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POWER IN DEAF PEDAGOGY AND CURRICULUM DESIGN: MULTIMODALITY IN THE DIGITAL ENVIRONMENTS OF DEAF EDUCATION (DE^2)

Abstract: Deaf people are a heterogeneous global minority singularly linked by technology. I posit that deaf people wield the cutting-edge of innovation by developing or repurposing digital technologies in deaf education as a means to leverage the affordances of visuospatial sign languages and multimodal communication. Throughout, I investigate a nexus of historical, cultural, social, political, and ideological struggle where deaf people use their own power and self-determination to counteract harmful forces like oppression and exclusion. To do this, I synthesize the *digital environments of deaf education* (DE^2) and articulate a theory of deaf educational power centered on the interdependence of digital knowledge modes and the deaf users driving their development.

I situate *modes* as a fundamental unit of analysis. Multimodality is related to power and ethics in education and assists in critically analyzing DE^2. Multimodal theory illustrates how power is used in DE^2 and shows ecological relationships between pedagogical ethics and knowledge co-construction by deaf students and educators. In sum; deaf people use multimodal technologies to construct deaf-centric educational power. Three major findings are categorized: (1) the *purposes* for which DE^2 are designed, (2) the *practices* constitutive of DE^2, and (3) *disciplines* represented in DE^2 research. Two exemplars from category 3 are shown and analyzed. Both interrelate Deaf Culture, sign language, and digital education technologies. One is situated in a deaf student protest about language and communication access. The second is rooted in the multilingual characteristics of an international consortium related to deaf science epistemologies. Overall, I elucidate a social history of technology in deaf education to show that DE^2 is a globalized phenomenon transcending geopolitical boundaries.

Keywords: deaf education, multimodality, digital education paradigms

Introduction: Digitizing Deaf Education

Deaf students increasingly encounter digital tools in education and are expected to learn in spaces saturated with a diversity of cultures, languages, and communication modes united and dominated by technology.[1] The ascendant emphasis on technologically-enabled deaf education is consistent across a diversity of global sites of deaf education[2]. Historically, most deaf education scholarship is produced in Western Europe and the United States; however, it is precisely the proliferation of new communication technologies in educational research that has resulted in increasing interconnectedness for deaf educators, students, and research teams across the Americas, Asia, Africa, Europe, and Oceania[3]. These "glocal" deaf education collaborations span from Scandinavia to the Mediterranean, and include Eastern European countries like Poland. Indeed, an early draft of this paper was presented by me at a Polish conference about this history of technology[4]. Despite demographic heterogeneity, it should be emphasized that there are widespread *similarities* in how technologies are used by deaf people. While the local contexts change, the need for technology in deaf education is constant.[5]

In contemporary deaf higher education, students encounter manifold forms of internet-enabled information environments; however, they are seldom designed for their learning needs – instead, they are designed for and by people who aren't deaf.[6]

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1 M. Keating, G. Mirus, *American Sign Language in Virtual Space: Interactions between Deaf Users of Computer-Mediated Video Communication and the Impact of Technology on Language Practices*, "Language in Society" 2003, vol. 32 (5), pp. 693–714; H. Knoors, M. Marschark, *Language Planning for the 21st Century: Revisiting Bilingual Language Policy for Deaf Children*, "Journal of Deaf Studies and Deaf Education" 2012, vol. 17 (3), pp. 291–305; M. Maiorana-Basas, C.M. Pagliaro, *Technology Use Among Adults Who Are Deaf and Hard of Hearing: A National Study*, "Journal of Deaf Studies and Deaf Education" 2014, vol. 19 (3), pp. 400–209; A. Young, B. Temple, *Approaches to Social Research: The Case of Deaf Studies*, Oxford University Press, New York 2014.

2 H. Knoors, M. Brons, M. Marschark, *Deaf Education beyond the Western World*, Oxford University Press, New York 2019.

3 H. Knoors, M. Marschark (eds.), *Educating Deaf Learners: Creating a Global Evidence Base*, Oxford University Press, New York 2015.

4 The International Committee for the History of Technology's (ICOHTEC) 46th Symposium, July 22–27th, Katowice, Poland.

5 A. Young, B. Temple, op. cit.

6 J. Beal-Alvarez, J.E. Cannon, *Technology Intervention Research with Deaf and Hard of Hearing Learners: Levels of Evidence*, "American Annals of the Deaf" 2014, vol. 158 (5), pp. 486–505; G. Valentine, T. Skelton, *'An Umbilical Cord to the Word:' The Role of the Internet in D/Deaf People's Information and Communication Practices*, "Information, Communication & Society" 2009, vol. 12 (1), pp. 44–65; J. Weber, M.E. Skyer, *"The Aesthetics of OER, Deaf Pedagogy, and Curriculum Design Contra the 'Wicked Policy Problems' of Deaf Education*, "Revista Iberoamericana de Educaión a Distancia" 2022, vol. 25 (2), pp. 2–21.

This nondeaf ontogenetic locus constrains and disempowers deaf students.[7] It is therefore important to evaluate whether or not the proliferation of digital education technologies across numerous global sites is to the advantage or disadvantage of deaf students who are very often compelled to use them.[8]

Deaf people relate to the world and to educational content via technology. As Sutherland and Padden argue, the intersection of deaf education and technology must be contextualized by history, language, and culture.[9] Researchers of DE^2 must understand what technology generally means for deaf people prior to educational applications. Throughout this article, I abbreviate the *digital environments of deaf education* as DE^2. This is an umbrella term I devised to encapsulate numerous educational tools, applications, and skills deaf students use in digitally-networked spaces. DE^2 synthesizes the following terms I noted in the literature: *e-learning*, *Web-based instruction*, *digital learning*, *online teaching*, *distance education*, *e-literacy*, *computer-based instructional design*, *hybrid, blended, and flipped models*.[10] As I explore it, DE^2 is a nexus comprised of historical, linguistic, and sociocultural domains. Fundamentally, DE^2 is centered on an ethics of increasing access and redressing inequity.

7 B.S. Parton, *Sign Language Recognition and Translation: A Multidisciplined Approach from the Field of Artificial Intelligence*, "Journal of Deaf Studies and Deaf Education" 2006, vol. 11 (1), pp. 94–101; A. Sutherland, T. Padden, *Videoconferencing for Deaf People: A Case Study of On-line Education for Deaf People*, "Deafness and Education International" 2006, vol. 1 (2), pp. 114–120.

8 H. Lang, *Higher Education for Deaf Students: Research Priorities in the New Millennium*, "Journal of Deaf Studies and Deaf Education" 2002, vol. 7 (4), pp. 267–280; R. Swanwick, M. Marschark, *Enhancing Education for Deaf Children: Research into Practice and Back Again*, "Deafness and Education International" 2010, vol. 12 (4), pp. 217–235.

9 A. Sutherland, T. Padden, op. cit.

10 S. Burgstahler, *Opening Doors or Slamming Them Shut? Online Learning Practices and Students with Disabilities*, "Social Inclusion" 2015, vol. 3 (6), pp. 69–79; E. Keating, G. Mirus, op. cit.; G. Nuccetelli, M.T. de Monte, *Deaf People Education: Crossing Linguistic Borders through E-learning* [in:] P. Monachesi, A.M. Gliozzo, E. Westerhout (eds.), *Proceedings of the First Workshop on Supporting E-learning with Language Resources and Semantic Data*, Language Resources and Evaluation Conference, Valletta 2010, pp. 24–28; C.M. Shepherd, M. Alpert, *Using Technology to Provide Differentiated Instruction for Deaf Learners*, "Journal of Instructional Pedagogies" 2015, vol. 16, pp. 1–7; D. Power, M.R. Power, *Communication and Culture: Signing Deaf People Online in Europe*, "Technology and Disability" 2009, vol. 21 (4), pp. 127–134; A. Raike, *Searching Knowledge CinemaSense as a Case Study in Collaborative Production of a WWW Service in Two Universities* [in:] K. Misenberger, J. Claus. W. Zagler, A.I. Karshmer (eds.), *Computers Helping People with Special Needs: 11th International Conference*, ICCHP, Linz 2008, pp. 568–574; A. Raike, A. Keune, B. Lindholm, J. Muttilainen, *Concept Design for a Collaborative Digital Learning Tool for Film Post-Production*, "Journal of Media Practice 2013", vol. 14 (4), pp. 307–329; P. Van Haitsma, *New Pedagogical Engagements with Archives: Student Inquiry and Composing in Digital Spaces*, "College English" 2015, vol. 78 (1), pp. 34–55.

Research Questions

DE^2 describes a multitude of digital interactions between deaf students, educators, multimodal discourses, and educational materials. Furthermore, in this paper, I interpret pertinent research and case-based exemplars using a multimodal framework alongside selected theories of power, including disability-forward research on self-determination[11] and critical access studies.[12] My construction and interpretation of DE^2 is transformative and emancipatory in nature. I aim to center not only the practices of *educators* – particularly in deaf higher education – but also to support deaf *students* worldwide who use DE^2 to explore and express their own power. In short, I establish DE^2 as a nexus of deaf-positive power in education.

To understand the nexus, I devised two questions:

1. *What does the research show about how deaf students and deaf educators engage with digital education (e.g., DE^2)?*
2. And, *What relationships exist between multimodality, power, and DE^2?*

I answer the first question principally through a critical analysis of research on DE^2, as interpreted through multimodal theory. These findings are organized in three categories: *purposes*, *practices*, and *disciplines*. In the last category, I analyze case-based exemplars of DE^2 sourced from contemporary deaf higher education. One analyzes the role of technologies in an education-related protest led by deaf college students about communicational equity in the classroom. This example stemmed from my personal experience teaching an academic writing course, which co-occurred with the protests and was thematically focused on technological changes in (deaf) higher education. Many of the protest leaders were my students, perhaps inspired by the content of my classes. The second exemplar is situated in STEM disciplines and examines an internationally-constructed lexicon of astronomy terminology using an array of national and regional sign languages. This is one example of similar crowd-sourced lexicons based on sign language corpora, whose creation and dissemination are enabled by digital technologies.

As I organized answers to the first question, I found that they consistently evoked issues and concepts of power and self-determination. To fully answer the first query, I therefore, devised a second. The answer to the question about power is addressed in my introduction and conclusion. I also include an interlude about theories of power that assist in understanding the specific histories of oppression and exclusion in deaf

[11] R.M. Ryan, E.L. Deci, *Self-Regulation and the Problem of Human Autonomy: Does Psychology Need Choice, Self-Determination, and Will?*, "Journal of Personality" 2006, vol. 74 (6), pp. 1557–1585; M.L. Wehmeyer, *Self-Determination and Individuals with Severe Disabilities: Re-Examining Meanings and Misinterpretations*, "Research and Practice for Persons with Severe Disabilities" 2005, vol. 30 (3), pp. 113–120, https://doi.org/10.2511/rpsd.30.3.113.

[12] A. Hamraie, K. Fritsch, *Crip Technoscience Manifesto*, "Catalyst; Feminism, Theory, Technoscience" 2019, vol. 5 (1), pp. 1–34.

education, as related to sign languages and other semiotic modes[13] in deaf education. Across my questions, answers, themes, and exemplars, I focus on the beneficent potentiality of multimodality, a broadly useful theoretical framework for analyzing DE^2. Together, these enumerate commonalities and divergences of DE^2 under a common rubric of deaf-centric ethics and deaf-positive power.

Theoretical Framework: Multimodality and Deaf Education Technologies

Multimodality

In modern digital educational technologies, multimodality reigns supreme. The theory of multimodality posits that discourse is comprised of smaller parts called modes.[14] Consequently, multimodal education involves combining or juxtaposing modes in ensembles or assemblages to achieve educational goals.[15] Multimodality supports a complex understanding of educational discourse – including ecological relationships between ethics and pedagogy and people and praxis.[16] Multimodal theory explicitly includes but does not require educational technologies.[17]

Multimodal social semiotic theory[18] challenges how education is traditionally understood, mainly by superseding the traditionally-dominant focus of language.[19] Multimodal theorists claim that language is a fraction of the plurality of forms of information exchange. Foci of interest to multimodal education discourse analysts include color, shape, line, form, texture, gesture, movement, and pattern.[20] Leading

[13] Cf. G. Kress, *What is Mode?* [in:] C. Jewitt (ed.), *The Routledge Handbook of Multimodal Analysis*, Routledge, New York 2009, pp. 54–67.

[14] G. Kress, *Multimodality: Challenges to Thinking about Language*, "TESOL Quarterly" 2000, vol. 34, pp. 337–340; G. Wells, *Modes of Meaning in a Science Activity*, "Linguistics and Education" 2000, vol. 10, pp. 307–334.

[15] C. Jewitt, *An Introduction to Multimodality* [in:] C. Jewitt (ed.), *The Routledge Handbook…*, op. cit., pp. 14–27; G. Kress, C. Jewitt, J. Ogborn, C. Tsatsarelis, *Shapes of Knowledge* [in:] G. Kress, C. Jewitt, J. Ogborn, C. Tsatsarelis, *Multimodal Teaching and Learning: The Rhetorics of the Science Classroom*, Continuum, New York 2001, pp. 99–127; L. Unsworth, C. Cleirigh, *Multimodality and Reading: The Construction of Meaning through Image–Text Interaction* [in:] C. Jewitt (Ed.), *The Routledge Handbook…*, op. cit., pp. 151–163.

[16] G. Kress, *Multimodality: Challenges…*, op. cit.; idem, *Multimodality: A Social Semiotic Approach to Contemporary Communication*, Routledge, New York 2010.

[17] G. Kress, *Multimodality: A Social Semiotic…*, op. cit.

[18] Cf. R. Hodge, G. Kress, *Social Semiotics*, Cornell University Press, Ithaca 1988.

[19] G. Kress, *Multimodality: A Social Semiotic…*, op. cit.

[20] G. Kress, *Discourse Analysis and Education: A Multimodal Social Semiotic Approach* [in:] R. Rogers (ed.), *Critical Discourse Analysis in Education* (2nd ed.), Routledge, New York 2011.

scholars claim that it's not possible to think about education, technologies, or educational technologies without analyzing this proliferation of modes.[21]

Importantly, Kress argues that multimodality supports ethical pedagogical change.[22] For instance, college educators and minority students may use multimodal analyses to critically reflect on complex figurations of identity, ideology, hegemony, and power in pedagogy and curriculum present in classrooms.[23] As recent research (see below) suggests, this extends into digital classrooms as well.

Multimodal Deaf Education

In several ways, deaf education is related to multimodality, including a shared interest in data visualization and visual pedagogy. Multimodal research sometimes refers to sign languages and deaf people,[24] and newer deaf education studies evoke multimodal theories.[25] However, a comprehensive synthesis between these traditions has yet to occur. Should it occur, an appropriate place to begin is within DE^2, which supports flexible media frameworks and plural modes of discourse of interest to deaf educational researchers and teachers.[26]

Increasingly, multimodality is thought to be central to digitally-enabled deaf higher education.[27] Research on deaf higher education shows that multiple discourse modes affect knowledge-construction in interactions between deaf college students,

21 G. Kress, *Multimodality: Challenges…*, op. cit.; idem, *Multimodality: A Social Semiotic…*, op. cit.

22 G. Kress, *Multimodality: A Social Semiotic…*, op. cit.

23 M.J. Curry, *Media Literacy for English Language Learners: A Semiotic Approach*, "Literacy and Numeracy Studies" 1999, vol. 9 (2), pp. 29–46.

24 L.A. Becvar, J. Hollan, E. Hutchins, *Hands as Molecules: Representational Gestured Used for Developing Theory in a Scientific Laboratory*, "Semiotica" 2005, vol. 156 (1/4), pp. 89–112; G. Kress, *What is Mode?…*, op. cit.; idem, *Multimodality: A Social Semiotic…*, op. cit.; W.-M. Roth, *Gestures: Their Role in Teaching and Learning*, "Review of Educational Research" 2001, vol. 71 (3), pp. 365–392.

25 L. Hunter, *The Embodied Classroom: Deaf Gain in Multimodal Composition and Digital Studies*, "Journal of Interactive Technology and Pedagogy" 2015, vol. 8, pp. 1–19; M.E. Skyer, L. Cochell, Aesthetics, *Culture, Power: Critical Deaf Pedagogy and ASL Video-Publications as Resistance-to--Audism in Deaf Education and Research*, "Critical Education" 2020, vol. 11 (15), pp. 1–26.

26 E. Pizzuto et al., *Language Resources and Visual Communications in a Deaf-centered Multimodal E-learning Environment: Issues to Be Addressed* [in:] P. Monachesi, A.M. Gliozzo, E. Westerhout (eds.), *Proceedings of the First Workshop…*, op. cit., pp. 18–23; A. Raike, *Searching Knowledge…*, op. cit.

27 G. Kress, *Multimodality: A Social Semiotic…*, op. cit.; A. Raike, S. Pylvänen, P. Rainò, *Co-Design from Divergent Thinking* [in:] H.-D. Bauman, J.J. Murray (eds.), *Deaf Gain: Raising the Stakes for Human Diversity*, University of Minnesota Press, Minneapolis 2014, pp. 402–420; M.E. Skyer, *Pupil ⇄ Pedagogue: Grounded Theories about Biosocial Interactions and Axiology for Deaf Educators* (doctoral dissertation), University of Rochester 2021.

educators, and technological information-exchanges. Dowaliby and Lang[28] and Lang and Steely[29] show that deaf students learn with multimedia technology and engage with multiple, simultaneous modes that exist in "synergy" with one another.

My analysis explore this synergistic effect of DE[2] using multimodal theory, which includes but supersedes a focus on (sign) languages. This kind of research is in the minority in deaf education, which traditionally valorizes research on sign language. While I am a consistent supporter of sign language as one part of deaf pedagogy, I follow the evidence that shows that deaf education is more than just about sign language. The nonlinguistic focus is not without precedent in deaf education – interested readers may examine Furth's study on deaf cognitive process that sidestep language,[30] and current research on deaf language deprivation,[31] who show that deaf cognition is limited but not eliminated in the absence of language. However, the notion that (sign) language is not the only visual mode of importance in deaf education is *not* widespread in contemporary research. As I see it, multimodality proffers tools and terms to describe the gestalt sum *and* constituent parts of deaf pedagogy; it creates workable categories that analyze previously-ineffable dimensions of pedagogical and curricular design.[32]

Multimodal education is a broad framework encapsulating the subdomain of visuality. Multimodality helps educators understand visual tools,[33] which are understood to be a defining best-practice in deaf pedagogy.[34] Research about deaf visuality in education is increasing. There is an increasing emphasis on multiple modes and media

[28] F. Dowaliby, H. Lang, *Adjunct Aids in Instructional Prose: A Multimedia Study with Deaf College Students*, "Journal of Deaf Studies and Deaf Education" 1999, vol. 4 (4), p. 280.

[29] H. Lang, D. Steely, *Web-based Science Instruction for Deaf Students: What Research Says to the Teacher*, "Instructional Science" 2003, vol. 31 (6), p. 293.

[30] H.G. Furth, *Research with the Deaf: Implications for Language and Cognition*, "Psychological Bulletin" 1964, vol. 62 (3), pp. 145–164.

[31] N.S. Glickman, W.C. Hall, *Language Deprivation and Deaf Mental Health*, Routledge, New York 2019.

[32] M.E. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.

[33] V.R. Lee, *Adaptations and Continuities in the Use and Design of Visual Representations in US Middle School Science Textbooks*, "International Journal of Science Education" 2010, vol. 32, pp. 1099–1126; E. Marti, *Tables as Cognitive Tools in Primary Education* [in:] C. Andersen, N. Scheuver, M.P. Perez Echeverria, E.V. Teubal (eds.), *Representational Systems and Practices as Learning Tools*, Sense Publishers, Rotterdam 2009, pp. 133–148; C.C. Pappas et al., *Book Writing and Illustrating: Ways with Text and Pictures* [in:] M. Varelas, C.C. Pappas, *Children's Ways with Science and Literacy: Integrated Multimodal Enactments in Urban Elementary Classrooms*, Routledge, New York 2012.

[34] S.R. Easterbrooks, B. Stephenson, *An Examination of Twenty Literacy, Science, and Mathematics Practices Used to Educate Students Who Are Deaf or Hard of Hearing*, "American Annals of the Deaf" 2006, vol. 151 (4), pp. 385–396. DOI: 10.1353/aad.2006.0043; S.R. Easterbrooks, M. Stoner, *Using a Visual Tool to Increase Adjectives in the Written Language of Students Who Are Deaf or Hard of Hearing*, "Communication Disorders Quarterly" 2006, vol. 27 (2), pp. 95–109.

formats.[35] Deaf multimodal-visual pedagogy had been empirically documented in deaf higher education.[36] This research suggests that all deaf students learn visually and multimodally; however, it is unclear how deaf students and educators interact with multimodal curriculum in DE^2.[37] While research shows that deaf learning and deaf pedagogy are multimodal and emphasize the visual modality, elucidating the alignment of visuality and multimodality in DE^2 is less well-understood. Furthermore, the effects of power and self-determination on DE^2 is poorly theorized. Hence, these concepts provide the focus in the present article.

Deaf Education: Multimodality and Equity

Deaf students' learning foundationally diverges from nondeaf students.[38] In traditional "face-to-face" deaf educational interactions, exchanges are embodied through reciprocal, sustained eye contact and body proxemics in architectural spaces requiring clear lighting and adequate dimensions for proprioception.[39] These embodied differences are relative to teaching and learning and interact with DE^2 in complex ways that are only beginning to be addressed by research.[40]

Visual sensory systems and visual discourse modes are critically important for learning and teaching in deaf education.[41] Beyond visuality, deaf students learn through

35 M. Kuntze, D. Golos, C. Enns, *Rethinking Literacy: Broadening Opportunities for Visual Learners*, "Sign Language Studies" 2014, vol. 14 (2), pp. 203–234; M. Kuntze, D. Golos, *Revisiting Rethinking Literacy* [in:] C. Enns, J. Henner, L. McQuarrie (eds.), *Discussing Bilingualism in Deaf Children: Essays in Honor of Robert Hoffmeister*, Routledge, New York 2021, pp. 99–112.

36 M.E. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.

37 J. Beal-Alvarez, J.E. Cannon, op. cit.; H. Knoors, D. Hermens, *Effective Instruction for Deaf and Hard-of-Hearing Students: Teaching Strategies, School Settings, and Student Characteristics* [in:] M. Marschark, P.E. Spencer (eds.), *The Oxford Handbook of Deaf Studies, Language, and Education*, Oxford University Press, New York 2010; K. Ryoo, M.C. Linn, *Can Dynamic Visualizations Improve Middle School Students' Understanding of Energy in Photosynthesis?*, "Journal of Research in Science Teaching" 2012, vol. 49, pp. 218–243; G. Nuccetelli, M.T. de Monte, op. cit.

38 H.-D. Bauman, J.J. Murray, *Deaf Gain: An Introduction* [in:] H.-D. Bauman, J.J. Murray (eds.), *Deaf Gain: Raising the Stakes…*, op. cit., pp. xv–xlii; P. Hauser et al., *Deaf Epistemology: Deafhood and Deafness*, "American Annals of the Deaf" 2010, vol. 154 (5), pp. 486–496; T. Humphries et al., *Language Acquisition for Deaf Children: Reducing the Harms of Zero Tolerance to the Use of Alternative Approaches*, "Harm Reduction Journal" 2012, vol. 9 (16), pp. 3–9; H. Knoors, M. Marschark, *Teaching Deaf Learners*, Oxford University Press, New York 2014; M. Maiorana-Basas, C.M. Pagliaro, op. cit.

39 H.-D. Bauman, J.J. Murray, *Deaf Studies in the 21st Century: "Deaf Gain" and the Future of Human Diversity* [in:] L. Davis (ed.), *The Disability Studies Reader* (4th ed.), Routledge, New York 2013, pp. 246–262; H.-D. Bauman, J.J. Murray, *Deaf Gain: An Introduction…*, op. cit.

40 S. Katz, *The Covid Zoom Boom is Reshaping Sign Language*, "Scientific American" 2021, https://www.scientificamerican.com/article/the-covid-zoom-boom-is-reshaping-sign-language1/.

41 M.E. Skyer, *Invited Article: The Bright Triad and Five Propositions: Toward a Vygotskian Framework for Deaf Pedagogy and Research*, "American Annals of the Deaf" 2020, vol. 164 (5), pp. 577–591; M.E. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.

touch, vibration, and non-language sounds.[42] This lends deaf learning and deaf pedagogy a multimodal character, whose importance is only now beginning to be understood and theorized.[43] In addition to a basic focus on how modes and senses align, multimodality addresses educational ethics and power through curriculum design.[44] This focus meshes with deaf pedagogues' intentions of using digital tools to close communication gaps and to increase equity and access.[45]

Multimodality clarifies research about DE^2 because multimodality helps practitioners understand complex digital environments and focuses on areas that are within the teacher's control – like interactive web layouts.[46] In Greece, for instance, Kourbetis and Karipi analyze a complex digital ecology designed for deaf youngsters, including sign and text bilingual literacies and an array of deaf-centric, culturally-affirmative pedagogical and curricular resources, which are visual and multimodal in form and housed as one unified digital suite of resources.[47] In Scandinavia, Raike and colleagues illustrate that multimodal, multicultural, and multilingual web-enabled technologies in deaf higher education must be purposefully crafted to support the uniquely situated needs and abilities deaf students.[48]

In addition to a common respect for visual curricular and pedagogic design, multimodal theorists and deaf educators share a focus on the ethics of increasing access and empowerment and the reduction of exclusion or elimination of oppression. Multimodality illuminates the ethics of pedagogic choices about modes relative to students and their situated learning needs. Kress states, multimodal educators must "have a clear sense of the effects of their (semiotic) actions on others and act so as not to impair the potentials for [others'] actions."[49] Both issues – increasing access and preventing inaccessibility – are themes in DE^2.

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42 B. Bahn, *Senses and Culture: Exploring Sensory Orientations* [in:] H.-D. Bauman, J.J. Murray (eds.), *Deaf Gain: Raising the Stakes…*, op. cit., pp. 233–254; D.J. Napoli, *A Magic Touch: Deaf Gain and the Benefits of Tactile Sensation* [in:] H.-D. Bauman, J.J. Murray (eds.), *Deaf Gain: Raising the Stakes…*, op. cit., pp. 211–232.

43 A. Kusters, M. Spotti, P. Swanwick, E. Tapio, *Beyond Languages, Beyond Modalities: Transforming the Study of Semiotic Repertoires*, "International Journal of Multilingualism" 2017, vol. 14 (3), pp. 219–232; R. Swanwick, S. Goodchild, E. Adami, *Problematizing Translanguaging as an Inclusive Pedagogical Strategy in Deaf Education*, "International Journal of Bilingual Education and Bilingualism" 2022, pp. 1–18.

44 G. Kress, *Multimodality: A Social Semiotic…*, op. cit.

45 S. Burgstahler, op. cit.; F. Dowaliby, H. Lang, op. cit.

46 A. Raike, S. Pylvänen, P. Rainò, op. cit.; K. Straetz et al., *An E-learning Environment for Deaf Adults*, 2005, https://www.academia.edu/50539079/An_E_learning_environment_for_deaf_adults?auto=download&email_work_card=download-paper.

47 V. Kourbetis, S. Karipi, *How Can You Talk about Bilingual Education of the Deaf If You Do Not Teach Sign Language as a First Language?* [in:] C. Enns, J. Henner, L. McQuarrie (eds.), *Discussing Bilingualism in Deaf Children…*, op. cit., pp. 113–131.

48 A. Raike, *Searching Knowledge…*, op. cit.

49 G. Kress, *Multimodality: A Social Semiotic…*, op. cit., p. 18.

Educators and institutions for deaf college students must analyze and continually evaluate the potential benefits and detriments of modes in DE^2 by examining the outcomes of their curricular and pedagogic praxis. Overall, a multimodal ethics of equity in DE^2 hinges on: 1) providing equal access to discourse across cultural and linguistic divides and 2) redressing educational inequality related to perceived disadvantages of deafness.[50] In sum, multimodality clarifies interactions of power and knowledge in DE^2.

Historicizing DE^2: The Eruption of a Paradigm

The digital revolution of the early 21st century profoundly transformed universities across the globe. Although these changes are not homogenous, and depend on a diversity of geopolitical and economic contexts, the digital revolution constitutes a paradigmatic rupture that has irrevocably affected all who learn and teach in higher education.[51] Alongside appreciable increases in digital course offerings, new trends in technosocial education have meanwhile contributed to the development of remarkably different forms of knowledge, tools, and methods of teaching, learning, and educational interactions.[52] Digital education has also constructed specific dilemmas for faculty serving marginalized students, like disabled students and second-language learners. Readers will note that deaf students uniquely fit both criteria.[53]

Deaf-centric Technologies: Personal and Interpersonal

Deaf people have long driven the cutting edge of innovative technologies.[54] Thomas Edison who invented the light bulb was deaf. Vincent Cerf, one of the founders of the Internet, was deaf. Likewise, a team of researchers including deaf engineer Paul Taylor developed the first true modem and, in the process, ushered in a technosocial revolution. It is evident that deaf people were often in the vanguard in the events comprising this digital paradigm shift.[55] Somewhat differently, deaf people are very

50 H. Lang, op. cit.; P. Luft, M. Bonello, N.K. Zirzow, *Technology Skills Assessment for Deaf and Hard of Hearing Students in Secondary School*, "American Annals of the Deaf" 2009, vol. 4, pp. 389–399.

51 J. Clemens, A. Nash, *Being and Media: Digital Ontology after the Event of the End of the Media*, "The Fiberculture Journal" 2015, vol. 24, pp. 6–32; M. Peters, T. Besley, D. Araya (eds.), *The New Development Paradigm: Education, Knowledge Economy, and Digital Futures*, Peter Lang, New York 2014.

52 F.A. Hernandez et al., *Education in the Age of Extreme Digital Exploration, Discovery, and Innovation* [in:] M.A. Peters, T. Besley, D. Araya (eds.), *The New Development Paradigm…*, op. cit., pp. 94–114; M. Ito et al., *Hanging Out, Messing Around, Geeking Out: Living and Learning with New Media*, MIT Press, Cambridge 2010.

53 S. Burgstahler, op. cit.; G. Valentine, T. Skelton, op. cit.

54 H.-D. Bauman, J.J. Murray, *Deaf Studies…*, op. cit.

55 M. Maiorana-Basas, C.M. Pagliaro, op. cit.

often early adopters of personal technologies of deafness.[56] In this, deaf people frequently incur higher risks in a gamble for equity. Deaf personal technologies include digital hearing aids, cochlear implants, vibrotactile devices, sign language gloves, and – most recently – closed caption glasses with transcriptions produced by artificial intelligence.[57]

Deaf people's involvement with cutting-edge technology transcends personal tech. For example, early versions of mobile phone texting systems were vigorously adopted by deaf people,[58] which allowed deaf-nondeaf interactions to occur. Power and Power describe the global shift toward text-based communications (e.g., MMS and SMS) as prompted by the initial and creative adoption of texting by deaf people.[59] Likewise, video-based mobile telephony (e.g., Apple's Facetime) was spurred in part by deaf people's need for sign language in mobile applications. Video-relay technology (e.g., Sorenson, Purple, Convo) is another major site of change[60] at the convergence of technology, deafness, and sign language. While recent video-conferencing technology systems (e.g., Zoom, Teams) exploit multimodality, they also alter how deaf people use sign language in sites of higher education.[61]

Individually and collectively, these watershed moments in technological and cultural history have demonstrably improved deaf people's lives, individually and collectively. As a collective force, deaf people have irrevocably changed how all humans use technology. These result in intrinsic and extrinsic benefits for deaf people and broader nondeaf cultures.[62] For general readers, it should be noted that while there have been numerous outcries and ethical objections to *personal* technologies of deafness (e.g., cochlear implants), the deaf community has been globally in support of *interpersonal* communication technologies.[63] This global consensus on DE^2 is remarkable, given the myriad forms of diversity and the long history of conflict in deaf education.

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56 J. Virdi, *Hearing Happiness: Deaf Cures in History*, University of Chicago Press, Chicago 2019.

57 D. Eagleman, *Can We Create New Senses for Humans?*, TED Talks, 2015, http://www.ted.com/talks/david_eagleman_can_we_create_new_senses_for_humans?language=en; I. Parasnis, V.J. Samar, S.D. Fischer, *Deaf College Students' Attitudes Toward Racial/Ethnic Diversity, Campus Climate, and Role Models*, "American Annals of the Deaf" 2005, vol. 150 (1), pp. 47–58.

58 L. Sherriff, *Nokia Launches Mobile Phone for the Deaf: Portable Talk-Type System Developed with the Help of RNID*, 1999, https://www.theregister.com/1999/09/02/nokia_launches_mobile_phone/.

59 D. Power, M.R. Power, *Everyone Here Speaks TXT: Deaf People Using SMS in Australia and the Rest of the World*, "Journal of Deaf Studies and Deaf Education" 2004, vol. 9 (3), pp. 333–343.

60 R. Nowicki, *"Insights into the Autonomy of Video Relay Interpreters." Book Review of Alley, E. (2019), "Professional Autonomy in Video Relay Service Interpreting." Washington, DC: Gallaudet University Press*, "American Annals of the Deaf" 2020, vol. 165 (1), pp. 128–131.

61 D. Shah, *Software Allows Deaf to Speak over Mobile*, 2008, https://www.newlaunches.com/archives/software_allows_deaf_to_speak_over_mobile.php; S. Katz, op. cit.

62 H.-D. Bauman, J.J. Murray, *Deaf Gain…*, op. cit.

63 D. Power, M.R. Power, *Everyone Here Speaks TXT…*, op. cit.; J.M. Valente, *Cyborgization: Deaf Education for Young Children in the Cochlear Implantation Era*, "Qualitative Inquiry" 2011, vol. 17 (7), pp. 639–652; G. Valentine, T. Skelton, op. cit.

Historicizing Deaf Education and Contextualizing DE²

DE² is a microcosm of deaf education, containing all its tensions and ambiguities in miniature. Keating and Mirus define deafness as technological.[64] Likewise, Thoutenhoofd describes deaf experiences as "determined by technologies of deafness."[65] These positions argue that deaf ontologies are fundamentally mediated by technology. Perhaps it's not surprising then that technology plays an outsized role in deaf education. It is therefore essential that researchers recognize the deep interdependence between technological objects and the praxeology of their use by deaf people.

As I theorize it, DE² is a nexus of systems governed by values about deafness including ideology, culture, language, and history.[66] This nexus affects the construction and adaptation of DE² in the university. DE² affects different agents in different ways, as teachers and students think differently about access and barriers,[67] as do deaf and nondeaf persons, and able-bodied and disabled people.[68] College instructors – often without explicit training in ethics or technics – must curate digital curricula and digitally surveil spaces where deaf students interact online.[69] Deaf students, for their part, often desire tools that are not available to them,[70] or enter college lacking skills others take for granted.[71] DE² also highlights the role of technology in communication privation and language deprivation.[72] Later in this paper, I extend this basic argument to describe an analysis of power and self-determination of DE² using a selection of related theories.

DE²: Digital Environments of Deaf Education

Here, my scope and themes narrow. To answer my questions, I divided DE² into three categories with subthemes based on a generative synthesis of the literature.[73] The categories are, (1) *purposes* – defined as the overarching goals of DE²; (2) *practices*

64 E. Keating, G. Mirus, op. cit.

65 E.D. Thoutenhoofd, *Acting with Attainment Technologies in Deaf Education: Reinventing Monitoring as an Intervention Collaboratory*, "Sign Language Studies" 2010, vol. 10 (2), p. 223.

66 A. Raike, *Searching Knowledge…*, op. cit.; E.D. Thoutenhoofd, op. cit.; M.E. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.

67 G. Valentine, T. Skelton, op. cit.

68 A. Hamraie, K. Fritsch, op. cit.

69 S. Burgstahler, op. cit.; E.D. Thoutenhoofd, op. cit.; M.E. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.

70 H. Lang, op. cit.

71 F. Dowaliby, H. Lang, op. cit.

72 T.B. Burke, *Armchairs and Stares: On the Privation of Deafness* [in:] H.-D. Bauman, J.J. Murray (eds.), *Deaf Gain: Raising the Stakes…*, op. cit., pp. 3–22; L. Davis, *The End of Identity Politics: On Disability as an Unstable Category* [in:] L. Davis (ed.), *The Disability Studies…*, op. cit., pp. 263–277; J. Weber, M.T. Skyer, op. cit.

73 D.N. Boote, P. Beile, *Scholars Before Researchers: On the Centrality of the Dissertation Literature Review in Research Preparation*, "Educational Researcher" 2005, vol. 34 (6), pp. 3–15; J.A. Maxwell,

– defined as essential tools and concrete actions in DE², and (3) *disciplines* – defined as clusters of academic subjects supported by DE². These categories are not hierarchical; they overlap and diverge. For example, research on the design of digital tools relates to educational goals, and vice versa. As I read the literature and wrote drafts, other themes emerged. I used recursive methods, including process and thematic coding to synthesize and refine sub/themes.[74] In line with current methodological recommendations, I highlight studies that accord with either interactionist or constructivist forms of deaf-centric education.[75] When evaluating potential harms and benefits, I concluded that the balance of power must be orientated toward deaf students' innate capabilities. This was my cardinal point of orientation for evaluating ethics.

(1) Purposes for DE² in Higher Deaf Education

This section describes the rationales for DE² in higher education. It has three subthemes: (i) access and barriers, (ii) deaf development, and (iii) multimodal interaction and collaboration.

(i) Access and Barriers

The main purpose of DE² is to achieve communication parity between deaf and non-deaf people in education.[76] Access in DE² is often represented in structural metaphors like *bridges* to future successes or *barriers* curtailing it. Power and Power claim DE² will *level the playing field*.[77] However, empiricists like Maiorana-Basas and Pagliaro[78] and Luft, Bonello, and Zirzow[79] note that despite gains, new barriers prevent deaf students from accessing educational information. These barriers reify centuries-old ideologies that denigrate sign languages and deaf lifeways.[80] It's this tension – accessibility vs. exclusion – that most profoundly shapes the goals of DE².

Burgstahler sums up significant barriers that preclude deaf social and educational inclusion; in contrast, she emphasizes adaptation, flexibility, and creative utilization of DE² to keep deaf students apace with the social, cultural, linguistic and educational changes surrounding their schools. She suggests that Universal Design may enhance

Literature Reviews of and for Educational Research: A Response to Boote & Beile, "Educational Researcher" 2006, vol. 35 (9), pp. 28–31.

74 J. Saldaña, *The Coding Manual for Qualitative Researchers*, Sage Publications, London 2012.

75 M.T. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.; A. Young, B. Temple, op. cit.

76 H.-D. Bauman, J.J. Murray, *Deaf Studies…*, op. cit.

77 D. Power, M.R. Power, *Communication and Culture…*, op. cit.

78 M. Maiorana-Basas, C.M. Pagliaro, op. cit.

79 P. Luft, M. Bonello, N.K. Zirzow, op. cit.

80 L.J. Muir, I.E.G. Richardson, *Perception of Sign Language and Its Application to Visual Communication for Deaf People*, "Journal of Deaf Studies and Deaf Education" 2005, vol. 10 (4), pp. 390–401.

access in DE^2.[81] Luft, Bonello and Zirzow found that when deaf high school students arrived at college, they lacked requisite skills to engage and exploit educational digital media.[82] College-age deaf students were noted to be behind in educational attainment despite copious technologies to support learning.[83] These findings emphasize the need for continuous reflection on instructional practice relative to deaf students' needs,[84] which co-evolve.

DE^2 are subject to systematic and local forces including (scant) legal oversight and (weak) motivation for systematic improvement.[85] Seldom are digital courses designed for the diversity of deaf or disabled learners; nor has the aim of "Universal Design" led to universal implementation. Burgstahler illustrates *digital divides* preventing disabled students from fully accessible interactions in DE^2.[86] Advocates of DE^2 document a sharp contrast between a desire for deaf educational attainment through technologies and the reality of economic or social disenfranchisement for deaf people.[87] It is precisely this asymmetrical distribution of power and resources that prevents educational parity.

Maiorana-Basas and Pagliaro conducted the largest quantitative study available on DE^2 from the perspective of deaf students.[88] They collected survey data to determine how deaf people (n=278) engage with the Internet, personal media devices, and digital networks. They found that while DE^2 are saturated by technology, they are rife with information gaps. Maiorana-Basas and Pagliaro[89] and Shepherd and Alpert[90] speculate that gaps are due to legal loopholes. In the US, the Americans with Disabilities Acts (ADA), and Individuals with Disabilities Education Act (IDEA), are vague or noncommittal about web-based access, and result in non-existent transcripts or badly done captions for audio-visual media materials. As one social example: auto-generated subtitles are often derisively called "*craptions*" by deaf people. *Craptions* obscure meaning in educational videos, websites, and social media.

Scant oversight and lack of enforcement offer meager protections for deaf students' communication needs in schools, in public, and private life, and consequently create a "hit or miss" experience for deaf end-users. Maiorana-Basas and Pagliaro summarize,

> Unfortunately, online informational, instructional, and entertaining [media] whether recorded or streamed live, are rarely captioned, and there are no known laws that currently exist requiring captioning of all videos or audio content on the Internet, unless the content was broadcast first on

81 S. Burgstahler, op. cit.
82 P. Luft, M. Bonello, N.K. Zirzow, op. cit.
83 F. Dowaliby, H. Lang, op. cit.
84 Ibidem; H. Knoors, D. Hermens, op. cit.
85 S. Burgstahler, op. cit.
86 S. Burgstahler, op. cit.
87 E.D. Thoutenhoofd, op. cit.
88 M. Maiorana-Basas, C.M. Pagliaro, op. cit.
89 Ibidem.
90 C.M. Shepherd, M. Alpert, op. cit.

> television with captions. Thus, a great majority of information remains inaccessible to individuals who are DHH, which could ultimately lead to intellectual, economic, and social disparity.[91]

Similar findings are evidenced by qualitative research, in autoethnographies by Hunter,[92] and Sissell's (2014) case study. While nondeaf people take for granted access to podcasts, YouTube videos, live-stream news, or audiobooks, deaf users often find these information sources inaccessible. Perhaps it is not coincidental that deaf students lack for general knowledge.

(ii) Deaf Development

Maiorana-Basas and Pagliaro, Beal-Alvarez and Cannon, Shepherd and Alpert, Weber and Skyer summarize DE^2 as a technical means toward fostering psychosocial and economic development in deaf students.[93] These studies explore the role of DE^2 in developing and sustaining deaf students' inner psychosocial resources, like motivation, metacognition, critical thinking, and creative intelligences. DE^2 are thought to encourage deaf students to become agentive and empowered. It's assumed that deaf students will become both: more autonomous learners and more interconnected learners through the use of technological tools. The hope is that the use of digital tools will create a healthy feedback loop of development. A subset of this research shows that DE^2 are a means for economic advancement, as school is seen as a preparation for participation in capitalist economies, which value and all but require proficiency or computer expertise in a variety of languages and modes.[94] Deaf students in higher education may be doubly disadvantaged due to missing or distorted information inside and outside of digital classrooms. There is a real and measurable communication gap that may be intensified in DE^2. Without change, it will result in stagnating social prospects and higher unemployment for deaf students.

Lang reports a key contradiction in the literature about DE^2; *what deaf students desire in institutions of higher learning is not what they receive.* "What is needed or preferred by the deaf students does not appear to match what is offered."[95] Over a decade later, Shepherd and Alpert similarly note, "Educators at institutions of higher learning [lack] the confidence or experience to effectively utilize the plethora of digital tools."[96] This gap is problematic for both deaf students and the institutions that serve them.[97]

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91 M. Maiorana-Basas, C.M. Pagliaro, op. cit., p. 401.

92 L. Hunter, op. cit.

93 M. Maiorana-Basas, C.M. Pagliaro, op. cit.; J. Beal-Alvarez, J.E. Cannon, op. cit.; C.M. Shepherd, M. Alpert, op. cit.; J. Weber, M.E. Skyer, op. cit.

94 P. Luft, M. Bonello, N.K. Zirzow, op. cit.

95 H. Lang, op. cit., p. 274.

96 C.M. Shepherd, M. Alpert, op. cit., pp. 5–6.

97 S. Burgstahler, op. cit.

While DE² promise equitable development for deaf and nondeaf, empirical data and theoretical analysis show inconsistent growth. Producing reliable DE² research is a methodological challenge. Studies about DE² varied in methods and methodology. Generally, studies had small samples, inconsistent or incomplete descriptions of research design, and are seldom replicated.[98] Much DE² research describes what might be called a sociology of deaf technology practices, like the phenomenology of text or video messaging in private life.[99] Many quantitative studies relied on outdated terms and ideologies like *hearing impairment*.[100] These methodological limits restrict the applicability, generalization, and transferability of findings.

(iii) Multimodal Interaction and Collaboration

The Internet ushered in unprecedented development of media and modes. Proliferating ways of knowing, being, and information-exchange irrevocably altered human communication, which has enhanced significance for deaf individuals.[101] Deaf students using technology for learning are embedded in communities and institutions with goals that coalesce around ethical communication, democratic agency, and educational advancement.[102] In Raike's Scandinavian corpus and Kourbetis' Greek corpus – detailed next – researchers argue that deaf students are capable of learning digitally so long as educators can align technologies with learning needs. This exactly parallels the multimodalists' methodological concern for education as an equitable process of knowledge co-creation.[103]

In several Scandinavian-based studies, Raike and colleagues call for deaf-centric interface development for educational technologies, noting that digital tools are uniquely customizable and teachers can co-design them alongside deaf students.[104] Similarly, Kourbetis and colleagues offer a remarkably coherent program of multi-

98 J. Beal-Alvarez, J.E. Cannon, op. cit.; S.W. Cawthon, C.L. Garberoglio, *Research in Deaf Education*, Oxford University Press, New York 2017.

99 D. Power, M.R. Power, *Everyone Here Speaks TXT…*, op. cit.; D. Power, M.R. Power, *Communication and Culture…*, op. cit.; G. Valentine, T. Skelton, op. cit.

100 P. Gillard, G. Astbrink, J. Baily, *Mobile Communication in Real Time for the First Time: User Evaluation of Non-voice Terminal Equipment for People with Hearing and Speech Disabilities* [in:] T. Sobh et al. (eds.), *Innovative Algorithms and Techniques in Automation, Industrial Electronics, and Telecommunications*, Springer, Dordrecht 2007, pp. 347–352.

101 G. Kress, *Multimodality: A Social Semiotic…*, op. cit.; D. Power, M.R. Power, *Communication and Culture…*, op. cit.

102 H. Lang, D. Steely, op. cit.; E.D. Thoutenhoofd, op. cit.

103 G. Kress, *Multimodality: A Social Semiotic…*, op. cit.

104 A. Raike, *Searching Knowledge…*, op. cit.; A. Raike, K. Hakkarainen, *Concept Maps in the Design of an Accessible CinemaSense Service*, "Art, Design, & Communication in Higher Education" 2009, vol. 8 (1), pp. 27–55; A. Raike, S. Pylvänen, P. Rainò, op. cit.; A. Raike, J. Saad-Sulonen, J. Scheible, *Visual Tools for Accessible Computer Supported Collaboration* [in:] K. Misenberger, J. Claus, W. Zagler, A.I. Karshmer (eds.), *Computers Helping People…*, op. cit., pp. 142–149.

modal DE² involving cross-sections of deaf communities, including researchers in higher education, deaf artists and storytellers, and deaf students and educators who are themselves, deaf.[105] As an example, Kourbetis, Boukouras, and Gelastopoulou argue "multimodality allows D/HH children to have a better understanding [through] interactive digital [tools] and applications."[106] This notion struck a chord with me, where first thematic note of *collaboration* was met by a second in *interaction*.

For example, Pituzzo and colleagues document affordances in deaf multimodal-visual pedagogies indicating that DE² is contingent not only on multimodality, but multilingual, and multicultural resource pedagogies that, together, constitute an "interaction paradigm"[107] built *with* deaf collaborators not *for* them. Shepherd and Alpert also describe an "interactive collaboration"[108] between professors and deaf students using digital networks and tools. This uniquely distinguishes multimodal DE² in comparison to another framework for web design – Universal Design for Learning (UDL) – which argues in support of designs *for* disability not designs *with* disabled people.[109]

(2) Pedagogical Practices using DE²

Here, I illustrate how DE² tools are applied with two subthemes: (i) design and adaptation of DE² and (ii) the praxis of DE², both informed by the purposes listed above. Both themes focus on the actions that teachers can make using DE².

(i) Design and Adaptation

Deaf students and deaf educators are agentive subjects who use educational technologies to navigate higher education.[110] For deaf and nondeaf people, higher education is a point of entry into public and private life through communities of civic participation.[111] Therefore, the designs of DE² are as diverse as the contexts they reside in and the purposes for which they were constructed. Vis-à-vis DE², teachers of deaf

[105] V. Kourbetis, M. Gelastopoulou, *Using ICT to Develop Universally Designed Educational Materials for Students with Disabilities*, ICICTE 2017 Proceedings, pp. 12–21; V. Kourbetis, S. Karipi, op. cit.

[106] V. Kourbetis, K. Boukouras, M. Gelastopoulou, *Multimodal Accessibility for Deaf Students Using Interactive Video, Digital Repository and Hybrid Books* [in:] M. Antona, C. Stephanidis (eds.), *Universal Access in Human-Computer Interaction: Users and Context Diversity*, Springer International Publishing, Cham 2016, p. 95.

[107] E.A. Pizzuto et al., op. cit., p. 22.

[108] C.M. Shepherd, M. Alpert, op. cit., p. 3.

[109] A. Hamraie, *Building Access: Universal Design and the Politics of Disability*, University of Minnesota Press, Minneapolis 2017; National Deaf Center, *Universal Design*, 2019, https://www.nationaldeafcenter.org/resource/universal-design.

[110] M.E. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.

[111] G. Kress, *Multimodality: A Social Semiotic…*, op. cit.; E.D. Thoutenhoofd, op. cit.

students design varied practices, methods, and techniques to promote civic maturation and academic achievement.[112]

There are generalist software and hardware adapted for use in DE^2. Previously, I noted technologies developed by deaf communities that have seen wide uptake by the nondeaf. Here, I show the opposite: deaf students and educators who creatively adapt general technologies. Kropp and McCartin illustrate adapted use of hardware like Smartboards and iPads and also software like Microsoft's PowerPoint, or Zoom, and ooVoo.[113] Thoutenhoofd analyzes relations of 1) technosocial services and 2) monitoring functions as core components of DE^2. Technosocial services relate the corporeality of deafness to specific tools like "YouTube, Facebook, Reddit, Twitter, and… wikis, blogs, RSS feeds, sharing tools, [and] mash-ups,"[114] whereas monitoring functions include a compulsion to not only participate but to be digitally surveilled meanwhile. Thoutenhoofd warns of potentially nefarious uses for DE^2 that include biocontrol by nondeaf institutions that do not value the crucial ontological and epistemological differences that characterize deaf learners.

DE^2 provides newly networked modes of collaboration in collegiate classrooms.[115] For example, Kropp and McCartin describe how blogs can improve student-teacher interactions with writing if they're differentiated for deaf ways of knowing.[116] Cannon, Fredrick, and Easterbrooks[117] and Malzkuhn and Herzig[118] describe digital hardware like laptops and tablets as useful tools for teaching deaf students using interfaces that enhance visuality and prompt participation. Panera describes teaching deaf college students with programs like Microsoft Word's built-in tools like Grammar-Check and Track-Changes.[119] In contrast, Maiorana-Basas and Pagliaro identify technologies not fully customized for deaf student needs.[120] Likewise, there are tools that are in-between – those that are good enough but could be much better, such as apps that support sign language like Marco Polo, or proprietary software developed

[112] J.A. Albertini, R.R. Kelly, M.K. Matchett, *Personal Factors That Influence Deaf College Students' Academic Success*, "Journal of Deaf Studies and Deaf Education" 2012, vol. 17 (1), pp. 85–101; F. Dowaliby, H. Lang, op. cit.; H. Lang, op. cit.; H. Lang, D. Steely, op. cit.

[113] M. Kropp, E. McCartin, *Using Blogs and Tech Tools to Teach Writing to Deaf and Hard of Hearing Students* [in:] J. Nickerson (ed.), *Teaching for Success: Literacy, Diversity, and Technology*, PEPNet-South, Knoxville 2008, pp. 97–104.

[114] E.D. Thoutenhoofd, op. cit., p. 225.

[115] L. Hunter, op. cit.; C.M. Shepherd, M. Alpert, op. cit.

[116] M. Kropp, E. McCartin, op. cit.

[117] J.E. Cannon, L.D. Fredrick, S.R. Easterbrooks, *Vocabulary Instruction Through Books Read in American Sign Language for English-language Learners with Hearing Loss*, "Communication Disorders Quarterly" 2010, vol. 31 (2), pp. 98–112.

[118] M. Malzkuhn, M. Herzig, *Bilingual Storybook App Designed for Deaf Children Based on Research Principles*, "International Journal of Advanced Computer Science" 2013, vol. 3 (12), pp. 631–635.

[119] J. Panera, *Computers and the Writing Process: [Deaf] Students' Comfort Level with Computer Assisted Writing – Shortcomings of the Grammar Checker* [in:] J. Nickerson (ed.), *Teaching for Success…*, op. cit., pp. 109–114.

[120] M. Maiorana-Basas, C.M. Pagliaro, op. cit.

by Gallaudet University's VL^2 (visual language, visual learning), including e-books, that require costly microtransactions or upgrades.

(ii) The Praxis of DE^2

Praxis is a unity of theory, action, and reflection. It applies to all personnel and processes in education. Most studies about the praxis of DE^2 are operationalized using goals outlined in category 1 (purposes). For instance, they attempt to enhance equitable communication, even if deaf students' lived experiences fall short of the intended ideal. Here, I explore perceptions of efficacy in praxis; first, from the university instructor's vantage, then from deaf students' points of view.

While multimodal DE^2 is increasingly the norm in deaf higher education, faculty are often hired with the assumption they can *already* expertly navigate these systems. Wood illustrates how digital instructional applications called Learning Management Systems (LMS), like Blackboard, Canvas, and MyCourses, must be continually customized for deaf students to visually archive and organize curriculum.[121] Skyer documents that pedagogic, curricular, and assessment tools may leverage DE^2 by enhancing sign language and multimodal feedback.[122] Other researchers clarify that DE^2 praxis differently affects learning and teaching, each must be first understood separately and only then as an interdependent conjunction.[123]

Just as superior design in DE^2 leads to superior praxis, inferior design begets inferior praxis. When new technologies are unveiled, they often create new unintended problems. These dilemmas frustrate deaf learners and are unsatisfying for educators. For example, while YouTube videos can support incidental learning;[124] non-existent or distorted captions negate their potential. Likewise, despite built-in functionalities for text- and video-messaging, popular social media apps generally lack inherent requirements for captions or image descriptions, making their use dependent on the willingness of informal groups of volunteers to add captions or textual description to aid disabled people. TikTok, Snapchat, and Instagram are the newest in this series including now-defunct apps like Vine and Telegram, among others. This is disheartening as previous technologies, like .gifs *were* fully accessible for deaf people.

Generally, the cycle of praxis using DE^2 should be imbued with a comprehensive, multimodal pedagogic and curriculum design process, such as those advocated by Raike and colleagues and Kourbetis and colleagues. This reflection on action and theory may close many of the most problematic gaps noted by Burgstahler and others.[125]

[121] K.M. Wood, *Blackboard in College Writing Classrooms with Deaf Students* [in:] J. Nickerson (ed.), *Teaching for Success…*, op. cit., pp. 115–117.

[122] M.E. Skyer, *Writing Critical Deaf Pedagogy* [in:] P.J. Graham, N. Neild (eds.), *Strategies for Promoting Independence and Literacy for Deaf Learners with Disabilities*, IGI Global 2022 (in preparation).

[123] E. Keating, G. Mirus, op. cit.; G. Nuccetelli, M.T. de Monte, op. cit.

[124] M.J. Hopper, *Positioned as Bystanders: Deaf Students' Experiences and Perceptions of Informal Learning Phenomena* (doctoral dissertation), University of Rochester, Rochester 2011.

[125] S. Burgstahler, op. cit.

(3) Disciplines of DE²

This section describes: (i) language and arts, (ii) and STEM discipline clusters evidenced in DE² research. Following the summary of these categories, I highlight one positive exemplar of each type of multimodal DE² as used in deaf higher education.

(i) Language and Arts-based Classrooms

In the US, deaf education language coursework centers on ASL and English but bleeds into other creative arts classrooms and disciplines like drama, filmmaking, graphic design, and cultural studies. While the main sign language and written language may differ, traditional print-based literacy attainment is the single most commonly described topic in all deaf education; and it's no different in deaf higher education. College educators use multimodal and visual tools to promote bilingual-bimodal literacy[126] and to support composition, rhetoric, and academic writing.[127] Critical ASL literacy studies in this vein aim for systemic empowerment for deaf pedagogues, students, and researchers.[128] Multimodal-digital pedagogy might enhance synchronous distance learning for geographically scattered deaf students, thereby creating and sustaining new sign language communities.[129]

Deaf students' and teachers' ideologies about language and multimodality in relation to deafness affect their educational praxis in language and arts disciplines. DE² in language and arts contexts are thought to enhance motivation for reluctant learners through customized pedagogy attuned to fractal forms of deaf identity and myriad individual differences.[130] They are thought to support the positive development of deaf identity and Deaf Culture.[131] Via adapted language practices, DE² support socio-linguistic empowerment.[132] For instance, Hunter illuminates a power struggle pitting nondeaf ways of knowing against deaf ways of knowing and describes how

[126] J. Panera, op. cit.; J. Seessel, *Listening to Silenced Voices: Teaching Writing to Deaf Students and What It Can Teach Us about Composition Studies*, "Teaching English in the Two-Year College" 2013, vol. 40 (4), pp. 399–415.

[127] L. Hunter, op. cit.; M.E. Skyer, *Writing Critical…*, op. cit.

[128] L. Fleischer, *Critical Pedagogy and ASL Videobooks* [in:] H.-D. Bauman (ed.), *Open Your Eyes: Deaf Studies Talking*, University of Minnesota Press, Minneapolis 2008, pp. 158–166; R. Harris, *Seizing Academic Power: Creating Deaf Counternarratives* (film produced by S.C. Loeffler, published by ASLized, 2015), https://www.youtube.com/watch?v=C3Ae20lXJ1I; eadem, *Seizing Academic Power: Creating Deaf Counternarratives. Transcript* (produced by S.C. Loeffler, published by ASLized, 2015), http://aslized.org/wp-content/uploads/2014/12/AcademicPowerTranscript.pdf; M.E. Skyer, L. Cochell, op. cit.

[129] H. Lang, D. Steely, op. cit.; G. Valentine, T. Skelton, op. cit.

[130] J.A. Albertini, R.R. Kelly, M.K. Matchett, op. cit.

[131] L. Hunter, op. cit.; E. Keating, G. Mirus, op. cit.

[132] J. Seessel, op. cit.

multimodal DE[2] enables bimodal literacy inclusive to deaf and nondeaf ways of knowing that can redress subtle imbalances in power in the classroom.[133]

An exemplar that combines these findings occurred while I taught academic writing in a deaf university setting. Concurrent with my teaching, I witnessed a large-scale and highly coordinated protest led by the deaf student body who mobilized against unjust barriers they faced. It became a frequent topic of my class lectures and activities. Likewise, the course LMS became grounds where student debates about the protest occurred. As a part of my pedagogic reflexivity, I enhanced the focus of a rhetorical unit ("Synthesis") to focus on the changes and challenges affecting (deaf) higher education. Among topics of discussion were the increasing use of MOOCs (large-scale online courses) and the rise of video-based pedagogy in online spaces (e.g., Khan Academy). I continually asked my students to reflect on their own lives and experiences, which they did in their assigned writing tasks and sign-language based discussions. Some discussions that began in physical classrooms spilled over into digital modes and sites outside of class. The protest was not comprised entirely of my students, but many of my students were rank and file members. As the protest matured, I was able to discern my "thumbprint" on their modes of activism and writing assignments, which became increasingly technological, multimodal, and agentive. The multimodal assemblage (shown in Figure 1) compiles several photos I took of a public display of protest banners and agitprop media.

Figure 1. CAN! Protest Banners

Source: Skyer, 2015

[133] L. Hunter, op. cit.

Readers should note that digital tools were instrumental, not incidental to protest organizations and the consolidation and communication of demands. Present in the image is the Facebook icon and Twitter hashtags, which were used to show solidarity and to drum up support from others in and beyond the university. Also noteworthy are the foci on a plurality of modes – including: sign language, speech, cued speech, and writing; as well as their overall multimodal communication strategy – including, iconography, color, layout, and typography. These deaf students used an array of modes with aplomb and by doing so, they express their own power using deaf-centric aesthetics.

The "Communication Access Now!" (CAN!) (2015–2016) protests eventually resulted in major concessions from University personnel about direct access to bilingual, sign-based teaching across the unit. The student-based collective adapted methods and a slogan from a famous (and successful) direct-action struggle from deaf education's history (e.g., "Deaf President, Now!"). The students were able to affect positive social change using a convergence of their own power, multimodality, and DE^2. The eventual policy victory rippled across other university stakeholders. CAN! set forth positive dialogues between students, faculty, and administration about the role of not only language but all forms of communication in pedagogy and curriculum.

(ii) STEM Classrooms

STEM disciplines include sciences, technology, engineering, and mathematics across many specializations in higher education, like human anatomy and laboratory sciences. Pappas and colleagues[134] and Wells[135] indicate the enhanced importance of multimodality in STEM education, explaining that STEM teachers rely on complex visual representations in conjunction with multimodal ensembles to illustrate both abstract and concrete ideas to novices. Kress notes that science representations are dependent on multiple modes for explication, including but not limited to images, languages, and gestures.[136] Becvar, Hollan, and Hutchins explain that science teachers require unique repositories of multimodal methods to *do* science teaching including spatial-dynamic gestures, visual representations, graphic illustrations, and more.[137]

DE^2 may exploit these modal affordances; however, as Kress explains, "we cannot assume that translations from one mode to the 'same' mode in another culture can draw on the same resources."[138] This implies that the interplay between modes in digital and traditional teaching may differ for deaf and nondeaf learners even as they

[134] C.C. Pappas et al., op. cit.
[135] G. Wells, op. cit.
[136] G. Kress, *What is Mode?…*, op. cit.
[137] L.A. Becvar, J. Hollan, E. Hutchins, op. cit.
[138] G. Kress, *What is Mode?…*, op. cit., p. 57.

learn the same content – raising important questions about differentiation in both mainstream and specialized sites of deaf higher education.

In deaf education, visual tools play an outsized role, often supporting or supplanting verbal representations.[139] DE^2 offer native support for images and multimodal STEM pedagogy. Deaf education researchers of STEM education highlight the utility of static images, pictorial representations, sign language-based movies, and other graphic approaches for deaf student learning, stating that they facilitate factual recall, engagement, and discussion among students and their teachers.[140]

Multimodal DE^2 in STEM courses create new pathways and barriers for accessibility. Easterbrooks and Stephenson explain that technology is a key practice in their meta-analysis of deaf STEM pedagogies. They describe DE^2 as "visual supports" best used in conjunction with "skilled explanation and discussion," noting that standalone digital learning is *not* a best practice for deaf learners.[141]

Dye, Hauser, and Bavelier document that deaf college students in STEM courses must divide visual attention and work harder to gain the same information as compared to nondeaf students.[142] Deaf students can struggle, simultaneously splitting their attention between: 1) text-based content, 2) sign language interpreters, 3) illustrations, diagrams, and images produced by their professors, 4) signs from deaf peers, 4) paralinguistic information, 5) gesture, and 6) facial cues.

Behm, Kushalnagar, Stanislow, and Kelstone explore this conjunction in a digitally-networked DE^2 classroom site.[143] They focused on real-time captioning: "Engineering…makes heavy use of detailed visuals [and challenges] deaf students [who have to] constantly look away from the static image[s and captions] to search and observe details in the lecture visually."[144] I reiterate my prior finding on the importance of interaction and collaboration in multimodal DE^2.

An exemplar of multimodal DE^2 in deaf higher education shows one possibility for international deaf-nondeaf, student-and-educator collaborations in a STEM context. Through a participatory digital convergence, the International Astronomical Union (IAU), a "network of more than 12,000 astronomers [from] around the globe,"[145] constructed a unique linguistic repository of 47 astronomical sign language entries

[139] M.E. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.

[140] F. Dowaliby, H. Lang, op. cit.

[141] S.R. Easterbrooks, B. Stephenson, op. cit., p. 386.

[142] M.W.G. Dye, P.C. Hauser, D. Bavelier, *Visual Skills and Cross-Modal Plasticity in Deaf Readers*, "Annals of the New York Academy of Sciences" 2008, vol. 1145, pp. 71–82.

[143] G. Behm, R. Kushalnagar, J. Stanislow, A.W. Kelstone, *Enhancing Accessibility of Engineering Lectures for Deaf and Hard of Hearing (DHH): Real-time Tracking Text Displays (RTTD) in Classrooms*, American Society for Engineering Education, Seattle 2015.

[144] Ibidem, p. 657.3.

[145] M. Bartels, *Learn to Say Astronomy, Constellation, Solar Eclipse, and More in Sign Languages*, "Newsweek" 2017, https://www.newsweek.com/learn-say-astronomy-constellation-solar-eclipse-and-more-sign-languages-743043, n.p.

in 22 sign languages. There are over thousand individual entries in this lexical table, freely available for anyone via Google Docs.

In Figure 2, I excerpt a small portion of the larger spreadsheet. My extract consists of two multilingual, multimodal entries, one for "constellation" and the other for "binary star." Besides the main inclusion of sign languages, the table also involves multimodality, including several visual modes like photography, drawing, text, kanji, color, and layout. Also included in the original spreadsheet (*not shown here*) are video clips demonstrating and comparing sign productions. Through multimodality and DE[2] the international lexicon expands epistemological rigor and mutual-intelligibility in STEM deaf education. Kate Meredith, who was the project director explains, "Many students are not exposed to [deaf astronomy role models and] don't have that incidental learning in astronomy."[146]

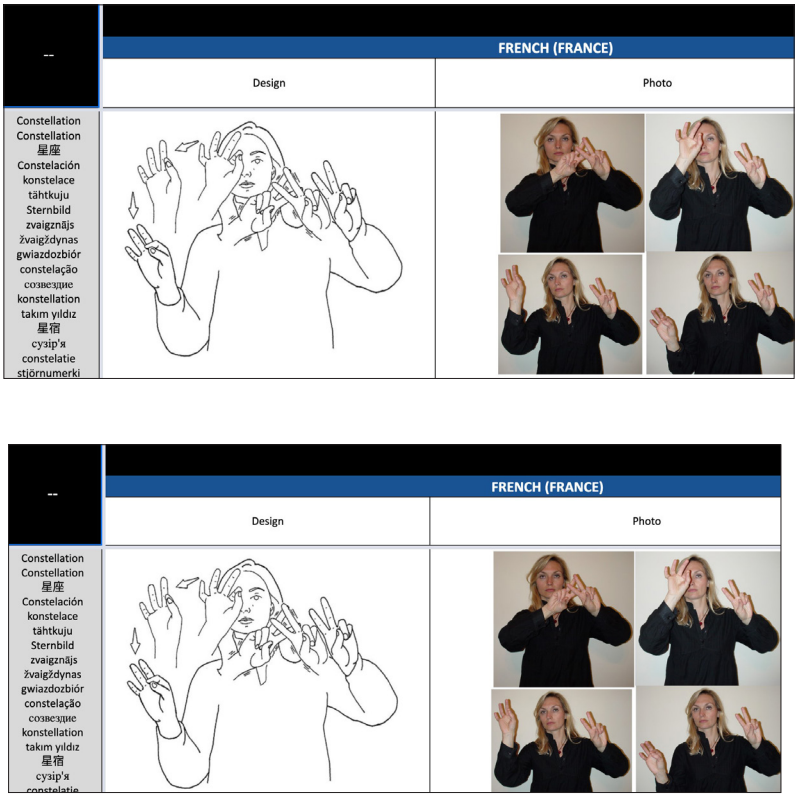

Figure 2. Astronomy Spreadsheet Examples

Source: International Astronomical Union (2017)

[146] Quoted in: ibidem, n.p.

The IAU collaboration is not the only rigorous study involving collaborations of deaf and nondeaf faculty and deaf students using cross-cultural and intercultural sign languages in and beyond STEM disciplines. Researchers at several sessions of the 10th Annual Deaf Academics Conference (DAC) explored these ideas using DE^2 as a critical tool of knowledge construction and dissemination. DAC is a learned society which *only* features research by academics who are deaf. The 2021 conference occurred at the height of the COVID-19 pandemic, and was entirely online. I attended it as a participant. The sessions I attended demonstrated similar findings to the IAU collaboration, about using multimodality and multiple sign languages (including International Sign), including other studies about lexical and multimodal collaborations. DAC featured DE^2 research produced by deaf academics in Scotland,[147] collaborations between Norway and the United States,[148] member countries of the European Union,[149] and collaborations between The Philippines, Japan and China.[150]

Of these, Quinn and Cameron and Domingo, Minakawa, and Li are explicit in their focus on DE^2 in STEM deaf education, with Quinn and Cameron's team further focused on developing new STEM-based lexicons for use in deaf higher education, specifically in chemistry. While these findings both demonstrate the importance of DE^2 and serve as a proof of concept for DE^2, further empirical research is needed to understand other dilemmas. For example, how do multilingual deaf students learn in DE^2? Or, how, precisely, do language and nonlanguage modes relate in DE^2? What role does International Sign have in DE^2? Empiricism is needed to answer these questions sufficiently, as current research is lacking.

Discussion: DE^2, Ethics, Empowerment

Throughout this article, I have alluded to and directly discussed how DE^2 is related to power and self-determination by deaf people. Here, I focus in granular detail on these and related concepts. Two disability-forward theories of power are cited. The first is self-determination theory, coined by Ryan and Deci[151] and explored in disability

147 G. Quinn, A. Cameron, *Signs to Unlock Scientific Concepts Deaf Academic Conference*, 10th Annual Deaf Academics and Researchers Conference: Strengthening Deaf Academics and Researchers Agora, Montreal 2021.

148 J.J. Murray, H. Haualand, *Teaching Transnationally: International Signs and Cross-Disciplinary Collaboration in an Online Course on Transnational Deaf Lives*, 10th Annual Deaf Academics and Researchers Conference: Strengthening Deaf Academics and Researchers Agora, Montreal 2021.

149 A. Kusters, *International Sign as a Conference Language*, 10th Annual Deaf Academics and Researchers Conference: Strengthening Deaf Academics and Researchers Agora, Montreal 2021.

150 R. Domingo, A. Minakawa, Q. Li, *Panel. An Autoethnography Method on the Study of Power Dynamics on Language Ideologies in the Context of Deaf Communities in The Philippines, Japan, and China*, 10th Annual Deaf Academics and Researchers Conference: Strengthening Deaf Academics and Researchers Agora, Montreal 2021.

151 R.M. Ryan, E.L. Deci, op. cit.

activism research[152] and deaf education research.[153] The second is sourced in critical access studies, as it relates to designs constructed by disabled people to address situated needs.[154]

"Disabled people are experts and designers of everyday life," claim Hamraie and Fritsch.[155] While these authors describe learning research and claim that technology "can be used to both produce and dismantle injustice,"[156] they do not explore the agency of teachers with disabilities as designers of pedagogy and curriculum. This is unfortunate, but it opens a critical space to braid these threads together in the context of DE^2. As I have argued, both deaf educators and deaf students use design to express their own power. This praxis supports but does not guarantee increasingly ethical processes and outcomes as informed by the ethical use of power and other forces like self-determination that work to provide educational access and reduce concurrent inequities across discursive, linguistic, communicative, and cultural domains.

Human diversity includes the diversity of deaf experiences. Ryan and Deci argue: self-determination – an agentive, internal locus of-control – is fundamental to being human. Ryan and Deci claim that "the degree to which educators support autonomy versus control behavior is a powerful predictor of school engagement and learning outcomes".[157] To explicate an implied point, in the context of DE^2, deaf educators should support students in their development of becoming more self-directed learners, doing so should improve teaching and learning outcomes. Independent living and thinking in deaf education is not the only goal, as deaf communities are vital sources of strength, knowledge, and deaf-centric power.

Themes of agency and self-determination in DE^2 cut in two directions. One supports the self-directed behavior of deaf educators who (mostly) wish to meet the situated needs of deaf students, reduce or eliminate exclusion, and prompt or sustain deaf-positive empowerment. This is readily shown in Korbetis' Greek corpus. The second theme requires that deaf students participate knowingly in the processes, as interactive collaborators who are acknowledged as legitimate knowers and valued co-constructors of knowledge. This is demonstrated in Raike's Scandinavian corpus, which valorizes deaf students in higher education who direct their own community-focused learning using technologies, processes, and outcomes evocative of DE^2 themes.

The notion of self-directed, community-based education has been contextualized for deaf higher education by researchers at the National Deaf Center in the United

[152] M.L. Wehmeyer, op. cit.

[153] S.W. Cawthon, C.L. Garberoglio, op. cit.; National Deaf Center, *Poll: Pandemic Hits Deaf Students Harder*, e-mail released research brief, May 5, 2020, http://eepurl.com/g3hy3T.

[154] A. Hamraie, K. Fritsch, op. cit.

[155] Ibidem, p. 2.

[156] Ibidem, p. 3.

[157] R.M. Ryan, E.L. Deci, op. cit., p. 1567.

States.[158] In the recent memo about the COVID-19 pandemic, NDC described the massive, unprecedented shift to accommodate DE[2] for remote learning and distance education. NDC concludes that most (if not all) institutions for deaf higher education, including administrators, students, educators, and supporting staff were woefully underprepared for full immersion into technologically-dominated educational spaces. Their memo powerfully demonstrates that much work is left to be done. A short list of crises are summarized next.

When deaf students were denied sign language interpreters, they had feelings of abandonment, isolation and helplessness. When confronted with automated captioning rife with errors or when they lacked access to content such as podcasts and video lectures, deaf students actively sought out additional teaching and tutoring to fill in gaps. Many surveyed deaf students noted that nondeaf students did not need to expend so much energy to attain basics access. These deaf students described how they were thrust into uncomfortable roles, where they needed to negotiate the basics equity with people who held great power and authority over them. They found themselves in complex negotiation positions, "between…professors, themselves, and the disability services office".[159]

NDC project leader Cawthon explains,

> This is an urgent issue of inequality. Deaf students are not being considered valued members of the college learning community…Deaf students should be focusing their energy on learning, not using all of their energy to struggle for access. It is adding more stress to an already stressful time, creating a mental health issue as well.[160]

As the NDC memo shows, deaf students know what they want. They know what they need in higher education – it is up to educators and institutions to act in accordance. To understand the nexus of DE[2], I use multimodal theory to highlight issues of power and ethics in deaf pedagogy, including subthemes like inequality and marginalization. Studying deaf epistemological knowledge and ontological reality from the vantage point of multimodality in the context of DE[2] suggests that current theoretical frameworks like UDL – Universal Design for Learning – are not sufficient. They are not situated theories and are therefore inadequate for deaf students.[161]

Multimodal theory may unstick some stuck places of deaf education[162] via new theoretical foundations focused not only on the ethics of pedagogical actions but on complex, and interdependent *interactions* involving deaf students, as individuals and in groups, who are competent and able co-designers of their own education.

158 National Deaf Center, *Universal Design…*, op. cit.; idem, *Poll: Pandemic Hits…*, op. cit.

159 National Deaf Center, *Poll: Pandemic Hits Deaf Students Harder*, e-mail released research brief, May 5, 2020, http://eepurl.com/g3hy3T.

160 Ibidem.

161 S. Burgstaler, R.C. Cory, *Universal Design in Higher Education: From Principles to Practice*, Harvard Education Press, Cambridge 2009.

162 R. Swanwick, M. Marschark, op. cit.

As Hamraie and Fritsch show, disabled people capably solve their own problems – because others can't or won't.[163] The best time for change was long ago, when the problem of inequality in DE^2 was first noted by Lang.[164] The second best time for change is right now.

Conclusions

I analyzed the digital environments of deaf education (DE^2) using three categories with subcategories to answer my first research question. My findings illustrate the complexity of deaf pedagogy under digital conditions. First, I showed a trio of *purposes* for DE^2: (a) providing access and closing communication gaps, (b) enabling deaf development, and (c) fostering collaborative multimodal interactions. Second, I cited *practices* of DE^2s, including (d) the design and adaptation of situated pedagogy and curriculum, (e) and the reflective use of pedagogical praxis. Finally, I summarized (3) *disciplinary units* of DE^2: (f) language and arts and (g) STEM, and documented exemplars in each sourced from deaf higher education. To answer my second question, I explored multimodal research about pedagogical ethics and took a sojourn into theories of power and self-determination.

Kress – one founder of multimodality – emphasizes the power of deaf people and sign languages in his theory of multimodality. For instance,

> The fact that dominant, mainstream society has called these semiotic resources 'languages' – sign languages – is a consequence of histories of power and the misrecognition due to power. Signing is a complex resource founded on the logics of space and time jointly, on simultaneity and [sequence] beyond gesture…Signing is different to either speech or writing in its materiality and in its social histories.[165]

In addition to extensive research showing that sign languages are *Languages*, full and proper, Kress instructs us that they are also multimodal forms of social semiotics. As such, they come imbued with complex social histories that are situated, that they are tied in with pedagogical ethics, and even relate to the aesthetics of deaf education. To be unambiguous, I am a full-throated supporter of sign languages as a central foundation of deaf education; however, sign language alone is not the sum of deaf education; researching multimodality reveals nuances about these same domains. Researching sign languages reveals much about how power is used and how it flows in deaf education spaces.

Multimodality theory has grown by its inclusion of deaf perspectives. Deaf educators and researchers similarly stand to benefit from multimodal introspection. This is particularly apparent when theorizing the effects of power in relation to sign

[163] A. Hamraie, K. Fritsch, op. cit.
[164] H. Lang, op. cit.
[165] G. Kress, *What is Mode?…*, op. cit., p. 67.

languages regarding local and global deaf populations who use digital educational technologies. Recent scholarship, including this analysis of DE^2, shows the strong impact of ideology on the acceptance of sign languages by those who are not deaf in deaf higher education and outside of deaf education workspaces.[166] This acceptance or refusal functions as a proxy for other aspects of power: *Those who reject or fail to support sign languages reject and fail to support deaf people*.

Superimposing deaf education and theories of multimodality makes good sense, generally, and in the context of digitization in particular. Each tradition clarifies the other and strengthens the ethics of deaf pedagogy. This synthesis rightly tips the balance toward deaf ways of being and knowing. Moving forward, it's important for researchers to create cogent multimodal frameworks to guide teachers and programs in self-assessing DE^2. Although DE^2 works toward discursive parity, advancements aren't universal; the gap between potentiality and actuality is wide, resulting in a constrained, phonocentric DE^2 experience amplified in mainstream deaf collegiate contexts, where personnel and institutions often lack background knowledge about deaf education.

Multimodality disaggregates complexity. It's essential to improving the praxis of deaf pedagogy in DE^2 in general and in higher education, specifically. Deaf educators must adapt toward deafness in the design and use of DE^2 tools and technologies, in pedagogy and curricular design, or deaf students will continue to suffer educational and social exclusion, and the people who comprise Deaf Cultures will face epistemological decline.

Special ontological and epistemological considerations are warranted for deaf leaners who navigate education visually and multimodally.[167] Doing so is just – ethical – to borrow a phrase from Kress. Institutions of higher learning that claim to serve *all* students must account for the unique and situated needs of deaf people who perceive the world in foundationally divergent ways.[168] Deafness significantly changes the experience of accessing, using, learning, and using digital information technologies. I have only begun to answer my second research question, this paper provides initial work to open up a novel problem space to theorize the power of technology and multimodal deaf pedagogy. From it, I invite others to build guidelines for the ethical use of multimodality in DE^2. These findings indicate exciting avenues for the ethical development of research and practice using multimodal DE^2. Given their expansive and increasing use, foraging and exploring these pathways is not just warranted – but necessary for the survival of deaf people and deaf lifeways.

[166] A. Kusters, M. Green, E. Moriarty, K. Snoddon, *Sign Language Ideologies: Practices and Politics* [in:] A. Kusters, M. Green, E. Moriarty, K. Snoddon (eds.), *Sign Language Ideologies in Practice*, De Gruyter Mouton, Boston–Berlin 2020, pp. 3–22; T. Reagan, *Ideological Barriers to American Sign Language: Unpacking Linguistic Resistance*, "Sign Language Studies" 2011, vol. 11 (4), pp. 606–636.

[167] P. Hauser et al., op. cit.; M.E. Skyer, *Pupil ⇄ Pedagogue…*, op. cit.

[168] R. Swanwick, M. Marschark, op. cit.

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