Thriving in the Wild

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Thriving in the Wilds

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Table of Contents

THRIVING IN THE WILDS 1
Thriving in the Wilds 2
October 14 - 15, 2023, 2
Iowa City, IA 2
University of Iowa 2
Conference Organizers 2
Table of Contents 3
Session A: Poster Sessions and Lightning Talks 7
Thriving on the Metaverse: A Review of Immersive Virtual Reality Application for Social-Emotional Learning 7
Entropy as an Indicator of Learning through Exploration in a Puzzle Video Game 9
How Movements and Speech Contribute to the Conceptual Understanding of Mathematical Functions? 12
Pedagogy Scientists: Designing academic literacy spaces for primary education teachers 14
Co-Developing a Third Space with Mathematics Educators of Color 17
Embodied and Productive Disciplinary Engagement 20
Disrupting Colonial Structures in Data Storytelling 23
How is Exploration/ Exploitation Related to the Learning Process in Video Games? 25
“I was Able to Understand it Better than Normal Science”: Students’ Identity Work in Embodied Science Activities 27

Exploring elementary students' negotiation processes in network data creation 30
Responsive Online Pedagogy in Practice: Empowering Learners in IU High School's Introduction to Computer Science Course 32
Enhancing Science Learning through Immersive Augmented Reality: Expert Insights on Usability 34
Varying Perspectives: Teachers' Perceptions of Traditional Ecological Knowledge as a Knowledge System Within Science Classrooms 38
Investigating Gesture's Effect on Encoding Mathematics Problems 40
Graduate Teaching Assistant (GTA) Service-Learning in Action 42
Automatic speech recognition (ASR) in noisy classrooms: 45
Evaluating the usefulness of three popular ASR tools 45
AEECI development and Validation 48
Neural Correlates of Spatial Reasoning in STEM Education 50
Examining Distributed Spatial Sensemaking in an Elementary School Summer Camp 52
Session B: Workshops and Forums 54
Aftertastes of anti-Blackness in the Learning Sciences 54
From Transformative Opportunities to Reproduced Ideologies: A study of discourse, tools, and multi-level interactions within equity-oriented new teacher mentoring 56
Writing Gone Rogue: Public Pedagogy and the Learning Sciences 58
Switch Mode - Debugging in a Hybrid Environment 60
Becoming intertwined and learning to sense together in professional coffee roasting 63
Session C: Wild Ideas and Paper talks 66
Does the rock learn too? Posthumanism, the mind-body problem, and weathering 66
Scratch as a Programming Tool: An Investigation into its Potentials for Creating Computational Thinking-aligned Experiences 68
Transmuting cognitive and emotional liabilities into assets for science engagement 71
Interrogating Graded Classroom Participation 73
Enhancing Argumentation Skills in Science Education: 75
A Web-Based Inquiry Approach for Middle School Learners 75
The Interplay of Individual and Group During Collaboration 77
Exploring the Boundary of Informal and Formal Learning Environments 79
Embodied Expressions while Learning Fractions in Naturalistic Classroom Observations 80
Drawing Upon Computational Experiences to Navigate Ontologies 83
Learning Flexibility and "Stretching" Through Co-Curricular Involvement 86
English Learners Thriving and Surviving in Rural Schools 89
Engaging with Critical Data Perspectives and Practices to Encourage Expanded Notions of Local Climate Data: Preliminary analysis when co-designing a local, online, map-based, educational resource 91
Which Comes First? An Initial Design of Instructional Ordering on Conceptual and Procedural Knowledge in Eighth-grade Algebra 93
A Mixed-Method Examination of a Sports Technology Makerspace 96
Session D: Workshops, Forums, and Talks 98

Exploring the Meaning of Thriving in Academic Spaces: An Experimental Collaborative Autoethnography Forum 98
Attentive Allies: Landscape Architects as Facilitators to Promote Early Childhood Nature-based Educational Programs 100
Is laser tag a children's museum?: A genuine question 102
Getting Started with VR in the Classroom 104
Diffractive Seeing: Exploring approaches to nonhuman agency for interaction analysis 105
Workshopping Ethnographic Methods and Participatory Activities for Identity Research 108
Scaffolding Students' Questions to Support Thriving in Phenomena-Based Classrooms 111
College Students' Experiences with Academic Help-Seeking in a Cultural Context 114
Play as a Mechanism for Thriving in Elementary Mathematics Classrooms 116
Surfacing Teachers' Dispositions for Student-Directed Critical Inquiry – Design-Based Research for a Professional Development Workshop 119
Representation in science: How teachers perceive and use representations in elementary classrooms? 122
Towards Critical Data Literacy in Data-Infused, Project-based Interdisciplinary Learning about Japanese American Internment 124
Individual and collective math learning in a civic data science project 127

Session A: Poster Sessions and Lightning Talks

Thriving on the Metaverse: A Review of Immersive Virtual Reality Application for Social-Emotional Learning

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Keywords: Virtual Reality, Social-emotional Learning, Education Technology

Abstract:
Introduction: How can virtual reality technologies help humans thrive in the real world? The advancement of immersive virtual reality (IVR) promises new opportunities to enhance social-emotional learning (SEL) and social-emotional skill development in the 21st century. By replicating real-life scenarios and the dynamics of human interactions in the virtual world, IVR can address challenges that stem from the lack of “an ecology of human interaction in real-life situations” (Walker & Weidenbenner, 2019). More importantly, IVR can enhance the learning experience by increasing student engagement; providing constructivist, authentic experiences to impact student identity; allowing for new perspective-taking and empathy; and supporting creativity and the ability to visualize difficult models (Hu-Au & Lee, 2017). While boasting these merits, IVR is still a relatively new technology where its impacts on education are still controversial. Thus, it is important to critically investigate the use of IVR in SEL. The current study, thus, seeks to examine the benefits and constraints of such use cases to inform future research and learning designs that will use IVR for SEL.

Method: Given that there are many dimensions of SEL to be covered, previous research or reviews on IVR use for SEL often focus on one or two aspects of SEL only. Hence, for our review, we decided to take a narrative approach, where we explored and provided a more comprehensive overview of IVR uses in different social-emotional skill domains. During our search process, we employed different keywords for key SEL competencies coined by the Collaborative for Social and Emotional Learning, such as “mindfulness", “emotional regulation", “self-efficacy", “empathy", “social awareness”, “collaboration" and “intercultural competency". Moreover, unlike existing narrative reviews about IVR, we selected articles that produced empirical evidence for analysis only. The current review also excluded studies that were published before 2019, are conceptual papers, are conducted in clinical settings on subjects with intellectual disabilities, and only use desktop-based VR, which is considered less immersive.

Findings: IVR has the potential to become a powerful instructional tool for social-emotional skills development. IVR allows participants to see the world from different perspectives, live in a different body, and immerse themselves in a highly realistic virtual environment. With these unique affordances, IVR allows individuals to practice and develop important social-emotional skills as if they are participating in real-life situations. However, it must be noted that the research on the effectiveness of IVR in SEL is still limited, and it is not yet possible to draw definitive conclusions on how to effectively incorporate IVR. Some studies have pointed out that IVR is not necessarily more effective in enhancing SEL than the traditional teaching approach (Tan et al., 2022) and can even be harmful to different aspects of social-emotional development

(Martingano et al., 2021). These limitations pose interesting questions for us to consider how we can effectively adopt IVR in the SEL other than relying on it as the chief instructional means. Based on the findings, we propose suggestions for applying IVR in the SEL classroom.

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Entropy as an Indicator of Learning through Exploration in a Puzzle Video Game

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Keywords: Game-Based Learning, Exploration, Entropy, Naturalistic

Abstract:
Learning necessitates venturing beyond the familiar to explore the unfamiliar, a process known as exploration [1]. Alongside play [2], developmental psychology [3], and machine learning [4], research argues video games promote learning through exploration [5]. However, empirical studies linking exploration and learning in video games, especially on a larger scale, are scarce. Therefore, this study employs sample entropy on log files of students playing Baba is You [6][1] to offer a different perspective on exploration. Exploration, defined as acquiring new knowledge through concerted variation [7], and entropy, which quantifies randomness and uncertainty [8], seem to share a connection centered around random activity. Two perspectives shed light on this relationship in Baba is You. One perspective suggests a funnel-like progression where exploration initially has high entropy, decreasing as new information is gathered [9]. However, the funnel view may oversimplify exploration, as another perspective suggests that exploration can lead to certainty about something while introducing more uncertainty about something else [10], resulting in relatively consistent entropy. For example, the discovery of a new game mechanic may yield high entropy as players explore its boundaries before and after the moment of discovery. Thus, two initial research questions were explored: (1) How does entropy vary within a level for winning players compared to those who leave, and (2) Do players with higher entropy complete more levels?

A research edition of Baba is You, a puzzle game where players learn game mechanics to solve levels of varying difficulty, was distributed to 184 middle school and college students, who played the game at home for at least one hour per week for three weeks. Entropy was calculated from player actions in log files.

Preliminary findings indicate that player entropy across the first eight levels was higher for winning players and remained relatively stable, regardless of whether players won or left. This suggests consistent entropy within specific levels, contradicting the aforementioned funnel-like progression. It also suggests that completing levels is associated with exploring the game space more. Additionally, there was a small yet nontrivial correlation ($r = .20$) between average entropy and the total number of completed levels, further supporting the idea that exploring the game space enhances understanding of the underlying rules.

One limitation is the smaller number of players who leave levels compared to those who win, so exploring later levels that fewer players solve may be beneficial. Secondly, selection begs

refining to include only a player's first attempt on a level, potentially further balancing the difference between winning and leaving players.

This emerging work highlights differences in entropy for players who won versus those who left and establishes a relationship between entropy and the number of levels completed. Given the increasing complexity of big data in education [11] and the growing integration of video games in classrooms [12], this research aspires to bridge the gap between the literature on entropy and exploration and contribute to theoretical accounts of learning through exploration.

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How Movements and Speech Contribute to the Conceptual Understanding of Mathematical Functions?

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Keywords: Gesture, Whole-body Movement, Operational Speech, Mathematical Function, Multimodal Analysis

Abstract:
Functions in math education are important because they are how we describe the relationships between variables or sets and are the conceptual basis for algebra and calculus, as well as computer programming, scientific modeling and engineering design. Unfortunately, the subtlety of function concepts and their multiple representations often lead to widespread misunderstandings. Embodied approaches have been shown to facilitate understanding of specific functions often represented as graphs (Gerofsky, 2010; Tancredi et al., 2021). Yet, the concept of a function itself remains underexplored (Tall et al., 2000). This study aims to investigate how body-based experiences can enhance students' understanding of functions as entities, their input and output relations, and transformations.

Embodied approaches posit that bodily experiences are ubiquitous resources for grounding the meaning of mathematical concepts to one's perceptual and motor experiences. Co-speech gestures can reflect the semantic content of one's speech and thought and indicate emerging understandings when knowledge is in transition (Goldin-Meadow et al., 1993). The type of gesture and its conceptual meaning are particularly consequential. Dynamic depictive gestures, which enact spatial-temporal transformations of mathematical entities, predict geometric proof performance (Nathan et al., 2021). Additionally, operational speech, which describes goal-directed actions performed on imagined mathematical objects, can contribute to proof performance (Pier et al., 2019). A few studies have investigated the embodied nature of mathematical functions. Gerofsky (2010) showed that top mathematics students often engaged in whole-body movements when reasoning about Cartesian graphs. Tancredi et al., (2021) conducted an embodied design, eliciting students' whole-body movements to facilitate their understanding of trigonometric functions and corresponding graphs. Rather than focusing solely on understanding graphs, we explore the role of body-based experiences in influencing students' conceptual understanding of the function concept. We investigate: How do students' gestures, whole-body movements, and operational speech contribute to a scientific understanding of students' emerging concept of mathematical function?

This study will use a between-subjects experimental design recruiting undergraduate students. Participants will participate individually in an experimental session in a laboratory setting. Participants' responses (i.e., provably false or true and verbal justifications) to several conjectures about high school-level functions will be videotaped. An example of a conjecture could be "What is the meaning of ?" Responses will be coded for gestures, especially dynamic

gestures, whole-body movements, occurrences of operational speech, and the accuracy on conjectures about mathematical functions. Regression analysis will differentiate the contributions of specific gesture types, movements, and speech patterns associated with the performance. Qualitative analysis of participants' nonverbal movements and verbal reasoning will generate a corpus of relevant movements for developing future embodied interventions. Participant recruitment is planned for this fall.

This research explores the relations between movement, gesture, speech, and cognition in math functions. By identifying specific gestures and movements that embody functions, this study will add to the growing evidence that cognitively relevant movements are most consequential and contribute much-needed pedagogical approaches for elucidating mathematical functions through embodied interventions. Our future study will develop an embodied intervention instructing students to perform relevant movements to improve their understanding of the concept of function.

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Pedagogy Scientists: Designing academic literacy spaces for primary education teachers

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Keywords: Academic Literacy; Teacher Training; Primary Education.

Abstract:
This abstract describes the implementation of Cientistas da Pedagogia (Pedagogy Scientists), an on-going program for professional development of Brazilian teachers promoted by Brazilian graduate students based in the United States and Brazil. This project aimed to develop mentoring activities for academic literacy [1], tailored to primary education teachers. We followed the constructionist principle of learning-by-making [2] and encouraged teachers to develop a research paper, which served as an object to think with [2,3] to enhance their teaching practices. Ultimately, we seek that primary education teachers in Brazil organize their experiences and thrive by sharing their work with the international scientific community and become part of the Learning Science field.

Early childhood and elementary school educators feel undervalued [4] due to low social prestige and remuneration [5]. These workers mainly belong to disadvantaged social classes and have adopted teacher professionalization as a form of insertion into the formal job market [5,6]. While Brazilian governmental policies promote graduate level qualification to enhance primary education careers [7], one of the hurdles to access graduate courses is having published papers [8,9].

Therefore, educators require opportunities to share their knowledge with a broader audience. We hypothesized that enabling Brazilian primary educators to access academic literacy projects would allow them to thrive in specialized conferences and teacher training institutions. Importantly, this work highlights the academic production of historically marginalized non-native English speakers and encourages the international science education community to increase diversity in educational practices [10].

As a first edition, we developed 30 hours of mentoring activities for five educators in early childhood and elementary education, to structure teachers' publications utilizing the backward

design theory [11] and prior-knowledge consideration [12]. We conducted tutoring activities minding participants' zone of proximal development [13] and personalized plans to promote academic literacy [1]. This happened in mentees' first language (Portuguese) and mentors translated the papers to English. We implemented the project in four phases. First, encouraging mentees to share their previous documentation, data, and artifacts. Second, reviewing constructionist literature, while promoting group work to organize relationships between theory and classroom experiences. Third, writing the papers with mentor guidance. Fourth, translating, receiving feedback from senior academic researchers, and reviewing the papers.

In interviews and observant participation [14], mentees reported that these activities led them to a process of reflecting [15] on their teaching methods, pedagogical decisions, and awareness [13] of their theoretical-practical mastery. These deliberations resulted in the emergence of novel research ideas and demonstrated to educators the potency of their work. Two educators also decided to submit one of their projects to a local journal. Mentees achieved our goal of critically promoting intentionality and depth in their own practice, while disseminating their research findings, and studying constructionist theory.

In conclusion, data suggests that Cientistas da Pedagogia contributes to the literature on inclusive practices within the academic literacy framework, exploring a constructionist approach, enhancing the design of educational opportunities for educators. This project highlights the significance of applying theoretical concepts to classroom practices more systematically, facilitating the professional development of educators.

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Co-Developing a Third Space with Mathematics Educators of Color

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Keywords: Third space, funds of knowledge, mathematics educators of color

Abstract:
In the United States, decisions about mathematics education have historically been controlled by teachers, administrators, and policymakers who are predominantly white (Battey & Leyva, 2016). This creates a school culture where ways of knowing and being that fall outside the norms of white, western ideals are not heard or valued (Sleeter, 2011). Mathematics educators of color deserve a space that values their voices and experiences through building a collaborative, supportive, and joyful community.

Gutiérrez et al. (1999) conceptualized third spaces as discursive spaces in which “alternative and competing discourses and positionings transform conflict and difference into rich zones of collaboration and learning” (p. 287). There has been research demonstrating that physical third spaces have the potential to create the same rich zones of collaboration (Civil et al., 2005). A third space allows both the first space (traditional school setting) and second space (norms and values at home) to interact and create new opportunities for learning. We propose co-developing a rich and meaningful third space for mathematics educators of color that fosters both collaboration and community.

Educators of color have essential ways of knowing and life experiences that can contribute to the creation of a third space. Moll et al. (1992) defined these ways of being and knowing as funds of knowledge, which are “historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being” (p. 133). Thus, we ask the following research questions: How do we, educators of color and university researchers, co-develop a physical third space? How can a co-developed, physical third space foster a rich and collaborative community between mathematics educators of color and researchers?

We use community-based research (CBR) to deconstruct power rules that are typically formed in an educational research project (Rodriguez, 2013). CBR is a valuable methodology for this project, as our goal is to center the collaboration between K-12 educators of color and academic researchers. The first phase of our project involves co-constructing a celebratory third space for educators of color to build trust and camaraderie as the foundation for a community. The second phase of the project centers around using focus groups (Jayanthi & Nelson, 2002) with educators of color in attendance to help identify characteristics of the third space that foster community as well as highlight future growth opportunities. The goal for this second phase is to build community and trust between educators of color and researchers.

Co-developing this third-space community will allow both for continued relationship building as well as opportunities to co-identify issues in K-12 mathematics where more action needs to be taken. By identifying issues in K-12 mathematics education, educators of color and researchers will collaborate to address the disconnect between academic research at the university level, K-12 education standards and practices, and the realities of working in a classroom.

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Embodied and Productive Disciplinary Engagement

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Keywords: Embodied learning, engagement, mixed-reality learning environment, asset-based pedagogies

Abstract:
The Productive Disciplinary Engagement (PDE) framework (Engle & Conant, 2002; Engle, 2012) is frequently integrated with other frameworks for assessing engagement (Agarwal & Sengupta-Irving, 2019; Lee, 2021; Scott et al., 2006; Thompson, 2014). The Connective and Productive Disciplinary Engagement (CPDE) framework further extends PDE by expanding epistemic diversity and what counts as disciplinary learning (Agarwal & Sengupta-Irving, 2019). Pairing educational technologies with PDE and asset-based frameworks (Alim & Paris, 2017; Danish et al., 2020; Lindgren & Johnson-Glenberg, 2013) can boost student engagement and performance in science (Keifert et al., 2020). However, CPDE frameworks are often applied post data collection, overlooking opportunities to incorporate students' prior knowledge and cultural assets into research designs.

This study investigates the role of CPDE, mixed-reality environments, and embodied learning as asset-based strategies supporting science instruction. The analysis is part of a larger project entitled Generalized Embodied Modeling to support Science through Technology Enhanced Play (GEM-STEP). In this project, mixed-reality and motion-tracking technologies leverage embodied learning and play for scientific modeling, an essential disciplinary practice (Danish et al., 2022). Two research questions guide the study: (1) How might technology-mediated embodied learning promote CPDE? (2) What are the tensions and opportunities in enhancing future research designs within a CPDE framework? Insights from this exploratory study will inform how students' cultural and intellectual assets can be integrated in upcoming GEM-STEP implementations.

The overarching objectives of GEM-STEP investigate learning processes involving various scientific models: text-based, embodied, and mixed-reality. Researchers collaborated with two fourth-grade science teachers to co-design and co-facilitate a 14-day curriculum on food webs and photosynthesis. This curriculum leveraged GEM-STEP models to project students' movement onto a shared simulation screen, enabling them to embody various phenomena, such as a gopher evading a hawk and carbon dioxide and water molecules interacting at a chloroplast. I utilized a priori codes, aligned with the CPDE framework's principles, to analyze post-interview data—problematizing (survival within a food web), authority (students as stakeholders), accountability (taking responsibility for peer learning), and resources for sense-making (mixed-reality models, play, and prior knowledge).

Although the GEM-STEP curriculum was not initially designed for CPDE, it helped identify assets students bring to the learning environment, specifically prior knowledge, collaborative

play, and agency with bodily movement. Also, it potentially offered more accessibility to our science curricula. The GEM-STEP models minimized reliance on monolingual discussions and text-based instruction, inviting students into modeling practices through play-acting the science phenomena they were learning—as animals in a balanced ecosystem and molecules involved in photosynthesis. However, despite most students being able to describe how this embodied learning was helpful in learning about food webs and photosynthesis, they encountered difficulties in providing a general definition of a scientific model. Further analysis of assessment and video data might clarify students' thinking about how different types of models best help them learn specific science concepts. Moreover, by identifying cultural and intellectual assets during the research design phase, future implementations could reveal opportunities for CPDE and enhance learners' practice with scientific models.

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Disrupting Colonial Structures in Data Storytelling

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Keywords: Storytelling, Datafication, Decoloniality

Abstract:
This poster is a theoretical framework on the relationship between coloniality and data epistemologies. I review a lens through which we can imagine decolonial data futures by expanding coloniality and data epistemologies, exploring decoloniality with data epistemologies, and imagining decolonial data futures. Colonialism persists as a structure in the U.S. that informs residents' epistemologies, which includes what we know and how we think. One thread of colonialism is that a person is only human if they are rational and objective (Wynter, 2003). Claims to rationality often use data as evidence and follow the data epistemology that data provides an "aura of truth, objectivity, and accuracy" (pg. 663, boyd & Crawford, 2012).

Connections between data interpretation and what becomes the "truth" can mislead to narratives such as "the numbers speak for themselves" without acknowledging the interpretation in the process. The erasure of interpretation makes it so only some stories have power. Another layer is data manufacturing– human construction of data which does not naturally exist in the world (Selwyn, 2021; Van Dijck, 2014). Datafication contains a conflict between the describer and described when organizations extract information from individuals and use it to tell stories without the original individual's knowledge and context (boyd & Crawford, 2012). The stories are framed in subject-object terms, such that the one described is dehumanized and loses their agency. Relationality is a practice of connection and understanding subject-subject relationships that humanize people (Simpson, 2014). Subject-subject relationships within data storytelling are one form of decoloniality, and it can bring in voices of the people whose story is described.

Imagining everyday forms of respecting beings through stories aligns with the idea that "Stories are not separate from theory; they make up theory and are, therefore, real and legitimate sources of data and ways of being" (pg. 430, Brayboy, 2005; Simpson, 2014). Exploring the role of storytelling in theory making requires new methods and relationships within learning sciences research. A prime example is Participatory Design Research (Bang & Vossoughi, 2016), which responds to the history, power, and relationality of partnering with communities and honoring the stories told with communities. Incorporating Indigenous storytelling and relationality helps imagine decolonial data futures rather than a datafied colonial one.

Some examples of disrupting data colonialism are "queer data", "black data", "crip technoscience", and "data feminism". These groups tell stories with data that are critical and radical to counter colonial structures and dominant views of data. For example, data feminism "argues that dimensions typically excluded from data science, such as care, emotion,

relationality, and attention to context, are central to data projects that contribute to justice and liberation" (Lee et al., 2021). It applies ideas of relationality to stories told with data and is an example for how people might counter issues of power in data. I outline the relationship between colonialism and datafication, so we can promote indigenous resurgence rather than the continued colonial erasure of Indigenous knowledge across learning environments. More work needs to be done on how to decolonize interactions with data.

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How is Exploration/ Exploitation Related to the Learning Process in Video Games?

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Keywords: Exploration, Exploitation, Learning, video games, Self-efficacy

Abstract:
How do Video game players decide when to continue using a strategy that has worked for them in the past or invest time in exploring a new strategy?

Prior studies have shown that video games impact various human behaviors, such as learning and problem-solving (Adachi & Willoughby, 2013; Gee, 2009). Literature suggests that exploration and exploitation contribute to game learning (Schilling et al., 2003). Many players understand their actions and the capacity to shape the virtual world, and this recognition is typically combined with ideas of control, power, or superiority (Christoph & Tilo, 2012).

Self-efficacy, a belief in a person's capacity to achieve success, is influenced by prior experiences (Bandura, 1997). Video game self-efficacy s may be a predictive factor for the effects of de-sensibilization, the ability to know new games, the types of video games players play, and the length of time they spend. (Allan, 2010). However, to explore and improve learning, people might need sufficient self-efficacy to overcome stress in search of a way to solve the problem differently. However, the number of studies that explore this relationship is limited.

In this study, we investigated the relationship between players' self-efficacy and exploration/ exploitation strategies and how they affect the learning outcomes in the game Baba is You. Baba is You is a commercially available, puzzle-based video game that won numerous awards at its release.

The study used data collected by 168 college and middle school game players, including log data, self-reporting surveys, and video recordings of players thinking aloud and playing. Our analysis is divided into two phases addressing two hypotheses. Our first hypothesis is that the results will show how players' self-efficacy relates to game strategies and impacts their learning process. We investigate this using log and self-reported survey data to generate heat maps of player movement in the game environment and categorize players' movement based on their game strategies in previous levels. Our second hypothesis is that there are different kinds of exploration and exploitation, and these different kinds of exploration/exploitation can affect players' learning processes differently. This hypothesis will be investigated via video data, specifically categorizing all kinds of exploration and exploitation based on the player's movement and self-efficacy. Data analysis is currently in progress, with anticipated completion in September 2023.

This study will unpack the efficacy of video games in facilitating the learning procedure and problem-solving. By identifying factors affecting players' performance and analyzing their exploitation and exploration strategies, the present research aims to understand how players' behavior and performance can improve in a video game context. The study's results can be used in practice by designers of games, educators, and educators who wish to create interactive and effective learning experiences using video games.

Based on the results from the studies described above, future research might investigate players' resilience while playing a video game based on their exploration/ exploitation.

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“I was Able to Understand it Better than Normal Science”: Students’ Identity Work in Embodied Science Activities

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Keywords: embodied learning; identity work; science

Abstract:
In science education, increasing attention has been given to the importance of supporting students to not only learn content, but to develop identities as competent doers of science (Barton & Tan, 2010; Varelas, 2012). Science identities may be shaped by many factors, including individual interest (Crowley et al., 2015), curriculum (Chu et al., 2017), and interactions between teachers and students (Jackson & Suizzo, 2015). We focus on the ways that a particular classroom activity, learning science through technology-supported embodiment, contributes to students’ identity work, or the ongoing process of authoring oneself in science (Calabrese-Barton et al., 2013). Embodiment has potential to broaden ways of participating, and thus participation, in science (e.g., Pierson & Brady, 2020), but it is less clear how participation in embodied activities supports positive identity work. Following Hand & Gresalfi (2015), we build on sociocultural approaches to identity and examine the ways in which our designed activities, particularly the foregrounding of embodied activity, afforded and constrained how students were able to participate and the sense that they made of that participation.

We explore this question in the context of a class of 22 fifth grade students in the Midwestern United States, who participated in ten days of embodied science activities using the GEM-STEP software, a platform that supports students to engage in mixed-reality modeling (Danish et al., 2022). During the embodiment, students controlled agents in lake and garden ecosystems via either moving through the classroom wearing hats or lanyards with pozyx tags on them, or through an iPad (Figure 1). Thirteen students participated in an individual interview about their relationship to science and their experiences with our activities.

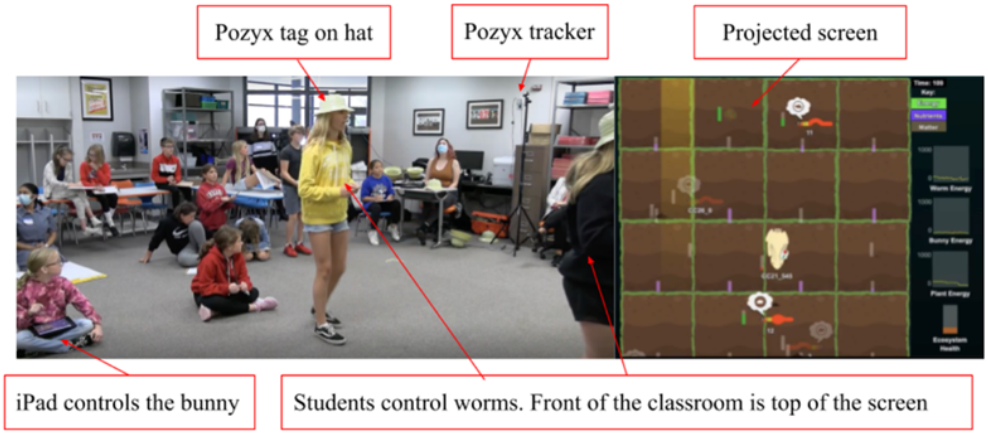

Figure 1: Students embody worms and bunnies (left) and the projected GEM-STEP screen (right)

We began by watching the identity interviews for each student, writing analytic memos (Saldana, 2011) that focused on how students described their experiences with science and with GEM-STEP. We conducted Interaction Analysis (Jordan & Henderson, 1995) of the classroom video to understand how embodied science activities might have supported moments for positive identity work. Specifically, we noted how students positioned themselves and were positioned, what it meant to be successful, and bids for recognition and holding the floor.

The analytic memos about the interviews suggested that nearly all the students had a positive experience with GEM-STEP. We identified two initial reasons that students liked GEM-STEP: it let them move around/engage playfully and interactively, and it let them work together in productive ways. In addition to liking GEM-STEP, students also felt that they were good at it, an important contributor to positive identity work. This held true for both students that already liked and felt good about science, and for students that did not. In the classroom video, the embodied activities seemed to allow students to engage in positive identity work by having opportunities to own and try out ideas, to be viewed as successful, and to address frustration. This work suggests that learning science through embodied activity has the potential to support students to reframe their views of science and how they relate to it.

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Exploring elementary students' negotiation processes in network data creation

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Keywords: data literacy, network visualization, negotiation, conversation analysis

Abstract:
This analysis is housed within a larger project called Visualizing Funds of Identity (VFOI; Stiso et al., 2023), which leveraged an open-source network visualization tool, Net.Create (Craig et al., 2021) to help 5th and 6th-grade students explore data literacy concepts over the course of a three-week curriculum. Net.Create provides a platform for creating and representing complex data in both dynamic network visualization and table form. It allows students to work on a collective network simultaneously by creating nodes of various types and linking each node via different kinds of edges.

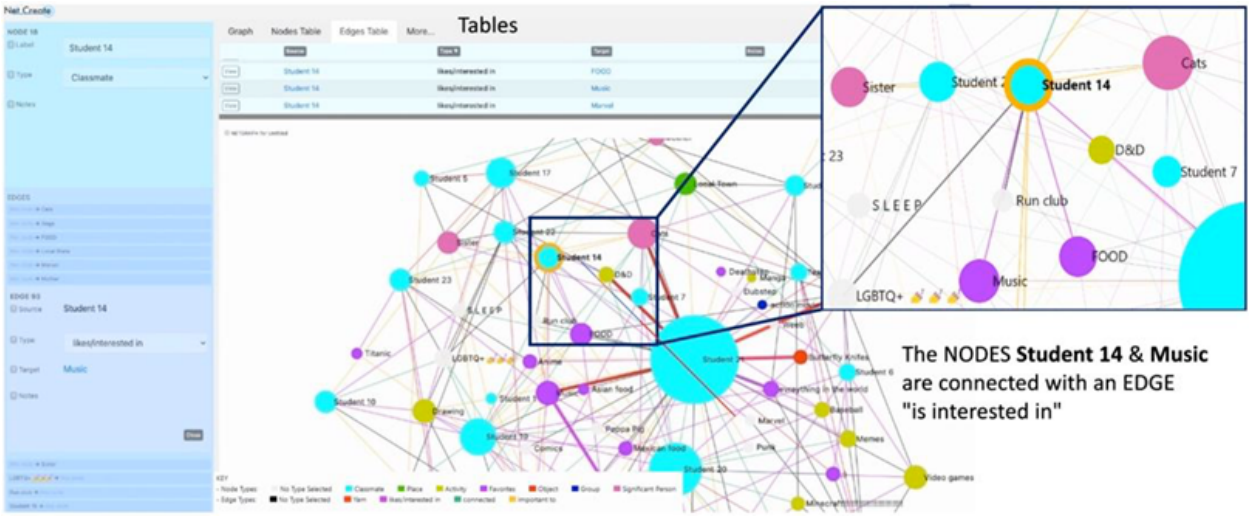
This analysis focuses on students' identity network, in which nodes represent individual students, hobbies, or locations, and the edges (lines between them) represent relationships such as "likes/interested in." (Figure 1). This identity network is a virtual version of a physical yarn network that students constructed on day 1 in which each student acted as a node (representing themselves) and was connected to peers who had overlapping interests/experiences using a string of yarn. A researcher created a digital replica of the yarn network using Net.Create to model students as individual nodes that were connected to other nodes of classmates, significant people, and objects through edges of three categories (like/interested in, connected, important to). This digital network was used for the day 2 activity, in which students worked in small groups of two to three to continue to create new nodes and edges so that the final/complete network could represent the class identity as a whole.

Students' data creation in Net.Create was framed by facilitators as relatively unstructured, as students were instructed to "connect yourself and your group members to nodes that are there or any new nodes that you want to create." Students, across all small groups, demonstrated two distinct approaches to data creation: 1) creating edges to existing nodes and 2) creating new nodes of their interests and then creating connections. Although both data creation approaches are task-oriented, they imply students' different views about the network (e.g., using this network to represent themselves holistically versus representing themselves quickly/easily; what images/identities they want to represent to the class) and reflect students' different data literacy practices (e.g., data creation before data extraction).

This analysis applies Conversation Analysis (CA) to explore students' negotiation of these two data creation approaches. CA uses audio and video data from naturally occurring interactions to understand participants' social practices by analyzing the orderliness of social actions (Schegloff

& Sacks, 1973), identifying patterns embedded in interactions (Marguttia & Drew, 2018), and determining what social outcomes of the practices have achieved (Sidnell, 2010). Conversation analysts attune to subtle nuances in conversation features, such as intonation, breath, and pacing, and then demonstrate the functionality of those features (Sidnell, 2010). Attentive findings of the current analysis are to present representative excerpts that were transcribed using a modified Jefferson's (2004) conventions to demonstrate how conversation features reveal an escalation of rejection in negotiation and how students employ different conversation technics (e.g., soften agreement) to maintain harmonious group dynamics.

Figure 1 Students' identity network in Net.Create.



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Responsive Online Pedagogy in Practice: Empowering Learners in IU High School's Introduction to Computer Science Course

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Keywords: Online learning, Situative theory, Educational assessment, Instructional design

Abstract:
Navigating into the digital age calls for fresh and inventive learning landscapes that help students reach their potential. This poster presents an innovative online course, Introduction to Computer Science (ICS), instituted at IU High School. The course has been designed with a distinct, customized assessment framework with the intent to facilitate meaningful learner engagement, stimulate critical thinking, nurture autonomy, and cultivate an in-depth understanding of the coursework. Poster attendees will how the implementation of balanced assessment approach to virtual course design can offer a fuller picture of learner understanding as well as how to implement the assessment approach themselves.

Developed using Responsive Online Pedagogy (Itow and Beam, 2019), the ICS course facilitates Productive Disciplinary Engagement (PDE) through expansively framed activities that push on both novice and expert ideas productive), are focused around target content or concepts (disciplinary), and draw on & extend student experience and interests (expansive; see Engle et al., 2012; Dan et al., 2020). Paired with Hickey and Zuiker's (2012) "multi-level" assessment framework, the ICS learning environment offers detailed evaluation of student learning.

At the core of this multi-level assessment framework are the "immediate," "close," "proximal," and "distal" levels. These levels drive engagement with content and promote self-evaluation and summative assessments. This integrated method forms a dynamic learning journey that brings together different assessment levels to ensure full understanding and effective performance evaluation.

What makes this assessment framework stand out is its tangible effect on students' intellectual development and academic success. Through this, learners find ways to form deeper connections with the subject, creating a rich educational environment that fosters learning, application, and the ability to contextualize knowledge in real-world settings. By understanding this approach, participants can see how it not only encourages intellectual growth but also nurtures skills essential for future pursuits. Indeed, a key characteristic of this framework is its focus on developing learner independence. It guides learners to discover relevance in personal experiences and use these as steppingstones for their academic growth. It is a way to shape learners who are self-driven, which notably enhances motivation, resilience, and engagement.

By engaging critically at the "immediate" level, undertaking self-assessment at the "proximal" level, and facing summative exams at the "distal" level, learners naturally build resilience as an essential skill. Continuous feedback is a key part of the framework, strengthening this resilience, enhancing learning strategies, and refining problem-solving skills. As learners understand the purpose and relevance of assessments, active involvement in the educational process increases. This aligns with studies that highlight the role of assessment as a learning tool, not just a measure of academic performance (Galy et al., 2011).

The introduction of this multi-level assessment framework exemplifies an effective strategy for creating thriving learning environments. It provides a compelling model for those in education looking to design engaging and effective online learning platforms and participants are encouraged to consider the potential of this model to transform learning design in the digital era, moving beyond mere survival in education, and creating environments where students genuinely thrive.

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Enhancing Science Learning through Immersive Augmented Reality: Expert Insights on Usability

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Keywords: Augmented Reality, Usability, User Experience, Design-based research, Science learning, Task design.

Abstract
This poster presentation discusses the usability evaluation of the augmented reality application "HoloOrbits" for Microsoft HoloLens 2. Augmented reality (AR) has demonstrated significant benefits in education (Akçayır & Akçayır, 2017; Hoppenstedt et al., 2021; Radu, 2014). AR improves learning processes by reducing cognitive load and enhancing material retention (Hoppenstedt et al., 2021) and enhances student engagement and knowledge retention (Moro et al., 2023). Furthermore, head-mounted displays (HMD) like Microsoft's HoloLens 2 offer efficient interaction methods (Lauer et al., 2021). Recent research highlighted the needs for more usability studies to enhance the impact of AR on student learning and integrate user experience considerations for the effective adoption of AR in education (Law & Heintz, 2021). In digital learning environment design, involving subject matter and user experience experts is important to enhance user experience. Their expertise also helps ensure effective learning activities design and iterate on simulation design (Hoppenstedt et al., 2021; Lauer et al., 2021). In this study, we aim to collaborate with experts, and refine usability aspects that are vital for maximizing the benefits of AR in education (Radu, 2014; Moro et al., 2023).

HoloOrbits (see Figure 1) is an augmented reality application developed for Microsoft HoloLens 2 for students to learn planetary motion and Kepler’s laws. Since design based research is guiding the iterative design and development of this application, we invited 11 participants who have expertise in subject matter, user experience (UX), and instructional design. Participants joined one hour sessions that consisted of a tutorial of the HoloLens, a series of tasks in HoloOrbits: (1) manipulating and (2) observing the exoplanetary system, and (3) measuring distances between different components of the system. Participants were then asked to participate in a usability survey, and a semi-structured interview. In this study, we focused on the analysis of the survey data, consisting of multiple choice and open-ended questions.

Despite rapid prototyping challenges, participants reported low (71.8%, n=9) and some (18.2%, n=2) anxiety levels and moderate (27.3%, n=3) to high (54.5%, n=6) enjoyment, indicating a favorable emotional response. However, using air tap gestures was problematic for the users (54.5%, n=6), causing friction and difficulty in navigating the application (45.4%, n=5). Additionally, some users (36.4%, n=4) experienced frustration with the application menus, suggesting the need for a more streamlined and intuitive user interface. The users' feedback also highlighted high levels of immersion (100%, n=11) and accurate representation of the

subject matter (63.4% n=7). The application was generally successful in providing a neutral (27.3% n=3) to clear and very clear (54.5% n=6) understanding of the presented information and utilizing visual elements effectively to convey the subject. In future studies and iterations of HoloOrbits, we aim to address usability issues and challenges. We plan to continue to enhance immersion by ensuring that the subject matter is accurately and engagingly represented. In addition, we plan to incorporate alternative options such as voice commands or different gesture-based controls that would help to alleviate the difficulties encountered with air tap gestures.

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Figure 1 Screenshot of HoloOrbits Prototype

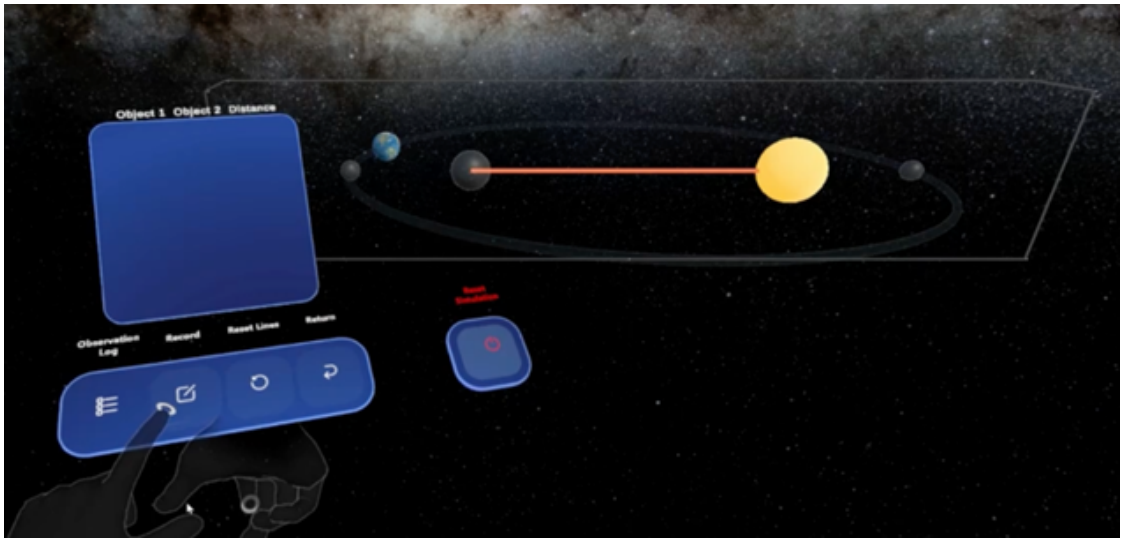

Table 1 Usability Survey Questionnaire Sample Items

Category	**Item (All items were rated on a scale of 1-5)**
User Experience	How immersive and realistic did the augmented reality environment feel?
	How easy were the hand gestures to navigate the augmented reality simulation?
	How easy was it to understand and navigate the main menu? If you had any difficulty in using the menu, please describe.
Subject Matter	How accurately did the simulation represent the scientific concepts it was trying to teach?
	How effective was the simulation in teaching you about the scientific concepts ?

	How clear and concise was the information presented in the simulation?

Varying Perspectives: Teachers' Perceptions of Traditional Ecological Knowledge as a Knowledge System Within Science Classrooms

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Keywords: Curriculum development, Next Generation Science Standards (NGSS), Professional development, Traditional Ecological Knowledge (TEK), Westernized science

Abstract:
Recent science and mathematics education efforts have articulated the need to address issues of identity and power in schools (e.g., Gutiérrez, 2013). To accomplish this, different worldviews can be discussed and acknowledged in classrooms and classroom instruction (Kimmerer, 2012). Bringing Traditional Ecological Knowledge (TEK) into science classrooms, for example, can open the classroom to multiple views of what science is and also welcome those from non-dominant backgrounds (Zidny et al., 2023). However, identifying how to do this in K-12 science classrooms can be challenging. To address this challenge, it is important to understand teachers' initial perceptions of TEK. This poster reports preliminary findings from a study exploring teachers' initial perceptions of TEK.

This exploratory study was conducted in the context of a Biology Integration Institute funded by the National Science Foundation (NSF). In June 2023, we held a three-day workshop for K-12 classroom science teachers, and science and education graduate students focused on developing NGSS aligned units integrating the Institute's basic science focus. Materials were created by interdisciplinary design teams of workshop participants. While there are multiple ways of knowing, we saw TEK as closely aligned to the science focus of the research institute: understanding ecological symbiosis and as such saw TEK as a way of creating opportunities for non-dominant students to make connections to their lives. As part of this workshop, participants were introduced to TEK through an assigned reading (Kimmerer, 2002) that defined the construct, and identified strategies for implementation in biology education. After reading, we asked participants to respond individually to reflection questions, and discuss their ideas in their small interdisciplinary design teams before sharing in the whole group setting.

Data sources for the larger study included written reflection responses, and audio-recorded small-group and whole-group discussions. We examined the TEK reflection questions completed by participants and selected moments from the audio recordings about the discussion of TEK for our research project. Through an inductive qualitative approach, we completed a thematic analysis (Braun & Clarke, 2006) to identify themes for how teachers perceived TEK. In this poster, we present Kyle, Jessica, and Jacqueline's (pseudonyms) perceptions of TEK through analyzing their small group conversation. This conversation was selected as it highlights varying views about TEK's presence in a science classroom. Our study

illustrates a key tension in accepting TEK by teachers in a science classroom, in that only two of the teachers saw TEK as a way to provide access to core biological concepts.

As discussed in the full poster, our findings have implications for us as professional development providers and curriculum writers. As a result of our work, we are identifying strategies for modifying teacher professional development and curriculum materials to support classroom communities that allow all learners to thrive.

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Investigating Gesture's Effect on Encoding Mathematics Problems

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Keywords: Mathematics, Gesture, Eye-Tracking

Abstract:
Children's success in early mathematics is important for future success in school (Claessens & Engel, 2013). Therefore, supporting mathematics learners early is an important component of enhancing student outcomes. Learners can be partially supported by adding gestures to instruction. Instruction that includes gestures is more likely to assist students in learning mathematics than instruction with does not include gestures (Singer & Goldin-Meadow, 2005). However, the mechanism through which gesture enhances student learning is not clear.

We previously conducted a study to investigate visual attention as a mechanism for gestures influence on learning. We did this by measuring first through third graders' visual attention while solving mathematical equivalence problems after instruction with gesture compared to instruction without gesture (Omitted, 2022). We found that children who learned using instruction with gestures were more likely to solve the problem correctly when they had more fixations on the blank. Children who learned without gesture showed the opposite pattern with less fixations on the blank predicting higher likelihood of success. This is surprising because children often ignore the blank when reconstructing mathematics problems (McNeil & Alibali, 2004). One explanation for this finding is that gesture provides spatial information which facilitates a more complete mental representations of mathematics problems. Therefore, the next step in understanding gesture's mechanism is determining what knowledge differences drive the changes in visual attention.

As a first step towards this goal, we are assessing children's knowledge after instruction to explain the differences in visual attention. To do this, we will assess three knowledge areas: mental representations, equivalence, and procedures. Our measurement of mental representations will use problem recognition and reconstruction tasks to assess how children store problem mental representations of the problems. We anticipate that these tasks will show differences in visual attention during encoding and increased preservation of the blank as a problem feature because of instructional differences. These differences would indicate that gestures in instruction facilitates learning through assisting in learners acquiring knowledge to build mental representations. For knowledge of equivalence, children will be asked to evaluate the smartness of several explanations of equivalence. We anticipate that instruction with gesture will increase the rating scores of correct equivalence understandings if gesture is aiding in equivalence knowledge. For procedural knowledge, children will be asked to evaluate the smartness of several correct or incorrect procedures. If gestures in instruction aid procedural

knowledge, then those instructed with gesture should be more likely to correctly evaluate correct procedures.

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Graduate Teaching Assistant (GTA) Service-Learning in Action

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Keywords: Service Learning, Community Outreach, Engineering Graduate Teaching Assistants (GTAs)

Abstract:
Learning to communicate and collaborate with others is essential at any job, especially during graduate school. One must communicate information clearly and effectively to motivate people. Giving effective feedback and presenting oneself professionally are valuable skills (Syllabus from GTA ENG course).

So why is it essential to train GTAs to be better educators while they are pursuing an advanced degree in the field of Engineering? Literature suggests that when one receives teaching training, one can acquire several skills relevant to any job (Chen et al., 2022; Choi et al., 2018). The GTA workshops aim to make GTAs become proficient teachers while applying these transferable skills in their classrooms, not just at the university level.

Additionally, universities rely on GTAs to teach countless courses (Nicklow et al., 2007; Alford, 1997). Evidence shows that GTAs are unprepared for instruction or lack the proper educational frameworks to be proficient teachers (DeChenne et al., 2015). Another issue is the lack of teaching preparation materials for GTAs (Liu, 2022), who often take teaching positions to help pay for graduate school, not because they want to teach.

Learning teaching skills is beneficial to becoming an effective communicator (Riese & Kann, 2022; Becker et al., 2017; Choi et al., 2018). To assist engineering masters and Ph.D. GTAs in honing their teaching skills (e.g., communication), a training course was created to strengthen their pedagogical and teaching theories (Chen et al., 2022). Pre and post-data findings from the spring of 2022 course represented that the Engineering GTAs felt more confident about enacting teaching methodologies from the topics taught throughout the GTA course (Shehab et al., 2023). In addition, an optional service-learning project was offered to the GTAs in the spring of 2023 course.

In a preliminary study, several GTAs in the graduate teaching course for Engineering TAs were paired with educational research assistants and local teachers to develop and execute a lesson in a K-12 classroom during the optional service-learning project. Utilizing Next Generation Science Standards (NGSS), Universal Learning principles, and the workshops as a guide, they created a lesson plan based on engineering concepts (Chen et al., 2023). The voluntary

workshops the GTAs attended enhanced and supplemented their engineering teaching pedagogies.

From this course, service-learning, and the workshops, the hope was that GTAs learned and enhanced the above beneficial skills in their teachings and professional lives. At the end of the service-learning project, an outside research assistant interviews all parties involved on their experiences.

These workshops have led to the idea of starting a standardized operating procedure for future engineering GTAs by implementing the GTA course, workshops, and a service-learning project. Plans are to create an outline for Fall 2023 to get more Engineering GTA's interested and continue building relationships with local schoolteachers in the community. Our preliminary service-learning workshops conclude that the GTAs, community teachers, and college of education research assistants benefit from the service-learning project. The skills learned benefit the individual and the university by giving them the necessary skills for teaching and future endeavors.

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Automatic speech recognition (ASR) in noisy classrooms: Evaluating the usefulness of three popular ASR tools

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Keywords: Automatic speech recognition, naturalistic classrooms, small group work

Abstract
Speech analysis plays a crucial role in understanding learning as a social and cultural process (Bonk & Cunningham, 1998). Conversations and discourse analyses are commonly used methods to examine how students construct shared knowledge (Goodwin & Heritage, 1990; Gee & Green, 1998; Slavin, 2012) and explore the acceptance, discussion, or rejection of ideas in collaborative learning settings (Baron, 2003). Detailed records of speech, such as transcripts, serve as valuable data sources for studying learning processes. It is not uncommon for students to have loud and noisy conversations with one another while working in small groups (Sherin & Star, 2011). Automatic speech recognition (ASR) tools have emerged as a time-saving solution for transcribing audio sources. However, the effectiveness of ASR tools in transcribing noisy classroom audio has received limited research attention, especially beyond one-on-one interview sessions.

This study aims to evaluate the performance of three popular ASR tools (Whisper, Temi, and Otter.ai) in transcribing noisy classroom audio. These ASRs were chosen for their well-trained speech-transcription models. Additionally, they offer two crucial features for discourse and conversational analyses: timestamps of speech and speaker diarization. Timestamps enable researchers to synchronize speech data with other data sources like video and content logs, while speaker diarization helps identify turn-taking patterns between students and teachers (Mu et al., 2020).

Methods
To assess the ASR tools' performance, a 1-minute segment with high levels of turn-taking, multiple speakers (students and teachers), and high loudness was selected from a larger 20-minute audio clip of students working in a small group obtained from a previous study (Author et al., 2023). This segment was expected to present significant challenges for all three ASRs. This study developed a coding scheme to categorize the ASR transcriptions and conducted a word-by-word analysis to compare them with human-generated transcriptions.

Results and Implications
This study is a work in progress; however, we believe that this word-by-word analysis will provide insights into the ASR tools' ability to transcribe student versus teacher speech, accurately transcribe words, words that the ASRs omit, and words that the ASRs were able to detect but transcribed differently compared to human-generated transcriptions. By evaluating these ASR tools' performance, researchers can better understand their suitability for qualitative

analyses, such as conversational and discourse analyses, and identify potential issues to consider when employing ASR in research. This study will contribute to enhancing the use of ASR in educational research, particularly in the context of noisy classrooms.

Table 1. ASR tools word-by-word comparison

Coding Scheme	**Whisper Count**	**Temi Count**	**Otter Count**
Words detect in ASR and human transcript that matched	78	103	71
Words detected in human transcript, but omitted by ASR	76	46	74
Words detected by ASR, but not human transcript	11	19	16
Words detected by ASR, but transcribed differently than human transcript	3	8	12
Total	168	176	173

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AEECI development and Validation

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Keywords: ableism, education, teacher perceptions

Abstract:
The Ableism in Education and Epistemic Cognition (AEECI) instrument was developed using existing research in disability studies, education, and special education fields to measure teacher ability to identify ableism in education and what the root causes of those ableist interactions are perceived to be. More than 50 years of research shows that inclusive education provides the best academic outcomes, social skills, and vocational prospects after graduation for students with dis/ability (Dessemont et al., 2011; McGregor & Vogelsberg, 1999; Van Mieghem et al., 2018). Despite this research, inclusive education is not being implemented effectively or fully for many students with disability (Krischler et al., 2019; US Department of Education 2021). As a result, teachers are often implicated as a barrier to inclusion (Carrington et al., 2014; Emam & Mohamed, 2011; Forlin & Chambers, 2011; Kim, 2011) despite research showing that the environment and climate of education setting interact with teachers' practice, beliefs, and attitudes regarding dis/ability and inclusive education (Greene, 2016; Kasa-Hendrickson & Kluth, 2005; Sandoval, 2016; van Steen & Wilson, 2020). One important component to identifying ableism and its causes in the education system is the perspectives of teachers because they are in the middle of the system and can identify barriers to its success (Rodden et al, 2018). Therefore this study seeks to examine teachers perceptions of ableism and their perceptions of root causes in education settings. In addition, it seeks to examine the use of an epistemic cognition model to assist teachers in the identification of root causes of ableism in scenarios of teacher practice with students of dis/ability, in order to identify potential points of intervention and advocacy in the future. The development and initial content validation of the instrument will be discussed, and possibly pilot data will be included as well.

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Neural Correlates of Spatial Reasoning in STEM Education

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Keywords: Spatial Reasoning, STEM, fNIRS, Gesture, Embodied Cognition

Abstract:
Manipulating students' use of and exposure to certain gestures during instruction has been shown to have a positive impact on a student's spatial reasoning skills (Stieff et al., 2016). Studies that have focused on this impact have strengthened claims that cognition is embodied. And spatial reasoning skills are a significant part of success in STEM education (Wai et al., 2009). One area of STEM that could benefit from gestures' impact on spatial skills is organic chemistry. With its' high failure rates, organic chemistry relies heavily on these skills. And many students in organic chemistry courses struggle with the encoding and transforming of imagistic mental representations that organic chemistry requires (Wei et al. 2009). Previous research on gesture use in STEM has been promising, showing that student-generated gesture, involving hand and finger movements during problem solving, can enhance spatial problem-solving accuracy in chemistry (Stieff et al., 2016). However, the neurocognitive mechanisms that underpin the effects of gestures' positive impact on these skills remains unclear. It is possible that gesture is merely an epiphenomenon, reflecting downstream manifestations of unseen non-motoric cognitive processes. For example, during problem solving, learners often display an attenuation of gesture production, suggesting a dynamic interplay between motoric action and other cognitive operations (Chu & Kita, 2011). This interplay could involve the recruitment of the visual system or the continued activation of the motor system without observable motoric action. To gain a better understanding, we take a bottom-up approach to look at the neurocognitive mechanisms that underpin the effects of gesture on spatial problem-solving. Scaling down our approach, we examined how gesture-based training may recruit different parts of the brain compared to traditional model-based training (Stieff et al., 2016). We accomplished this with an experiment in which we asked undergraduate students to solve novel organic chemistry concepts in the lab while we leveraged an innovative neuroimaging system, functional near-infrared spectroscopy (fNIRS). By comparing neural activity patterns between our gesture-based instruction and our model-based instruction conditions, we can isolate the specific neurocognitive mechanisms associated with gesture-enhanced spatial reasoning in STEM education. In doing so, this research will contribute to the broader literature on the learning sciences and embodied cognition by contributing to our baseline understanding of how gesture impacts spatial reasoning skills (Nathan & Alibali, 2010). This can then be integrated with other research and used to inform the design of future STEM learning environments.

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Examining Distributed Spatial Sensemaking in an Elementary School Summer Camp

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Keywords: Spatial reasoning, sensemaking, scientific reasoning

Abstract:
The term sensemaking has been widely used in science education to describe the process of making sense of scientific phenomena (Odden & Russ, 2018). Researchers argued that sensemaking is critical for science learning because of multiple reasons. First, it is essential in promoting deep learning such that it allows students to challenge their current knowledge given various new knowledge to build a new understanding of a scientific concept (Chin & Brown, 2000). Second, it is essential to facilitate transfer of learning (Kapon & DiSessa, 2012). And third, it is critical for knowledge construction and integration (Ford, 2012).

Sensemaking is critical in science learning because when students are learning science, not only do students need to understand what the phenomenon is, but also addressing why and how those phenomena occurred which in turns, forces them to reason about the scientific phenomena (Braaten & Windschitl, 2011). Science learning also involves students to provide mechanistic explanations which require integration of various forms of representations (e.g., visible and invisible entities, their properties and actions) using the theories that they know and ultimately turning it into the development of conceptual understanding of a scientific phenomenon (Kapon, 2016; Russ et al., 2009).

While sensemaking has been commonly used in science learning, in this paper, I am interested in examining the ways in which students make sense of spatial phenomena. Almost all of the studies examining spatial skills focus on isolating and measuring spatial skills as an internal cognitive process. These studies measure students' processing speed, mental manipulation of objects, and working memory tasks which are administered using psychometric tests. While those studies are excellent in providing valuable information to the current knowledge of spatial skills and understanding internal cognitive processes, there is a lack of understanding of how students think and reason spatially. To date, there is very little research that has explored spatial reasoning skills through qualitative lenses. A recent empirical study by Ramey et al. (2020) conducted qualitative analyses on students engagement in STEAM makerspace environments.

They were able to provide detailed insight into ways in which spatial reasoning skills are learned, enacted, and lead to problem solving insights as students engaged in a technology-based learning environment. While their study was able to provide insight into how students think and learn spatially in a STEAM makerspace environment, there is a need for further research to understand this phenomenon.

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Session B: Workshops and Forums

Aftertastes of anti-Blackness in the Learning Sciences

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Keywords: anti-Blackness, Black Life, Learning

Abstract:
"If you are silent about your pain, they'll kill you and say you enjoyed it." —Zora Neale Hurston

In this paper, I investigate a slice of the literature and place Black Studies and Black Education in conversation with the Learning Sciences to grapple with anti-Blackness as a primary aspect of analysis. Within Learning Sciences' braided strands of sociocultural, design, and cognition, there have been focuses on culture, ethnicity, and at times race (Nasir & Hand, 2006). This has opened up opportunities to consider how understandings of culture and race matter for our learning, including centering relationality (Medin & Bang, 2014; Warren et al., 2020), students' histories, their repertoires of practice (Gutiérrez & Rogoff, 2003; Nasir & Hand, 2006), and their home language uses (Lee, 1995, 2001). In recent years there has been a call to attend to power and privilege within the Learning Sciences (Esmonde, 2017), which opened up further exploration of critical theorist perspectives on learning. Within this paper I utilize BlackCrit to illuminate a specificity to be desired when it comes to understanding how anti-Black racism has historically and presently played a role in schooling (Dumas & ross, 2016).

I complicate Learning Sciences' relationships to theorizing with anti-Blackness' legacy in learning. Historically, learning scientists have drawn on the work of scholars of Black Studies, Black Psychology, Anthropology, and Education to open conversations on race and ethnicity (Lee, 2002, 2008; Nasir & Hand, 2006). This paper is an invitation to examine how anti-Blackness operates within U.S. schooling and society. I am grappling with the stakes of survival and thriving for Black people, particularly in places where one is meant to blossom and grow, such as in schools. I utilize anti-Blackness as an analytic lens to understand the specificities of how anti-Blackness shapes young people's educational experiences. This work is not meant to be a totalizing description of the role of anti-Blackness, but to capture a part of Black life. I gingerly hold the realities of anti-Black racism in my hands and grapple with the tensions of what it means to survive. I recognize that it can be deeply unsettling to grasp the horrors of the afterlives of slavery (Sharpe, 2016) in the United States.

Within this review, I am using the literature to explore the following research question, How might anti-Black racism be addressed within Learning Science Literature? This paper is an introduction to anti-Blackness for the Learning Sciences. I explore the history of anti-Blackness in Education literature, followed by looking at how anti-Blackness intersects with gender, age,

canon building, language, cognition, design, and the socio-cultural with educational spaces. The following section explores Learning Sciences to identify areas that might be generative in our further explorations of anti-Blackness in the field. From this review, I articulate four findings 1) anti-Blackness as permeating but not totalizing, 2) how silence reproduces anti-Blackness, 3) how Learning Science is methodologically implicated, and 4) an approach for naming anti-Blackness in Learning Science analyses.

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From Transformative Opportunities to Reproduced Ideologies: A study of discourse, tools, and multi-level interactions within equity-oriented new teacher mentoring

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Keywords: teacher learning, ideologies, tools, mentoring, sociopolitical learning theories

Abstract
Supporting teachers' racial equity learning remains a critical focus for teacher development efforts, and yet, understanding of teachers' equity learning as it unfolds in process, co-mediated by surrounding organizations and sociopolitical environments is still emergent (Nasir et al., 2016; Walkoe & Luna, 2020). This paper examines the processes, possibilities, and constraints of teachers' racial equity learning and enactment. Specifically, it examines how their collaborative learning is shaped by the available tools within their local organizations and the larger policy landscape. This qualitative case study of a new teacher-mentor pair illustrates how despite repeated dialogic engagement around transformative discourses, dominant ideologies, or socially shared ways of making sense (Hall, 1996) embedded within mentoring tools constrained learning trajectories.

Data comes from a larger Research-Practice-Partnership with a New Educator Equity Mentoring (NEEM) Program within a large public school district, characterized by decades of neoliberal reforms and grassroots organizing for racial justice. It draws from over 120 hours of observations and interviews. Reflective of district demographics, both the mentor and teacher are white, and all the students are students of color (majority Latinx). It focuses on two illustrative episodes, analyzed through critical discourse and interaction analysis (Jordan & Henderson, 1995; Fairclough, 2013) with attention to the multilayered racialized learning ecology (McKinney de Royston & Nasir, 2017).

Findings
Findings show that the available mentoring tools as shaped by interpersonal dynamics, organizational discourses and neoliberal reforms constrained educators' engagement with transformative equity meanings. The teacher and mentor negotiated numerous available organizational discourses of racial equity. However, power-avoidant discourses emerged as dominant when planning for enactment, reinforced by dominant ideological underpinnings of the available tools.

Moment 1: Discussing recently implemented "class roles," Evelyn (mentor) used NEEM language to "notice" a gender bias despite original intentions to increase participation of several Latinx boys. Ashley agreed, raising the question of "equity versus equality" for everyone to get a fair chance. The potential to unpack the co-construction of classroom participation and build

local theories of equity were missed as Evelyn directed them to the NEEM meeting reporting tool, asking for a simple “a-ha” of learning.

Moment 2: Ashley asked Evelyn to help plan a Restorative Justice (RJ) community circle after attending a district training, hoping to build community and more democratic engagement. The circle turned into a hybrid academic discussion as Ashley juggled curriculum pacing requirements and Evelyn encouraged Ashley to adopt a “No-Opt-Out” participation structure for the circle which aligned with her NEEM goal, despite Ashley’s description of RJ’s voluntary participation structure.

Significance

These moments illustrate how the dominant ideological underpinnings within the available tools, constrained educators’ engagement with transformative possibilities as their interactions unfolded within the organizational and sociopolitical landscape. This work expands understandings of teacher learning to attend to the racial equity learning of teachers, as essential and constrained actors. By attending to the available tools as negotiated and mediated within interaction, it adds to the growing body of research on teacher learning as a complex and multi-sited phenomenon within dynamic multi-dimensional sociopolitical environments and discourses.

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Writing Gone Rogue: Public Pedagogy and the Learning Sciences

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Keywords: public pedagogy, writing, creativity, translation

Abstract:
Our workshop will be a space to dream, think, brainstorm, and discuss possibilities around sharing our research in the public sphere. Specifically, we see a need to bridge the gap between current norms of academic publishing to supporting the creation of more creative works that speak to a broader audience. We position this ability to translate research to a wider audience as public pedagogy. Public pedagogy broadly refers to work that takes note of the politicized nature of education, and seeks to see and enact learning across multiple contexts outside of school and schooling (Giroux, 2016; Sandlin et al., 2011). More specifically, one form of public pedagogy is public intellectualism (Sandlin et al., 2011), where academics are typically communicating complex ideas, projects, and phenomena to a wider audience. In this workshop, we are seeking to create a space where learning sciences graduate students can begin to engage in the work of public pedagogy as part of their practice.

Many scholars in the Learning Sciences have started to experiment with alternative forms of communicating their research impacts. For example, Learning to Engage Zines (Curnow & Vea, 2021), the Blue Dandelion Collective Zines (2023), Humans of Learning Science Podcast (2022), and more. This work, while inspirational, is not yet the norm. Our aim is to work with other graduate student researchers, who are the future of the field, in imagining and formulating ideas for how our work can be communicated outside of the narrow limitations of traditional academic writing.

Participants in this workshop will walk away with an idea of how to translate their research to a wider audience, and examples of this in practice. To start, we will share a bit on what brought us to this work, and then lead a group brainstorming session on different forms that research can be communicated in (i.e. blogs, podcasts, videos, etc.) by sharing examples. Then, we will have participants think of a project they already have and brainstorm in groups how to share it. We will give time and some digital and physical materials for participants to express ideas that come up for them. In the last phase, we will do a share-out of work and talk about what was enjoyable about the experience, what was hard, and what type of resources they would need to go forward.

We both have some experience with incorporating public pedagogy into our larger lines of work. Mez has co-taught a course on public pedagogy which included advising student projects, and has some experience with pitching articles to public-facing outlets. Stephanie has experimented with multiple forms of public pedagogy, from making a zine based on a research article they

wrote, to podcasting, and being a panelist for public-serving organizations. Together, our experiences have led us to be in close conversation around creating forms of research that are meaningful outside of the academy. Through this workshop, we are aiming to broaden this conversation to include anyone who is interested in translating or otherwise creating this type of work.

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Switch Mode - Debugging in a Hybrid Environment

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Keywords: block-based programming, computing education, virtual robotics, text-based programming, debugging

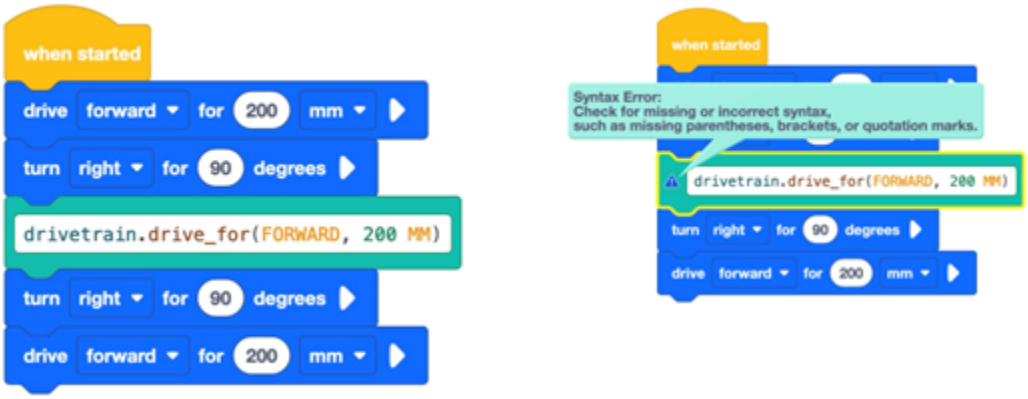
Abstract:

Switch mode is a new platform designed to provide additional scaffolds to help learners transition from block-based programming to text-based programming. VEX VR, a block-based programming environment that includes Switch mode blocks, allows the user to write Python code directly inside a block (Figure 1). Switch mode also includes several features to support learners in debugging their programs, such as syntax highlighting, variable monitoring, autocomplete and error outputs. In this workshop, we will focus on the error output of switch mode.

Figure 1: Switch Mode

A significant issue that novices face is the challenge of interpreting error messages (Becker et al., 2019; Nienaltowski et al., 2008), which includes both identifying where the error is and what the error is. Switch mode includes three different ways to display error messages. The first display approach renders an error bubble with a warning icon on the left side of the Switch mode block which identify the error exists in this block. The icon has a popup bubble that shows a simplified and readable error output. In the following case (Figure 2), the learner is missing a comma in the statement. This method shows a simplified message to help the learner understand both where the error is and how to fix it. Although the message does not provide an explicit suggested solution, it serves to scaffold the debugging process and helps learners develop essential skills related to locating, identifying, and resolving errors in their program(s).

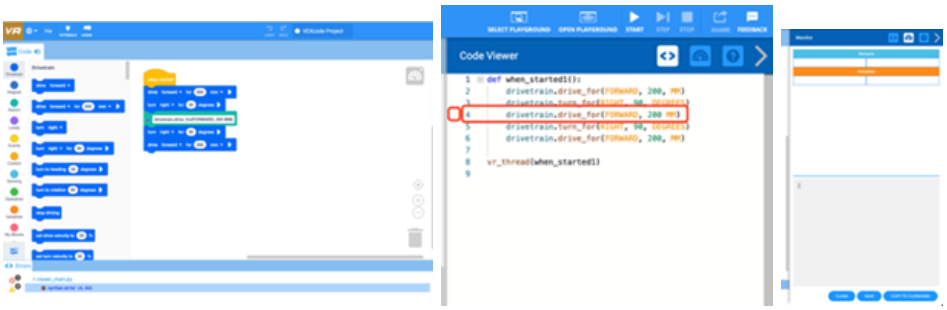
This approach also highlights a feature of the Switch mode approach, as there are only a few, and sometimes only one, text-based statements in the program, it means the error is coming from that set of commands. For example, in Figure 2, there is only one possible source of a syntax error, helping the learner know exactly where to look to resolve it, instead of having to parse through all 5 lines of the program.



(a) (b)

Figure 2: (a) Regular Switch block; (b) Switch block with syntax error warning;

The second place the error message is displayed in VEXcode is the error panel in the bottom of the screen (Figure 3a). The third display method is in the Python Code viewer (Figure 3b). The error line will be highlighted in yellow, and it will also have an error sign on the left side. Along with the error, the terminal panel under the monitor screen has the full traceback output that a standard Python displays, allowing learners to see the real version of error output alongside the full Python program. This is an effort to prepare learners for moving beyond BBP in general.



(a) (b)

Figure 3: (a) Error panel in the bottom of screen; (b) Error warning in Python code viewer

During the workshop, we will present an overview of the Switch mode and share a link, allowing participants to experience the Switch mode. Then we will provide participants with a series of tasks to debug in Switch mode. We hope the workshop will be generative for conversation

around the transition from block- to text-based programming as well as the study design that I plan to run in the later semesters.

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Becoming intertwined and learning to sense together in professional coffee roasting

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Keywords: sensory learning, ethnography, theories of becoming

Abstract:
How do communities arrange learning to see, smell, listen, and taste? This question sparked my ethnographic fieldwork with professional coffee roasters in May 2022 (Davey & Stevens, 2023). And thirteen months and 230 hours of fieldwork later I find myself with a new question: How do we understand sensory learning when our theories emphasize the spoken word, physical artifact, or observable task—none of which demonstrate roasters' sensory knowledge? One answer is to become intertwined with our research participants.

To warrant this claim I portray two apprentices' stories of becoming alongside my journey as an emerging sensory ethnographer (Pink, 2009) and learning scientist. Our intertwined stories expand existing models of apprenticeship, like legitimate peripheral participation (Lave & Wenger, 1991), which do not fully consider a learning scientist's role in (re)configuring endogenous learning arrangements (Stevens, 2013). Our stories also contribute new cases of becoming (c.f., Kaiser, 2005; Nasir et al., 2020) and complicate theories which view learning as unfolding along a trajectory toward expert performance. These theories (e.g., Bransford et al., 2014) identify expertise through manifestly observable data (such as recorded interviews) and increasingly successful completion of activities, but movement through roasters' sensory realms cannot be understood in this way.

Professional coffee roasters' senses—particularly smell and taste—are central to their workplace practices. To name only one example: roasters perform quality control on the coffees they roast through a practice of cupping. Cupping involves the standardized preparation and tasting of coffees via the Specialty Coffee Association's cupping protocols (SCA, 2003). Yet, I find that cupping is anything but standardized, especially for apprentice roasters and their participant observers. As an apprentice in a recent cupping said, "I'm just totally overwhelmed. After the fourth one [coffee] I hit a wall and can't taste anything." I, too, have struggled to develop my palate toward the fine sensory discernment (Goodwin, 1997) required by the professional roasting community. And in these moments of collective sensory overload is where we have also found our collective sensory learning.

Through microethnographic (Streeck & Mehus, 2005) and interaction analyses (Jordan & Henderson, 1997; Hall & Stevens, 2016) I demonstrate how our developmental trajectories became intertwined (Latour & Woolgar, 1986, p. 216; Merleau-Ponty, 1968, p. 130): as the apprentices refined their senses, they improved my ability to research and communicate about the senses, which in turn promoted their sensory learning. I develop the case with principles of

cognitive ethnography (Hutchins, 1995) and show that the apprentices learned to coordinate quantitative displays of data with sensory information across time and space. And I highlight moments where my ethnographic presence (Fine, 1993) made the implicit explicit and encouraged our collective sensory learning. Thus, in addition to becoming members within communities of practice, I show that we traveled shared yet idiosyncratic developmental arcs that culminated in individually and culturally specific sensory palates. As learning scientists move among new people in new places (Nasir et al., 2020), roasters' stories provide guidance for theorizing about diverse forms of life, learning, and becoming.

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Session C: Wild Ideas and Paper talks

Does the rock learn too? Posthumanism, the mind-body problem, and weathering

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Keywords: posthumanist theory, nonhuman agency, materiality

Abstract:
Posthumanism broadly works to decenter humans in theories, research, and ultimately understandings of reality (Barad, 2003; Bennett, 2010; Taguchi, 2012). In education, posthuman approaches to nonhuman agency has been productively used to study preschool literacy (Kuby & Rowsell, 2017; Haus 2020; Harwood & Collier, 2017; Hackett & Rautio, 2019), environmental education (Clarke & Mcphie, 2020; Weldemariam, 2020), and maker education (Keune, 2022; Sheridan et al., 2020; Wohlwend et al., 2017). However, human decentering in these studies appears to stop at the physical engagement level; humans are still the only actor who is presented as learning, sometimes framed as "attuning" to their nonhuman co-actors. To fully embrace the posthuman perspective, what is gained, complicated, and lost when framing nonhuman (and nonliving) actors as learning too? Using a video of preschool children describing how they climb a large rock as a prompt, I will posit that the physical process of weathering - in this case, repeated use of a particular foothold - might be an analog to neuroscience descriptions of learning, the "body" side of the mind-body problem. While any "mind" of a nonliving nonhuman such as a rock is inaccessible to humans, the "body" evidence of change from inter/intra-action might serve as a productive alternative, particularly when paired with recognition of co-constitution across timescales (Lemke, 2003). My goal is to complicate how we might conceptualize evidence of learning in order to more fully treat nonhumans as equal participants and students in learning spaces/moments.

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Scratch as a Programming Tool: An Investigation into its Potentials for Creating Computational Thinking-aligned Experiences

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Keywords: Computational Thinking, Scratch Programming, Constructionism, Technology-based Learning Environments

Abstract
In 1967, Seymour Papert introduced Logo, fostering math learning via a virtual turtle. Aligned with Constructionism, Logo aimed for practical learning while cultivating computational thinking (CT). Despite potential, differences between Papert and educators limited Logo's classroom use. In contrast, Scratch, inspired by Logo, gained popularity for media-rich creation, social interaction, and CT. Research gaps, including higher education and collaboration, call for further exploration. The current study will look to address these issues by examining the presence of CT in undergraduate and graduate students as they participate in interactive activities with their peers and reflect upon their experiences while developing programs using the Scratch programing environment. It will be grounded in the theoretical principles of Constructionism and on the conceptual framework delineated in 2012 by Brennan and Resnick. In this mixed-method study, 2023 data from 16 undergrad/grad students in an online participatory learning course at an R1 research university was collected. Primary data encompassed scratch projects, discussion board posts, and reflective assignments. Quantitative analysis of Scratch projects will use Dr. Scratch, offering scores on CT. Qualitative examination of posts and assignments will identify such thinking evidence through coding and categorization. Themes from these dynamic categories will inform final results. A previous pilot study using 2020-2021 data from the same course hinted at improved CT through iterative project design and interactive discussions. In conclusion, This study will look to explore the learning processes of higher education students as they interact with scratch, with the intentions of addressing gaps in the CT literature.

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Transmuting cognitive and emotional liabilities into assets for science engagement

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Key Words: Positive Psychology, Cognitive Engagement, Emotion, Science Education

Abstract:
In higher education, learning experiences elicit from college students more than cold cognition—they elicit emotion too (Jaber & Hammer, 2016). These emotions vary in their duration, valence, intensity, and conscious awareness, but each emotional experience guides a student towards either academic persistence or attrition (Jaber & Hammer, 2016; Nerantzaki et al., 2021). Individual differences such as gender, race, first generation status, and political ideology may inform a student's risk level for experiences such as imposter syndrome or the politicization of scientific topics, which may in turn play a role in emotional arousal during the learning process (Gable & Haidt, 2005). We aim to shed light on how dynamic variations in students' emotional engagement interact with their cognitive engagement when learning challenging content. To accomplish this aim, we present a theoretical model combining two intellectual traditions that guide our emerging research: Intellectual Humility (IH) from Positive Psychology and Knowledge Resources from Knowledge-in-Pieces (KiP)—a theory of knowledge developed in the Learning Sciences. The KiP approach has been used in several disciplinary contexts, but focus on domain-specific knowledge leaves unknown the critical role that individual differences play prior to instruction. Given the historical and ongoing issues with teaching challenging or controversial subjects, we aim to engage the audience in a discussion regarding theories and strategies for facilitating learning in these contexts. We also invite personal stories, including challenges and successes, with teaching in these contexts. Our aim is to facilitate a collaborative discussion that informs teaching strategies and research being done in this area.

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Interrogating Graded Classroom Participation

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Keywords: Classroom Assessment, Undergraduate Education, Participation, Learner Differences

Abstract
Focal Question: How can faculty assess classroom participation in undergraduate education in a way that allows all of learners to thrive?

This Wild Idea investigates the common assessment practice of “participation” in undergraduate classes. Research supports that active participation in course work yields better learning outcomes. Yet when it comes to assessing participation, faculty at colleges and universities have wide variations in expectations of participation (Gainor & Precourt, 2017). A review of undergraduate syllabi show the breadth of participation tasks students must demonstrate for credit: from supplying one question in class to leading a discussion, from posting to an online discussion board to volunteering insightful commentary during whole-class discussions.

At the same time, growing attention is being given to student-centered learning, where mandatory participation does not fit the instructional method and may lead to shallow participation (Koehler & Meech, 2021; Paff, 2015). Whether graded or ungraded, challenges persist in stimulating meaningful classroom participation that produces effective learning opportunities.

This leads to the focus question: How can faculty assess classroom participation in undergraduate education in a way that allows all learners to thrive? Current research supports providing multiple opportunities for differing learner preferences and contexts, as well as Universal Design for Learning (Tobin & Behling, 2018). Audience members will be invited to contribute ideas on instructional design for a multi-modal framework for student participation in undergraduate coursework. Current frameworks on this topic will be supplied, including Participatory Learning and Assessment (Hickey, et al, 2020).

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Enhancing Argumentation Skills in Science Education: A Web-Based Inquiry Approach for Middle School Learners

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Keywords: scientific argumentation, science learning, instructional design, socioscientific issues

Abstract:
In response to calls from science education research, Next Generation Science Standards highlight several core practices of authentic scientific inquiry, including engaging students in evidence-based argumentation[1–3]. Instructional strategies which prioritize the role of scientific argumentation are widely considered to be effective for promoting the critical thinking skills and conceptual understanding of science learners[4–6]. This research commonly notes challenges faced by science learners in constructing and evaluating arguments, particularly regarding the recognition of counterarguments and navigating uncertainty[7,8]. Consequently, questions persist about the most effective use of argumentation activities in science classrooms [9,10].
Addressing these challenges, my 'wild ideas' session will present my plans to develop a curriculum unit focused on developing the scientific argumentation skills of middle science learners. Based on prior design-based research in this area[11–13], this unit will leverage a web-based inquiry science environment to scaffold learners' argumentation skills and conceptual understanding of organ structure and function through activities like critically evaluating evidence, constructing written arguments, and engaging in classroom debates about social justice issues in the organ transplantation system. As I am currently in the early stages of unit development, I will invite the audience to consider questions like: How can argumentative activities be designed to be personally relevant to students and enhance their conceptual understanding of science content? How might I engage learners in both dialogic (e.g., peer-to-peer debate) as well as monological (e.g., written essays) argumentation within this online space?

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The Interplay of Individual and Group During Collaboration

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Keywords: collaborative learning, collaboration, unit of analysis

Abstract:
Collaborative Learning (CL) and Computer-Supported Collaborative Learning (CSCL) learning environments leverage the social and interactive nature of learning (Vygotsky, 1978). CL involves students working together in groups to solve problems and build knowledge collectively (Dillenbourg, 1999), while CSCL integrates technology into collaboration (Dillenbourg et al., 2009). A challenging aspect of these studies is to identify the appropriate unit of analysis. Collaboration necessitates interactions between individuals and encourages collective thinking and knowledge construction within groups. From a sociocultural perspective, the unit of analysis necessarily broadens to the group and/or their environment (Dillenbourg, 1999). However, we should be cautious about neglecting the individual's role in group interactions. Examining individuals' participation and contributions may help us understand how the group collaborates. Thus, during collaboration, there is usually an interplay between individual and group-level processes, and considering both may help us better understand collaborative processes.

Thinking about a group as a complex system (Arrow et al., 2000) may provide some guidance. Several characteristics of complex systems (Ladyman et al., 2013) are also shared by collaborative groups, such as interactions between different systemic levels (students at the individual, group, and class levels), nonlinearity (i.e., no simple causality and small differences may greatly impact collaboration), and feedback, which I relate to how students regulate their own and others' learning and motivational processes (Järvelä et al., 2016). I would like to explore whether we can leverage complex systems thinking to better understand collaborative processes and the interplay between the individual and group as systemic functions.

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Exploring the Boundary of Informal and Formal Learning Environments

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Keywords: emancipatory education, agency, outdoor learning

Abstract:
Gert Biesta, an educational philosopher, proposed that the educational task of emancipatory education is by way of equality of intelligence (2017). My study aims to explore this idea of equality of intelligence as it relates to student agency in two different contexts, the informal and formal learning environments, and how students utilize their agency in each learning environment. The focus of the informal learning environment will be an outdoor education program and the formal environment will be an elementary education classroom. Methodology will be a multiple case study using go pro video, interviews and an app called Equity Maps. My plans for analysis are tentative, but I have been exploring discourse analysis (Gee, 2014). My research questions are: (1) How do students' perception of agency differ in the classroom versus in the nature program? (2) How do students "encounter their freedom" in the outdoor learning environment and how is that different then in the traditional classroom?

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Embodied Expressions while Learning Fractions in Naturalistic Classroom Observations

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Keywords: embodied learning, gestures, fractions

Abstract:
Gestures and bodily manifestations can support student learning.[1] Previous studies have documented the impact gestures have on learning, such as promoting retention,[2] assisting with attentional and procedural aspects of tasks,[3] and promoting high levels of mathematical constructs.[4] Furthermore, researchers have articulated the role of gesture types (e.g., pointing and representational) in developing mathematical understanding.[5] Moreover, these bodily responses are key components of semiotic bundles that emerge in the classroom, and the richness and complexity of the bundles help facilitate mathematical understanding.[6]
Although this body of literature has shown gestures' potential benefits and roles in mathematical learning, little is known of how to engage students in these embodied manifestations in the classroom. Most studies explicitly ask students to gesture[7] or imitate a movement.[2] However, recent work suggests that the gestures that emerge spontaneously seem to support student thinking more than instructed gestures.[8] A follow-up question is how to engage students in uninstructed gestures in a naturalistic classroom setting. Specifically, we ask:
1. Within the same lesson and conversational context, which prompts are more likely to yield student-embodied responses?
2. Which prompts lead to complex embodied responses?

To address these questions, we watched video recordings of the same lesson taught by eleven different US fourth-grade teachers and their students. Drawing from previous work,[8,9] we first identified student math-related embodied responses (i.e., pointing and representational gestures and actions), resulting in 58 embodiment instances. If these embodied responses were concatenated or combined in a single student turn, they were coded as complex (RQ2). We then traced back the prompts preceding each student embodied response and employed inductive coding, resulting in the following categories: teacher factual questions, teacher higher-order questions, self-prompted elaborations, and self-prompted gestures with no speech. To hold environmental factors consistent, we observed 2 minutes before and 2 minutes after each prompt and identified the prompt types in situations where they did and did not yield embodied responses (RQ1), resulting in 236 prompts. We then ran a logistic regression analysis to identify associations between prompt types and embodied or non-embodied responses and another logistic regression to identify associations between prompt types and simple or complex embodied responses.

The preliminary results show that within the same conversational context, spontaneous elaborations (OR = 9.12, 95%CI [1.37, 3.10] p < .001) and teachers higher-order prompts (OR = 4.95, 95%CI [0.77, 2.43] p < .001) were more likely to engage students in embodied responses.

Additionally, the embodied responses were more likely to be complex when the prompt is a teacher higher-order prompt (OR = 7.00, 95%CI [0.23, 3.87] p = 0.03). Although this work is still in progress, the preliminary findings suggest that when holding constant the same grade level, lesson, and conversational context, spontaneous elaborations and teacher higher-order prompts are significantly more likely to yield student gestures. Additionally, only higher-order prompts seem to be significantly associated with complex student-embodied responses. Future experimental work is needed to determine if these embodiment-associated prompts impact or facilitate students' mathematical understanding and the nature of this potential relationship.

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Drawing Upon Computational Experiences to Navigate Ontologies

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Key Words: Computational simulation, representation, ontology, science education

Abstract:
STEM students experience challenges when reasoning about complex systems that combine multiple ontologies. Particularly, students tend to focus solely on the aggregate level of phenomena, disregarding the individual level of interactions between entities within the system. This learning challenge becomes more prominent when these different levels of processes are ontologically distinct from one another. Computational environments, however, sometimes support students because these environments distinguish between aggregate patterns and individual interactions with such systems.

To explore students' learning experiences, we conducted a training study employing pre and posttests, three experimental conditions, and a computational simulation using NetLogo to visualize the complex system. The experimental conditions involve an equation instruction condition, an aggregate haptic model condition, and an individual haptic model condition. Participants were randomly allocated to one of these three conditions, and subsequently engaged in learning through an identical computational simulation on NetLogo. This experimental design draws inspiration from Schwartz & Martin's (2004) paradigm of Preparedness for Future Learning. The primary objectives were to (1) how do different modes of instruction prepare students for learning with the computational environments, and (2) how do computational experiences reshape students' drawing of Resting Membrane Potential.

To gain insights into student learning within the environment, we evaluated students' drawings and their verbalizations during think-aloud protocols. Employing qualitative analysis on the data, we observed that computational experiences influenced changes in students' drawing styles, prompted the inclusion of new physical entities in their drawings, and supported their recognition of multiple ionic mechanisms regardless of the experimental condition. However, students who received instruction involving individual haptic experiences tended to produce more accurate predictions and explanations during the protocol with the computational simulation.

Based on our findings, we conclude that drawing provides valuable insights into students' learning experiences with computational environments. The inclusion of computational environments encourages students to identify neglected entities, reorganize the entities, and consider multiple causal mechanisms. By incorporating these new entities, students demonstrate progress in navigating multiple ontologies within STEM education. Furthermore, haptic experiences augment computational visualizations, providing students with a more

immersive learning experience that aids them in coordinating randomness and determinism while navigating multiple ontologies.

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Learning Flexibility and "Stretching" Through Co-Curricular Involvement

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Keywords: Experiential Learning Theory, Learning Flexibility, Co-Curricular Activities, KLSI

Abstract:
In the past, assessment of the impact of co-curricular activities was "defined by retention, graduation, and then career attainment" (Dean, 2015, p. 27) with no way to directly link the measurement of these factors to the students' involvement in a specific co-curricular activity. Involvement in co-curricular activities does not occur in isolation; students are influenced by what they are learning in their classes, their work environments, and other co-curricular activity involvement (Pascarella & Terenzini, 2005). A broader measure could be beneficial when examining the relationship between specific student abilities and their involvement in co-curricular activities.

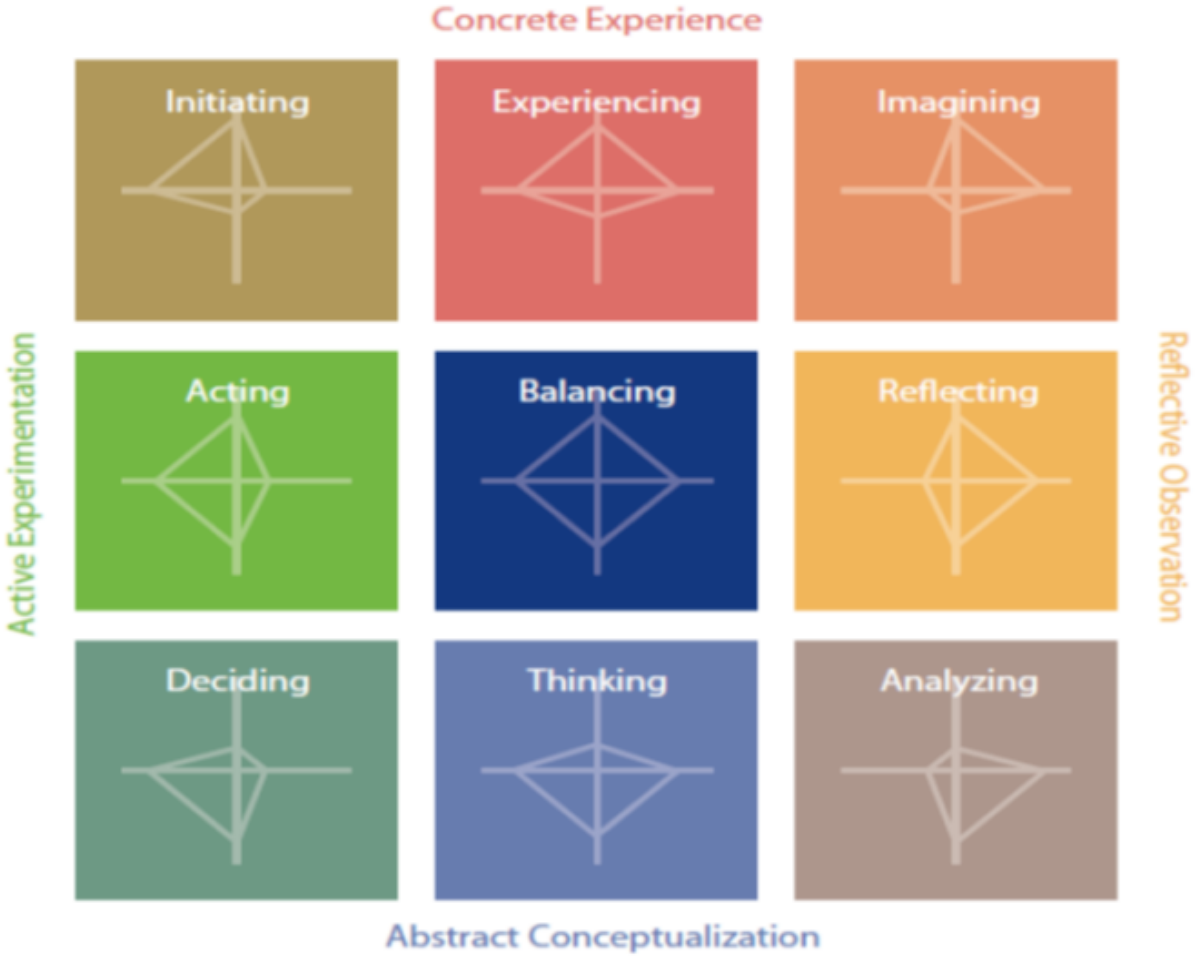
Experiential Learning Theory (ELT) and Kolb's Learning Styles Inventory are possible frameworks through which to understand how students learn. Research has shown that encouraging the learner to use the full learning cycle increases the learners' meta-cognitive skills (A. Y. Kolb & Kolb, 2009). A preference for the balancing mode (Figure 1) leads to the ability, in response to specific learning context demands, to utilize and engage all modes of the learning cycle (Peterson, DeCato, & Kolb, 2015) and to "see many different perspectives on issues and bridge differences between people with different styles" (Peterson & Kolb, 2017, p. 49), and results in a high score of learning flexibility. Learning flexibility has been related to a variety of positive traits including perception of oneself as directed, higher stages of adult ego development, less conflict and stress, more fulfilling personal relationships, and a greater overall flexibility in life (Peterson et al., 2015; Sharma & Kolb, 2010). Higher learning flexibility has been tied with higher communication and teamwork skills such as bridging differences between people, having higher resourcefulness, and more easily adapting to shifting priorities (Peterson & Kolb, 2017).

However, higher levels of education and educational specialization were found to be negatively correlated with learning flexibility, as there is a focus away from generalization to specialization (D. A. Kolb, 1981). Given that students become less flexible the higher the level of their education and educational specialization, and the benefits of flexible thinking, co-curricular organizations provide opportunities for students to maintain or develop higher levels of learning flexibility by spending time in each of the areas of the learning cycle. Involvement in co-curricular activities may combat the natural decrease in learning flexibility as students progress through college if different learning modes are used by the student in their co-curricular experiences. Given the importance of learning flexibility to multiple kinds of personal growth,

understanding how involvement in co-curriculars may enhance students' flexibility would be a substantial contribution to the scholarship on Experiential Learning Theory.

The purpose of this study is to assess the context dependency of the KLSI between the academic context and cocurricular context. This presentation will be based on a dissertation in progress.

Figure 1



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English Learners Thriving and Surviving in Rural Schools

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Keywords: English Learners, Rural, Narrative Inquiry, Midwest, Student Perspective

Abstract:
The purpose of this study is to determine whether students in rural schools who are learning English as a new language (ENL) use autonomous pathways that could be easily integrated into teacher training and the curriculum. This paper focuses on rural communities because they already struggle with limited resources and a dwindling teacher pool. Due to the current trend of agricultural product processing plants relocating from cities to rural areas, the population of English learners is quickly growing in rural areas. This brings new challenges and increased needs to the schools and teachers.

Through narrative inquiry which is the study of people's stories and grounded theory, a means of categorizing and analyzing the research, this study will examine the stories of English learners who matriculated in rural areas and gained a proficiency which allowed them to go on to college. Understanding learning and development is about understanding how people come to expand or change the ways they participate in a particular community as they appropriate its language, tools, and goals (Nasir, Rosebery, Warren & Lee, 2006). The purpose of this study is to yield a critical perspective—that of the students—instead of the traditional inquiry of the teachers, to find out how these students navigated learning English through school, home, and community activities The researcher uses situative theory to study the individual-in-a-setting. The situative view brings in an interactive component which is important to language learning because it shifts the curriculum from drills on grammar and vocabulary to understandings of how language operates. (Greeno, Collins and Resnick, 1996). This paper also seeks to gain a critical understanding of how these students negotiated the social structures in the school and community and how those structures affected their ability to succeed.

According to the Department of Education and the National Center for Educational Statistics (NCES), the number of English learners in the Midwest has grown from 200 to 400 percent (depending on the state) since 2013. Although Spanish is the predominant language spoken, other languages include Arabic, Vietnamese, Burmese, Chinese, Somali, Hmung and Karen. It is anticipated that all rural teachers will soon have at least one non-English speaker in their classroom.

There is a perception in rural communities that translators are required to communicate with ENL students before any learning occurs. The misguided notion that teachers need to be bilingual leads to one-sided collaborations with the teacher trained in ENL methods contributing only translating services and not meaningful lesson planning. (Pawan & Ortloff, 2011). It also impedes students who speak languages other than the dominant second language. Many suggestions have been made for improving the conditions of ENL students based on teacher

beliefs (Batt, 2008). Research has proven that changes need to come from the bottom up. Hearing the voices of former students is important and can lead the way to finding reforms leading to better pedagogy in rural areas for ENLs.

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Engaging with Critical Data Perspectives and Practices to Encourage Expanded Notions of Local Climate Data: Preliminary analysis when co-designing a local, online, map-based, educational resource

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Keywords: critical data science, climate change education, community knowledge, rural communities

Abstract:
In this presentation I report on my attempt to address the limitations of scientific climate data at the small scale of a community. Scientific climate models are derived from big data. As such, these models are most accurate at large scales. There are methods to “downscale” climate predictions but using them tends to magnify the uncertainty inherent in all predictive models (Shepherd & Sobel, 2020). Furthermore, data of any size are never neutral. All data collection plans are made by people that exist within unique socio-cultural contexts (Dalton & Thatcher, 2020). This lack of neutrality means that any data collected can be incomplete, biased toward, or completely leave out, particular variables. In an era when the United States lags far behind other countries in the percent of the population that sees climate change as a major threat (Tyson et al., 2023), uncertainty in scientific data works to open the door to rejection of the best – albeit imperfect – predictive climate information scientific institutions have to offer.

I propose that a solution might be to add more nuance to a local climate data set by using critical data perspectives and practices to highlight locally held climate data. Locally held data has historically been undervalued and under-accessed (Malgieri & Custers, 2018). By using the perspectives and practices of critical data science (Kitchin & Lauriault, 2014; Matuk et al., 2020; Wilkerson & Polman, 2020) this work challenges traditional notions of what climate data is, and who can hold or produce valuable climate data. By engaging with expanded notions of what climate data might be, we can begin to conceive of non-empirical climate data. Non-empirical “felt data” (Clegg et al., 2022) from participants' sensory-oriented experiences might include that summers are wetter, that tomatoes are now harder to grow than okra, or that bugs are now worse during the 4th of July community picnic than they used to be a decade ago.

I answer the research question: How, if at all, does engaging in critical data practices and with critical data perspectives invite expanded notions of the (a) production, (b) sharing, and (c) consumption of local climate data? Working with community members of a rural, coastal town in the summer of 2023, my qualitative analysis of video and audio data of a series of co-design sessions conducted in the indicate that participants struggled to understand their local knowledge as data, however, they did include local data of climate and landscape in the online,

map-based educational resource that they created. Participants were also found to be deeply pleased to create a map that reflected their community values and interests. My work begins to point to how expanded notions of local climate data might strengthen more traditional scientific climate data, however it also indicates more work must be done before such data sets might complicate, but also enrich, a community evidence base available for local decision makers.

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Which Comes First? An Initial Design of Instructional Ordering on Conceptual and Procedural Knowledge in Eighth-grade Algebra

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Key Words: Algebra, Instructional Ordering, Conceptual Knowledge, Procedural Knowledge, Mathematics Education

Abstract:
Algebra has been a preeminent predictor of success in high school mathematics. According to a study conducted by the U.S. Department of Education in 2010, 80% of high school dropouts indicated that they failed to graduate due primarily to not being capable of passing Algebra I (Schachter, 2013). It is imperative that mathematics educators critically examine why so many U.S. adolescents face algebra difficulties. For instance, Star (2005, p.404) maintains that "whether developing skills with symbols lead to conceptual understanding, or whether the presence of basic understanding should precede symbolic representation and skill practice, is one of the basic disagreements." However, no study demonstrates that a concept-to-procedure instructional sequence leads to more significant learning than a procedure-to-concept instructional sequence (Rittle-Johnson, Schneider, & Star, 2015). Aiming to fill this scholarly gap, this research project explores the puzzle of instructional ordering in algebra instruction. Exploring the relationship between conceptual and procedural knowledge spans a few decades in cognitive science and mathematics education. Scholars presented how concepts and procedures are distinct (i.e., Hiebert & Lefevre, 1986; Kieran, 2013). There has been a shift from the order of developing concepts and skills (i.e., procedures cannot be created without a solid conceptual knowledge base) (e.g., Briars & Siegler, 1984; Riley, Greeno, & Heller, 1983; Carpenter, 1986) to the recommendation that mathematical concepts and procedures evolve and strengthen each other (e.g., Baroody & Ginsburg, 1986; Hiebert & Wearne, 1996). Moreover, Kieren (2013) argues that concepts and procedures are interwoven, as proposed in National Research Council's Adding It Up. Other researchers echo that the relationship between conceptual and procedural knowledge is "bidirectional", even though teachers ultimately make pedagogical decisions in the classrooms (Rittle-Johnson, Schneider, & Star, 2015, p.588). Scholars have argued that we should formulate a comprehensive and organized knowledge system in which procedural and conceptual knowledge are intertwined to achieve a deep understanding, as Baroody, Feil, and Johnson's reconceptualization proposes. Building from these recent studies, I use their definitions of conceptual and procedural knowledge in this research.

To examine the crucial relationship of conceptual and procedural knowledge, I ask: How does the instructional ordering—concept-to-procedure or procedure-to-concept—affect the effectiveness of students' learning in eighth-grade algebra? To extensively examine this

question, I look into three intertwined sub-questions: 1) What is the relationship between conceptual and procedural knowledge in mathematics education? 2) How do the learning outcomes based on algebra lessons impact teachers' pedagogical decisions on the order of instructions? 3) What instructional strategies strengthen students' learning of conceptual and procedural knowledge? I utilize mixed methods – participatory action research (qualitative method) and pretest-intervention-posttest (quantitative method) – to collect and analyze data from eighth-grade algebra students.

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A Mixed-Method Examination of a Sports Technology Makerspace

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Keywords: sports, learning analytics, topic modeling

Abstract:
We examined a sport-focused Computer Science makerspace course during the 2020 and 2022 academic years, where the majority of enrollment was student-athletes (SAs), to understand how multiple methods surface learning insights in the space and to generate ideas for better fitting the course to the needs of the students. We focus on SAs and sports technology because of the rapidly changing status of SAs (Kunkel et al., 2021) and growing concerns about the invasiveness of contemporary sports technologies (Karkazis & Fishman, 2017). This work seeks to educate SAs so they can have more of a say in developing and implementing these technologies.

We focus on two questions. The first investigates how SAs gain familiarity with CS concepts through this course. The course aims to grow SA's confidence and agency by introducing concepts like data analytics and machine learning that underlie sports technologies in their field. The second investigates how SAs use technology skills gained through the course to solve personally relevant problems. Answering this question involves a computationally generated concept map of student interests and how they diversify over time. This mapping is one tool we have to visualize how students view the problem space in the field and to make informed decisions on how to change the course.

We gave surveys at the beginning and end of each term and collected final project reports as data. We answered question one by calculating average changes across subject areas and verified significance with Wilcoxon signed-rank tests. For question two, we employed topic modeling (Sherin, 2013; Martin & Sherin, 2013; Sherin et al., 2018). The topic model used on the final project reports was Latent Dirichlet Allocation (Hoffman et al., 2010), which enabled us to classify and categorize students' interests surfaced from the text.

We found statistically significant familiarity increases with nearly all concepts. The forthcoming qualitative analysis of the survey data will deepen our insight to capture the experiences students report as part of building confidence and agency. Topic modeling surfaced distinct groups of project ideas and pinpointed students' foci on computer vision for motion/activity tracking, virtual learning experiences, and using sports data analytics to teach other domains. By using a combination of traditional and novel computational methods to understand both the concept areas where student-athletes are gaining familiarity through our design and the interest areas salient to the student-athletes, we are in a strong position to respond to techno-athletic

needs, such that they are better informed and capable of navigating the technologies in the space, and personal needs, such that they can use their skills to solve problems that are meaningful to them.

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Session D: Workshops, Forums, and Talks

Exploring the Meaning of Thriving in Academic Spaces: An Experimental Collaborative Autoethnography Forum

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Keywords: autoethnography, postsecondary education, radical belonging

Abstract:
I am proposing a forum where participants collectively discuss, participate in, and examine autoethnography as a methodology for exploring what it means to thrive in learning spaces. I define autoethnography as a method that uses a forum participant's personal experiences as data for interrogating the concept of thriving in academia (Chang, 2013). I propose experimenting with a collaborative approach to explore the intertwining between individual experience and systemic practices that influence thriving (Lapadat, 2017). Collectively, we will explore the following research question during the forum: Drawing from our individual experiences, strengths, goals, and needs, how do we envision a learning sciences community that supports thriving in academic spaces?

The inspiration for this forum draws from the conceptual framework of radical belonging, a guiding framework for envisioning antiracist learning communities as an intertwining of social, academic, and democratic belonging (Louie et al., 2022). I draw parallels to the LSGSC Call for Submissions, which calls for an interrogation on how thriving has physical, emotional, moral, social, and academic components. The forum intends to ask participants to both foreground their individual academic learning experiences, and to collaborate to imagine a vision for collective thriving in the learning sciences community.

Collaboratively exploring autoethnography as methodology could start insightful conversation about the implications, challenges, and benefits that one may encounter when incorporating less traditional or less defined methodologies in our research projects. Some topics that can be touched upon include research ethics (navigating IRB's definition of research), validity (navigating definitions of rigor within academic communities) and finding one's own voice or research agenda (Forber-Pratt, 2015).

A proposed agenda for the 45-minute forum is as follows:

- (5 min) Introductions
- (10 min) What is autoethnography?
  - Whole group discussion on "non-traditional" methodologies for examining thriving in academic spaces, and their benefits and challenges

o Whole group discussion on autoethnography, probing for group's prior experiences, thoughts for the experimental activity, and open questions.

· (5 min) Setting community norms

o Norms for respecting each other's submissions, sharing what you are comfortable with, etc.

· (5 min) Generating autoethnographic data

o Participants will respond to the research question in whatever format they prefer.

o Facilitator will have materials prepared to support multiple creative formats, including paper/drawing utensils and electronic gallery submissions.

· (15 min) Collaborative data analysis

o Gallery walk of participants' submissions.

o Depending on group size, break into small groups.

· (5 min) Final remarks and discussion

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Attentive Allies: Landscape Architects as Facilitators to Promote Early Childhood Nature-based Educational Programs

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Keywords: Participatory Design, Nature-Based Education, Landscape Architecture, Forest Kindergarten, Pedagogical Benefits

Abstract:
By implementing nature-based activities, children can obtain various benefits through exposure to nature at multiple scales, such as developing their cognition and lifelong healthy habits and behaviors, promoting gross and fine motor skills, and improving their self-esteem, mood, and self-efficacy (Dadvand et al., 2015; Fjørtoft, 2001; Bang et al., 2018). Former studies found a positive relationship between childhood experiences with nature and adults' environmental beliefs (i.e., eco-centric or anthropocentric), environmental attitudes, the selection of environmental-related careers, and pro-environmental action (Ewert, Place and Sibthorp, 2005; Wells and Lekies, 2006; Rosa, Profice and Collado, 2018), etc. In this respect, early childhood interactions with nature cultivate a close relationship between children and their environment and thus can be regarded as a foundation for environmental education.

Despite these positive outcomes, various barriers to effective outdoor learning have been identified, such as local policy support, accessibility, safety concerns, culture concerns, and more specifically, teachers' attitude, experiences, and abilities (van Dijk-Wesselius et al., 2020; Oberle et al., 2021; Ernst, 2014). Accessibility and safety concerns are the most frequently studied environmental barrier, among which the research focus is usually on how to train more skilled and experienced teachers and gain support from the government or policy (Ernst, 2014; Coe, 2016; Brussoni et al., 2017). Very few studies have sought improvement through design approaches. It is common that landscape architects are not considered to be the facilitators of nature-based educational programs. However, landscape architects have the potential to benefit outdoor learning programs, not only by offering more appropriate spaces but also by improving the programs by emphasizing collaboration with different stakeholders in the design process and even making the design part of the programs. This study aims to show that involving landscape architects as facilitators in the nature-based educational programs can benefit the programs in many ways and the effect can be long-lasting.

The study is based on the 16 years collaboration between Miyano-oka, a forest kindergarten, and a team of landscape architects in Japan for conducting nature-based educational programs to preschoolers. We present the examples of programs in Miyano-oka and the strategies applied to develop these programs. We found that landscape architects can use various design

strategies to improve the existing programs and help in developing new programs. Among those strategies, participatory design can not only effectively help to overcome the barriers of outdoor learning, but also create long-lasting pedagogical benefits through forming participatory way of thinking and working in the education facility, thus proved the sustainable effect of participatory design.

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Is laser tag a children's museum?: A genuine question

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Keywords: museums, children's museums, play, informal education

Abstract:
On face value, children's museums and laser tag are different. One is educational. One is an entertainment attraction. One is exclusively designed for children. One is, presumably, for all ages. But boil it down and they're both playful, open-ended, interactive, active, and social spaces. In a community with both facilities, a family might alternate between the two or visit one then the other as their child grows. Both are excellent additions to a thriving community, feeding into the array of joyful moments that connect us to one another.

The comparison is compelling because children's museums resist intuitive coherence within the broader category of "museums." With roots in Dewey's progressivism and sturdy branches that grew under the lights of constructivism (Hein, 2017), children's museums offer experiences that are deemed "developmentally appropriate" for children (Herz, 2017). In recent decades, they have used research in cognitive development and play to call attention to how their offerings support children's social, emotional, cognitive, and physical development (White, 2013; Luke et al., 2021), thus facilitating learning.

Meanwhile, laser tag does not have the same responsibilities to these outcomes. But when it comes to implicit pedagogy, visitor experience, and the use cases for families, the affordances of a children's museum and a round of laser tag are somewhat similar. The same could be said of a number of contexts where children and families go to connect, play, learn, and grow: water parks, libraries, shopping malls, art museums and more all offer related opportunities and could be construed as learning environments. Among these myriad options, it is difficult to distill and put boundaries around the specialized environment of a children's museum, especially as museums of all types navigate educational reforms and social changes driven by neoliberal policies (Ash, 2021) and reckon with their institutional histories of racism, classism, ableism, and more (Raicovich, 2021).

The comparison of laser tag and children's museums was offered to me rhetorically by a faculty member who was reflecting on broader discourses of education, learning, and children's museums. The prompt was followed by the suggestion that answering the question, "what is a children's museum?" would be essential to advancing understanding of learning in these spaces. The proposed forum is a step towards taking this question and comparison seriously. In this forum, participants will engage the question in concrete terms: what are the theoretical, epistemological, economic, physical, and emotional similarities and differences between children's museums and the many alternatives that offer phenomenologically similar experiences? Following a brief presentation of typical children's museum exhibits and programs,

plus a brief review of existing research, participants will coconstruct a working framework for different types of playful spaces. I will solicit input on perspectives and literature from the learning sciences and other disciplines to consider in building the model. Throughout, participants will engage in dialogue with the presenter to situate and define children's museums in a way that honors their stated roots and unique contributions while realistically and holistically positioning their impact in today's educational landscape.

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Getting Started with VR in the Classroom

Cheryl Ferguson, David Lippe and Kai Clemons

Abstract:
Join the University of Iowa team in an exciting exploration of Virtual Reality and its possibilities for classroom use! In this workshop, we will introduce you to the Meta Oculus Quest 2 headsets, allowing you to immerse yourself in the virtual world. The workshop will follow a structured format, beginning with the "First Steps Program," designed to familiarize new users with the functionalities of the headsets. Afterward, you will have the opportunity to delve into a variety of titles that have been utilized by the Global Education team at the Staney Center for Peace and Security when working with Junior High and High School-aged students.

Some of the potential titles you can explore include:
1. "Traveling While Black": This immersive experience provides insights into the struggles and experiences of African Americans during the Jim Crow era, offering a unique perspective on history.
2. "On the Morning You Wake to the End of the World": Step into a thought-provoking virtual environment that explores the impacts of climate change, fostering a deep understanding of its consequences and the urgency for action.
3. "Anne Frank House Virtual Visit": Journey into the secret annex where Anne Frank and her family hid during World War II. This educational experience offers a glimpse into their lives, fostering empathy and understanding of the Holocaust.

By participating in this workshop, you will gain valuable exposure to Virtual Reality and its potential as an educational tool. We invite you to join us on this exciting journey of exploration and discovery at the University of Iowa.

After the workshop participants will be asked to complete a survey on how effective the workshop. Discussion on how to build a data collection tool that measures pre and post experience is requested.

Diffractive Seeing: Exploring approaches to nonhuman agency for interaction analysis

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Keywords: posthumanist theory, nonhuman agency, interaction analysis

Abstract:
All humans exist in and move through a physical, material world. While researchers in education, psychology, and the Learning Sciences have addressed the material aspects of human cognition through empirical work in embodied cognition (Alibali & Nathan, 2014) and distributed/extended cognition (Hutchins, 1995; Clark, 2008), emerging areas of scholarship focuses on how materials or nonhumans - particularly nonliving ones - shaping learning moments, which may be referred to as nonhuman agency. This workshop introduces four independent theoretical approaches to nonhuman agency, emphasizing the similarities and differences between theories and their resulting empirical lineage, and then invite participants to "try-on" the different theoretical lenses with two video clips (one from a makerspace and one from a nature-based preschool program; AV projection equipment required). The goal of this workshop is both to introduce participants to the concept of nonhuman agency and make evident the opportunities and limitations of the current theoretical lenses integration with interaction analysis methods (Jordan & Henderson, 1995).

The four theoretical approaches to nonhuman agency highlighted in this session are: 1) Schön's (1992) conversation with materials, 2) Karen Barad's (2003; 2007) agential realism, 3) Jane Bennett's (2010) vital materialism, and 4) nature-culture relations, headed by Megan Bang and colleagues (Bang & Marin, 2015; Bang et al., 2015). First, Schön's conversation with materials aimed to articulate the phenomenological experience of design, specifically the iterative process of internal ideation and external creation with materials. The metaphor of a conversation prompts researchers to identify when human and nonhumans are attending to and responding to one another. However, this perspective can obscure ever-present nonhuman contributions. Building from quantum physics and feminist science studies (Taguchi, 2017), Barad's agential realism emphasizes the constant enmeshing of human and nonhuman actors, using the metaphor of a web to describe the interlocking and entangled agencies of many bodies in becoming. For example, the act of climbing on a playground is requires the co-presence and physical engagement of a person, the rope net, the playground structure, and physical ground, meaning climbing is a person-rope-structure-ground assemblage (Hultman & Taguchi, 2010).

Jane Bennett's vital materialism similarly focused on human-nonhuman assemblages but positions analytical focus on agency of nonhumans as blocking human will instead of enabling it. Further, Bennett's original thesis included a call to understand the political implications of noticing how affect is created between humans and nonhumans; empirical research building on Bennett's work has included more attention to ethical and political outcomes than the prior two

traditions (e.g. Weldemariam, 2020; Nxumalo & Pacini-Ketchabaw, 2017). Finally, Bang and colleagues' relatively recent work focuses on Indigenous revitalization, including support for Indigenous ways of knowing regarding human-nature and human-nonhuman boundaries or the nature-culture relations. Analysis is focused on how humans socially construct local and ultimately cultural understandings of nonhuman agency and human-nonhuman kinship, recognizing how these then frame understandings of responsibility and reciprocity. While a recent synthesis addressed reasons for the lack of joint engagement across these theories (Rosiek et al., 2020), this session will focus on the use of these theories for interaction analysis moving forward.

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Workshopping Ethnographic Methods and Participatory Activities for Identity Research

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Keywords: ethnography, participatory methods, funds of identity, identity

Abstract
This research methods workshop will support participants in (1) scaffolding ethnographic research methods and (2) piloting participatory activities. This work is inspired by the first author's position as a graduate student, researcher, and practitioner and will be framed around researching identity within an informal Science, Technology, Engineering, and Math (STEM) program for middle and high school students. Participants with any level of interest or familiarity with ethnographic research, participatory methods, and funds of identity are welcome to participate in the workshop. All materials will be provided, but participants are encouraged to bring their own electronic device, a notebook, and pen or pencil.

Funds of identity, the theoretical framework for this workshop, describes the process of identity development as a person acquires experiences, materials, and knowledge within local contexts and broader structures that inform a person's sense of self.[4,5,7,10,11] Ethnography, the primary method to study funds of identity,[4,7] typically takes a holistic approach, focuses on people and cultures, occurs in naturalistic contexts, and involves multiple forms of data collection.[6] Within funds of identity research, arts-based methods[1] such as "identity artifacts" (e.g., self-portraits[10]) are commonly collected and complemented by interviews.[5,7] Some benefits of this approach include the ability to center participants' experiences[5] and triangulate data sources.[11]

To start the 45-minute workshop, the first author will introduce the context, theoretical framework, and goals. During the primary part of the workshop, participants will engage in a funds of identity activity in groups of three people. The group will choose one of six abbreviated funds of identity activities, all of which include arts-based and interview components – self portrait,[6,11] digital avatar,[9] visual mapping,[3] body mapping,[8] identity box,[2] and photovoice project.[11] One person in the group will take on the role of the ethnographic researcher, who will read the instructions, facilitate the activity, take field notes, and conduct the interview. The two other group members will participate in the activity and interview as students. During the final portion of the workshop, all participants will debrief as a large group. Possible topics for the large group discussion include sharing reflections on the workshop activity (from the perspective of researcher and/or participant), integrating their experiences and best practices using ethnographic methods, exploring potential ways they would analyze the data and measure long-term impacts, and suggesting new iterations of the participatory activities. The final two example topics for discussion have been suggested by a recent review of funds of identity literature as important directions for future work.[7]

Ideally, this workshop will help participants clarify what is meant by ethnographic research, support the scaffolding of ethnographic research methods and processes, and provide an example of pilot activities with a focus on identity that can be adapted to other research contexts and constructs. Personally, I hope this will support my own development through learning about ethnographic methods and practicing participatory activities that may be used in my own future research about identity.

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Scaffolding Students' Questions to Support Thriving in Phenomena-Based Classrooms

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Keywords: science, student questions, scaffolding, phenomena, problem-based learning

Abstract:
Inquiry inherently begins with a question. In this spirit, the Framework for K-12 Science Education and Next Generation Science Standards lists "Asking Questions and Defining Problems" as one of eight science and engineering practices (National Research Council, 2012; NGSS Lead States, 2013). Questions that drive instruction are vital because they bring many students' ideas, values, and interests to the table, thus promoting equity (Bang et al., 2017). Therefore, student questions play a key role in a storyline unit in which students investigate and explain answers to their own questions (Reiser et al., 2021). This work examines the role that crosscutting concepts (CCCs, listed in Table 1) can play in students' question development.

1. Patterns 2. Cause and Effect 3. Scale, Proportion, and Quantity 4. Systems and System Models	5. Energy and Matter 6. Structure and Function 7. Stability and Change

Table 1. Crosscutting concepts (National Research Council, 20120

Despite questions' importance, teachers report discomfort with engaging students directly in questioning and students ask scientific questions in classrooms only infrequently in the secondary space (Banilower et al., 2018). Furthermore, students' questions may fall outside the bounds of the content the teacher wishes to cover, presenting a tension between learning goals and promoting students' epistemic agency (Miller et al., 2018; Stroupe et al., 2018). Thus a framework is needed for helping teachers make use of students' questions.

The Anchoring Phenomenon Routine (Reiser et al., 2021) can help students generate questions that align with instructional goals, with intentional individual and whole-class activities leading toward the development of a class Driving Question Board. Language of the CCCs can help focus these questions. CCCs "help provide students with an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world" (National Research Council, 2012). In particular, questions that use language of multiple CCCs seem particularly supportive of students' future investigations (Voss et al., 2023).

Leveraging the idea of conceptual metaphors, Rivet et al. (2016) proposed that CCCs can serve as rules of the game, lenses, bridges, or tools. The theoretical framework (Fig. 1) shows the relationship between these different metaphors and portions of the Anchoring Phenomenon Routine as students initially engage with a phenomenon and identify where they have questions.

When students first engage with a phenomenon, they may use prior experiences of CCCs as rules of the game. Although they do not know what is happening, they recognize that one or more of these CCCs can be used to move toward an initial explanation. They can then use the CCCs as a lens throughout their initial sensemaking. At some point in the lesson, students also brainstorm related phenomena, at which point the CCCs can help bridge between their own experiences and the anchoring phenomenon. Finally, CCCs can serve as a tool in formulating productive questions. Students that ask productive questions are more likely to have their own questions answered, increasing their feelings of accomplishment at unit end and subsequent thriving.

The session will conclude with initial thoughts on how this framework might be used to study how students in a college physics course for non-scientists use CCCs to generate questions. Such work will target particular CCCs as students engage with the anchoring phenomenon. Students' questions and rationales will be examined for language mirroring that of the CCCs, and students' later explanations will be examined for continued use of CCCs. The author will also reflect on applicability across disciplines.

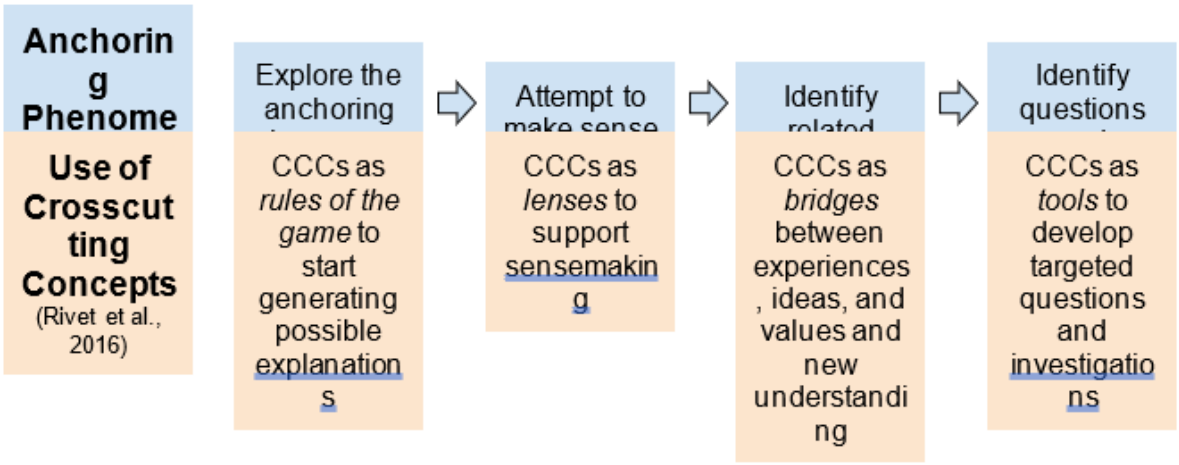

Figure 1. Theoretical framework for use of crosscutting concepts to generate productive questions about an anchoring phenomenon.

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College Students' Experiences with Academic Help-Seeking in a Cultural Context

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Keywords: help-seeking, culture, phenomenology

Abstract:
Academic help-seeking, which involves requesting support for an academic problem, has been consistently linked to achievement in college settings (Fong et al., 2023). Existing research often frames academic help-seeking as a self-regulated learning strategy; i.e., a self-initiated process that emerges from one's motivation to take responsibility for their learning (Newman, 2002). However, such conceptualizations of help-seeking often overlook how one's willingness to seek help may be shaped by their cultural context, or the shared assumptions, beliefs, and values of groups that are transmitted through social interaction (Triandis, 1995). It is critical that researchers situate students' learning behaviors within culture because all "mental life is lived with others, is shaped to be communicated, and unfolds with the aid of cultural codes, traditions, and the like" (Bruner, 1996, p. xi).

In this pilot study, I use an interpretative phenomenological approach to qualitative analysis (Smith et al., 2009) to explore how a sample of White-identifying college students experience academic help-seeking in a cultural context. Although it is critical that researchers examine how help-seeking experiences differ across diverse cultures, I focus on the experiences of White college students for multiple reasons. First, existing scholarship largely assumes culture is inconsequential for White students, which prevents research in our field from being fully inclusive (Roberts & Mortenson, 2023). Second, by shedding light on the cultural experiences of White students, researchers can challenge the assumption that findings obtained from predominantly White samples are generalizable to all populations (Roberts & Mortenson, 2023). Third, it is recommended that interpretative phenomenological research studies generally obtain homogenous samples (Smith et al., 2009), so I focus on one racial/ethnic group for the present study. Lastly, a self-awareness of one's own cultural beliefs and biases opens the door for meaningful partnerships with individuals from diverse cultural backgrounds (Foronda et al., 2016); thus, it is critical that all students, including White students, examine how their culture influences their learning. My research question is: Among White college students, how do cultural values influence one's willingness to seek academic help?

During the summer of 2023, I conducted individual, semi-structured interviews with five White-identifying college students at a public university in the midwestern United States. During interviews, participants shared about their background, cultural values, experiences in college, and experiences with academic help-seeking. Using Hycner's (1985) guidelines for the phenomenological analysis of interview data, I identified central themes related to my research

question. Findings suggest that academic help-seeking motivation can be influenced by cultural norms surrounding organizational membership, family upbringing, income status, and college life; as well as intertwined cultural influences surrounding multiple social identities.

I expect this work will highlight the importance of conceptualizing academic help-seeking as a socially negotiated rather than purely individual process (Nelson-Le Gall & Resnick, 1998), as well as pave the way for future work on the intersection of helping behaviors and culture. Ultimately, by placing academic help-seeking in a cultural context, educators can allow their students to thrive by creating supportive environments that are inclusive of diverse cultural backgrounds.

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Play as a Mechanism for Thriving in Elementary Mathematics Classrooms

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Keywords: mathematics education, play, elementary education, design
Abstract:
When considering the entirety of a student's trajectory throughout K-12 mathematics and beyond, it can be easy to overlook the significance of their earliest exposures to the discipline. However, even elementary-aged students begin to construct mathematical identities and dispositions about their relative smartness (Featherstone et al., 2011). Knowing this, it is perhaps equally, if not more important, to consider practices that support students' personal and emotional connections to the discipline, in addition to pedagogical strategies for mathematical learning. One such area that has been understudied in formal classroom spaces is play. Characterized as a virtue of human flourishing, play is an activity that expert mathematicians regularly engage with themselves, yet is often dichotomized from typical classroom practices and norms for participation (Su, 2020). As a result, students often see little connection to a discipline that has traditionally been defined in more rigid, narrow ways.

In this conceptual piece, I integrate mathematics education with the transformative possibilities of play. Specifically, I demonstrate the overlap between mathematics education and play through three bodies of literature. Starting broadly, I view discourses of mathematical competence as systems of power (Theme 1) (Cobb & Russell, 2015; Shah & Leonardo, 2016) that shape the everyday practices and norms of collaboration in classrooms (Theme 2) (Boaler & Staples; 2008; Esmonde, 2009). Consequently, these participation structures contribute to individuals' conceptions of whether or not mathematics is connected to who they are as people (Theme 3) (Jasien & Gresalfi, 2021; Nasir & Hand, 2008).

Throughout each category, I address the current state of mathematics education and identify ways in which play can extend those considerations from a theoretical perspective. In analyzing these themes through the lens of play, I argue for three possibilities of play for supporting student thriving in mathematics classrooms: (1) play as a disruptor of hegemonic discourses of mathematical capability, (2) play as a design consideration for mathematical learning, and (3) play as a connector between the self and mathematical activity. In doing so, I also argue for further empirical research into the role of play in shaping formal classroom experiences and supporting these conceptual conjectures.

After situating the literature, I end by introducing a conceptual framework for the transformative possibilities of play in mathematics education. Drawing on situative theory and critical childhood studies, this conceptual framework serves as both a lens for interrogating the current state of mathematics education, as well as reimagining and redesigning mathematics learning

environments through play-based disruption. Most notably, this framework views the centering of children's agendas as the ultimate demonstration of thriving in mathematics classrooms (James, 2011; Paley, 2007; Sutterlüty & Tisdall, 2019). While traditionally, adult-centric, hegemonic agendas have dictated mathematics teaching and learning practices (Dumas & Nelson, 2016; Yoon & Templeton, 2019), which in turns limits children's abilities to exercise freedom, disruption through playful mathematics may in fact expand adult's capacities to learn from and follow their children's creative leads and, consequently, shape learning environments accordingly.

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Surfacing Teachers' Dispositions for Student-Directed Critical Inquiry – Design-Based Research for a Professional Development Workshop

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Keywords: Design-based research, teacher professional development, contentious issues, equity, social justice, student-directed inquiry, relevant learning, social studies, English language arts, young adult literature

Abstract
Learners thrive in learning environments where the (hi)stories told reflect their own and their families' lived experiences—and where the work they are asked to do feels relevant. To make social studies such a place, I propose using young adult literature (YAL) as entry point into student-directed inquiries in middle- and high school. Compelling, fictionalized stories—for example, The Hate U Give (Thomas, 2017) or All American Boys (Reynolds&Kiely, 2015)—offer both mirrors and windows (Sims Bishop, 1990) into students' own and others' real experiences. From there, students can peer through sliding glass doors (Sims Bishop, 1990) to consider questions about how we should live together (Hess&McAvoy, 2015) via rigorous inquiry into contentious issues facing real people.

The learning sciences and teacher education combine in a design-based research (DBR) study (Easterday et al., 2014; McKenney&Reeves, 2018) for designing professional development for experienced educators across grades 6-12: participants experience a model (McGrew et al., 2018) of teaching inquiry with YAL and adapt their own existing units for student-driven inquiry along similar pedagogical lines. With each other's support in this approximation of practice (Kelley-Petersen et al., 2018) some barriers to using YAL for student-driven inquiry in social studies should be reduced. This workshop is mainly geared towards social studies educators across all disciplines, but the ideal scenario would include English Language Arts (ELA) teachers to best benefit from synergies for critical literacy: ELA educators bring the knowledge of a range of literature and critical approaches like reader-response theory and identity formation (Beach et al., 2015; Haertling Thein, 2023), and social studies teachers bring the social/historical origins and data to using a critical lens for thinking about how we should live together.

Overall, I am asking how teachers' dispositions regarding equity and social justice show in the inquiries they will let their students pursue. Through the workshop, educators' dispositions regarding teaching for equity and social justice—for example, do they exhibit color-blind (Bonilla-Silva, 2022) notions rather than antiracist tenets (King&Chandler, 2016; Pollock, 2008)?—as well as the extent to which they view their students as capable of deep thought and critical inquiry will be surfaced. Aside from very real constraints stemming from the educational

infrastructure (Penuel, 2019), teacher-inherent barriers to teaching for critical inquiry can be exposed, examined, and tackled in improved workshop iterations and future designs for preservice teacher preparation.

Although most DBR studies are conceived for mixed methods of data collection and analysis, the projected small N of this study and the focus on individual dispositions require qualitative methods (Glaser&Strauss, 1967; Glesne, 2016; Merriam&Tisdell, 2016): a pre-workshop survey about teaching contentious issues (no Likert-style items), video recorded interactions and any artifacts for reflection and teaching created in the workshop, plus a post-workshop interview. Such rich data require critical discourse and interaction analysis (Fairclough et al., 2011; Gee, 2014; Hall&Stevens, 2016; Jordan&Henderson, 1995) to identify educators' dispositions for teaching contentious issues and about their students' capabilities. A first iteration will provide critical improvements for the second, possibly redesigned one.

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Representation in science: How teachers perceive and use representations in elementary classrooms?

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Keywords: Science education, Representation, Teacher Education, Professional Development

Abstract:

Representations play an important role in scientific practice and, thus, science instruction (Ainsworth, 1999; Coleman et al., 2011). However, there is still a gap in what we know about elementary school teachers' understanding, perception, and application of representations within science instruction (Coleman et al., 2011). RepTaL is a multi-year project that includes professional development activities designed to help teachers think about ways to apply various representations in their science classrooms. In our paper, we aim to explore the following research question: How do teachers change their perception of representations, and how does the change influence their teaching practice in science classrooms?

Design: The Representations: Teachers as Learners (RepTaL) was designed from a sociocultural perspective of learning (Danish et al., 2020). Thus, there were several assumptions: 1) representations gain their meaning from the contexts in which they are used, and 2) the sociocultural context of a teacher's classroom can impact how teachers and students interpret the features and usefulness of the representations available. Our design-based research approach involved multiple years of iterative PD activities, using teachers' current understandings of representations as a foundation for cycles of collaborative planning, implementation, and reflection on science curricula and multiple forms of representations. Teachers and facilitators worked together in regular coaching sessions to address the challenges and needs as teachers expanded their knowledge of scientific representations.

Participants: The participants in this study are eight elementary teachers from Midwest U.S. (n =8). Two teachers joined in 2018 and participated for four years, three teachers who joined in 2019 and participated for three years, and three teachers who joined in this year and participated for one year. The current analysis focuses on the fourth year of the project.

Data Analysis: We applied two tracks of analysis, 1) For pre and post-interview, we applied thematic analysis with the RepTaL coding scheme, which explores multiple dimensions of understanding representations in science instruction. 2) For teachers' classroom teaching, we applied interaction analysis, with a focus on how the representation is used, and who dominates the use of representations.

Results: Our project helped teachers change their perceptions of how and why to use representations and provided meaningful collaborative experiences with other teachers. In the pre-interview, teachers said several PD sessions opened their view of representation. They would have students explore and build the representation instead of showing it to them. We

found that teachers used physical representation, diagrams, and videos in the classroom. Teachers had never considered using these representations in early-grade science classrooms. We also found that the teacher designed activities for students to lead and revise their own representation in class, making them “owners” of the representation and more engaged.

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Towards Critical Data Literacy in Data-Infused, Project-based Interdisciplinary Learning about Japanese American Internment

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Keyword: critical data literacy, ethics, interdisciplinary approach

Abstract
Curriculum and pedagogical practices have power and consequences; how we design and engage with the curriculum engenders possibilities and momentum to reproduce or transform trajectories of power. This study explores how an 8th grade Humanities teacher and her students learned, played, and expanded each other's understanding, identification, and agency with both data and social justice issues. We organize the literature spanning critical data literacy and ethics in STEM curriculum to offer conversations where we dream and strategize for data acumen and for critical, creative, and collective becoming.

Data literacy entails abilities to engage in inquiry processes including interpreting, evaluating, and critiquing data (Bargagliotti et al., 2022; Gal, 2002), and communicating data-driven arguments in daily-life decision making (Tygel & Kirsch, 2016) and broader socio-political contexts (D'Ignazio & Bhargava, 2015). Critical data literacy offers frameworks that recognize and challenge the presence of power in how data is generated, deployed, and eternalized (Louie, 2022) and emphasizes learners' multiple perspectives, agencies, and practices to "read" and "write" their worlds through data (Bhargava et al., 2015; Philip et al., 2013).

Vakil (2018) called for "radical possibilities of democratizing and humanizing technologies that can contribute to a vision for a more peaceful and harmonious world." (p.29). Towards this end, Vakil cautioned that the recent equity, diversity, and inclusion scholarship in Computer science education has largely focused on individualistic aspects of ethics and overlooked important sociopolitical contexts that predetermined the discipline's goals and values. Notably, data science is applicable to Computer science and lots of other STEM and non-STEM subjects. Hence, we plan to delve into the literature on data ethics, including ability to address bias in data use and the interconnectedness of ethical data use and data literacy.

Despite the complex history, lived experiences, and the diversity of Asian American communities, Asian American issues are rarely included in current k-20 curriculum; even when they are, Asian Americans are portrayed in racist fashion (An, 2022; Rodríguez & Kim, 2018). The distortion of Asian American history is entangled with national mindsets regarding immigrants that "ranges from ambivalent to increasingly hostile" (Goodwin, 2010, p. 3104) and the legacy of colonization, racism, and multiple marginalization (Kim, 1999) that regards Asian American as "forever foreigners" and "unassimilable."

While part of our research design has been established in the existing collaboration, including reading Farewell to Manzanar [1](1973) and the student body of partnered schools, we were struck by how our students, who are predominantly African American, drawing from their own awareness of and experiences with injustice, made sense of and pushed back against historical and present rhetoric behind the anti-Asian movement. We will examine how learning with a humanistic, thoughtful, and critical lens—with the help of data—our students wonder, question, and articulate the causes of injustice. We are confident their perspectives and experiences will further enrich our views and aspirations for data literacy.

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[1] a memoir by Jeanne Wakatsuki Houston and James D. Houston, which describes how Jeanne and her family experienced the internment of Japanese American during World War II.

Individual and collective math learning in a civic data science project

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Keywords: data science, civics, out-of-school learning, math education

Abstract:
Schools teach students the subject of math, hoping students will carry it into their everyday lives. As learning scientists have shown, we need to understand the actual and possible relations between school math and the many kinds of math that are done outside of school (Lave, 1988; Nasir, 2005; Stevens & Hall, 1998; Bevan et al., 2013). Recent studies have shown that math outside of school can have negative social consequences and hidden bias (O'Neil, 2017; Noble, 2018). Also needed are studies that go beyond critique, to document ways of doing math in the world for civic and social good (Esmonde, Curnow & Riviere, 2014; Taylor & Hall, 2013).

In this talk, we draw from ongoing ethnographic fieldwork with a team of data scientists who made and revised a synthetic data metric with the goal of having a positive social impact in their city. The first author followed the team for ten months as a participant observer (Spradley, 2016), collecting data on the team's key project activities, which included video-recordings of their project meetings and files from their online software repository and communication platforms (Pink et al., 2015). We used the cognitive ethnography approach (Hutchins, 1995) to follow across time and space how the team members and tools were coordinated together to solve a problem. The problem in this case was called "phantom buses", which is when a scheduled bus does not show up. The team shows us one particular way that math is used for civic good — the team "drew together" (Latour, 1986) diverse streams of publicly available data to construct a single number metric that represented the extent of the ghost buses problem, to prepare for an anticipated contestation with the city to urge the city to fix the problem (Nguyen & Stevens, 2023).

In this talk, using excerpts from the case material, we claim that the team's project was a context for collective and individual math learning. As a collective (Hutchins, 1995; Stevens & Hall, 1998; Curnow & Jurow, 2021), the phantom buses team learned new ways to use data for civic good which they 'taught' to others outside the team. And as individuals, each team member took opportunities to learn to use math-heavy tools beyond those that they used in their day jobs as professional data scientists. The Phantom Buses project team members stand in stark contrast to students in school, who are often trying to merely survive negative experiences with math class (Lave, 1992; Boaler, 2000; Nardi & Steward, 2003). The case material offers, we argue, clues for redesigning math learning environments for civic and social good.

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