on eliminating the barriers to learning imposed by space and time, enhancing learning experiences and student engagement, increasing learning retention through multisensory engagements, and increasing student motivation. He is particularly passionate about leveraging evolving immersive technologies and artificial intelligence to deliver learning that anchors students to the communities they serve, engaging them to become consequential change-agents for their professions and communities. He can be contacted at email: rkalunga@udc.edu.

**Carmen Ana Ramos-Pizarro** is a bilingual (English/Spanish) associate professor in the speech-language pathology program at the University of the District of Columbia (UDC). She earned her Doctorate in Voice Science from the University of Wisconsin-Madison and a Master's degree in Speech-Language Pathology from the University of Puerto Rico-Medical Sciences Campus. She specializes in voice disorders, speech science, and instrumentation in voice and speech assessment and intervention. She founded the voice care and gender-affirming voice in-house clinic, where she supervises graduate student-clinicians providing gender-affirming voice services to gender-diverse individuals from urban communities in the District of Columbia, Maryland, and Northern Virginia region. Her research interests center on integrating simulation-based education, artificial intelligence tools and immersive technologies into the clinical training of pre-service clinicians, specifically in voice assessment, gender-affirming voice care, and cultural responsiveness within the communication sciences and disorders curriculum. She can be contacted at email: carmen.ramospizarro@udc.edu.

**Fatma Elshobokshy** is the director of the Center for the Advancement of Learning at the University of the District of Columbia, leading digital transformation efforts to modernize curriculum and enhance student success. With over 15 years of experience in higher education, she focuses on improving learning outcomes and bridging the gap between education and employability. She has been instrumental in faculty professional development, ensuring quality assurance in UDC's distance learning, and expanding digital teaching initiatives. She has initiated and led major projects, including integrating immersive technology into UDC's learning ecosystem, reforming distance education, upgrading UDC's learning management system (LMS) to enhance accessibility, and expanding the HyFlex modality. Recognized with the 2024 Technology All-Star Award, she has published and presented widely on instructional design, educational technology, and faculty development. She can be contacted at email: fatma.elshobokshy@udc.edu.

**Tiffany Gurley-Nettles** is a distinguished scholar, educator, and clinical practitioner in speech-language pathology and health psychology. As the program director and assistant professor at the University of the District of Columbia, she is enthusiastic about mentoring the next generation of speech-language pathologists. She teaches various courses, including medical speech-language pathology, aphasia, neuroanatomy of the speech and hearing mechanism, and thesis seminar. Her commitment to student success is evident in her hands-on, interactive teaching method, which emphasizes experiential learning and critical thinking while infusing immersive technology and a mindfulness-based approach. In addition to her academic responsibilities, she maintains an active clinical practice, providing assessment and intervention services for individuals and their families with diverse communication needs, brain health and intervention, cognitive aging, and more. She has additional research interests and current projects in culturally responsive clinical supervision, immersive technology in speech-language pathology education, immersive technology in neurocognitive rehabilitation, and health trauma intervention. She can be contacted at email: tiffany.gurleynettle@udc.edu.