Opening Access and Diversifying Science Through Digital Storytelling and Near Peer Mentoring

Abstract

Science will truly be "open" when it attracts and retains more students from diverse communities globally. In the United States, there is a well-documented underrepresentation of students from racial and ethnic minority backgrounds in science, technology, engineering, and math (STEM-related) pathways, despite evidence suggesting that these students express interest in pursuing science majors. Near peer mentoring has emerged as an effective alternative to traditional forms of mentoring. In contrast to traditional mentors, near peers are just a few years older than mentees and thereby enjoy a shared language and greater degree of closeness. This research paper reports on a National Science Foundation (NSF) funded three-year study that is using digital storytelling (DST) to document with video the pairing of career-curious high school students (protégés) with STEM-identifying college students (near peers), who are all from underrepresented groups. This research presentation provides initial qualitative findings, and will feature video highlights from the study.

Keywords: STEM diversity, digital storytelling, near-peer mentoring, identity-based motivation

Opening Access and Diversifying Science Through Digital Storytelling and Near Peer Mentoring

Science will truly be "open" when it attracts and retains more students from diverse communities globally. In the United States, there is a well-documented underrepresentation of students from racial and ethnic minority backgrounds in science, technology, engineering, and math, often referred to as STEM pathways (Chemers, Zurbriggen, et al., 2011), despite evidence suggesting that these students express interest in pursuing science majors (Hurtado et al., 2007). Gender diversity is also limited (Nielsen, Alegria, Börjeson, et al., 2017). Scientific sharing will grow exponentially through broader representation of diverse voices and perspectives, which is critical in order to solve the world's complex problems.

Traditional academically focused approaches to recruiting students into science-related fields are often top-down, in which content knowledge is transmitted from an expert to a novice. Established methods also can rely on textbooks with rudimentary descriptions that are removed from firsthand experiences. Also, such approaches do not provide prospective recruits opportunities to engage with authentic role models.

While mentoring-based approaches have shown some promise in ameliorating these issues, many mentoring programs are academically oriented and mentors are often distant graduate students or professors (Pluth, Boettcher, et al., 2015; Tenenbaum, Anderson, Jett, & Yourick, 2014).

Near peer mentoring has emerged as an effective alternative to traditional forms of mentoring. In contrast to traditional mentors, near peers are just a few years older than mentees and thereby enjoy a shared language and greater degree of closeness (Zaniewski & Reinholz,2016).

This research paper reports on the first phase of a National Science Foundation (NSF) funded three-year study that is investigating how the effectiveness of one-on-one near peer mentoring can possibly be captured and utilized to motivate broader numbers of students. This phase is using *digital storytelling* (DST) to document with video the pairing of career-curious high school students (protégés) with STEM-identifying college students (near peers) who are all from underrepresented groups. With its intention to capture unscripted authenticity, DST borrows from the documentary film genre (Robin, 2008). In future phases of this research, edited video highlights of their relationships will be shared with prospective STEM pathway high school students through teacher-facilitated classroom screenings, offering the student audiences to possibly "see themselves" as scientists.

Theory and Hypothesis

This study is informed by *identity-based motivation theory* (Oyserman, 2015), a framework which posits that individuals interpret situations in ways that are congruent with their currently active identities. Extending this theory, a protégé who connects with a near peer may experience a high degree of *cognitive congruence* that in turn will influence how the adolescent's identity as a student takes shape—more specifically, as a future science student or scientist. Facilitated by a near peer relationship in the context of digital storytelling, this dynamic construction of a science identity through the creation and molding of students' possible future selves serves as the foundation for this research. As such, we hypothesize that a more informal approach that focuses less on content but more on social-cultural aspects such as overcoming personal struggles and institutional barriers as conveyed by near peers may be more salient to high school students—particularly students from historically underserved populations.

Brief Social-Psychological Interventions

Research has demonstrated that brief exercises targeting students' subjective thoughts, feelings, and beliefs can generate impressive short- and long-term gains in academic achievement compared to interventions that focus on academic content (see Yeager & Walton, 2011, for a review). Moreover, these brief interventions can have strong academic and psychological benefits, particularly for students of color (e.g., Cohen, Garcia, Apfel, & Master, 2006; Walton & Cohen, 2007). In a prominent study, academically struggling first-year college students who were shown videos of other students who described how their grades in college improved over time earned higher GRE scores and higher college GPAs compared to students who watched videos about students talking about their social and academic interests (Wilson & Linville, 1982). While those videos were scripted as part of a controlled laboratory experiment, our strategy involves structured and edited—but unscripted—video narratives that emerge from authentic interactions of aspiring students who are historically underrepresented in STEM-related pathways.

Why Near Peers?

One video-based professional development program defines near peer as "an individual who has recently gone through experiences that someone one or two stages behind is now or soon will be facing. A near peer occupies the space between a Peer and an Expert in a learning spectrum" (Michielsen, 2015). Near peer mentoring is also known by other terms, such as peer instruction, peer teaching, and peer tutoring, but all revolve around the common feature that a near peer is an individual who is *just beyond* the students they are instructing (e.g., Lockspeiser, O'Sullivan, Teherani, & Muller, 2008). Research shows that students tutored by near peers outperform students tutored by faculty members (ten Cate, van de Vorst, & van den Broek, 2012); yet, benefits are not limited to academic outcomes.

A near peer relationship model has two primary advantages that make it an ideal approach in the context of this research. First, the model capitalizes on the unique developmental period characterized by adolescence. The transition into and out of puberty is marked by profound shifts, notably the transition to greater autonomy. Adolescents become more interested in developing their own sense of identity and purpose along with a greater need for affiliation among their same-aged peers (McLean, 2005). The concept of *social congruence* refers to the closeness in roles between near peer and protégé. The hierarchical distance between the two is much smaller than the distance between professor and student, or adult mentor and adolescent mentee; this close distance allows for a greater degree of trust and informality (e.g., Lockspeiser et al., 2008; Schmidt & Moust, 1995). Because near peers are often similar in age but also possess what is colloquially termed "street cred," these individuals are likely to exert greater influence than mentors or coaches who are typically older individuals who may not share the same contemporary language as their younger protégés.

Second, near peers also possess greater knowledge in the learning spectrum. While this knowledge can be content-specific, it can also refer to institutional knowledge regarding unspoken norms and expectations. The concept of *cognitive congruence* refers to the closeness in maturity and age between near peer and protégé that allows the near peer to use language and examples that the protégé readily understands (e.g., Cornwall, 1980; Lockspeiser et al., 2008). It has also been defined as "the reduced distance in academic knowledge and cognitive development between near-peer teachers and learners" (Williams & Fowler, 2014, p. 143). It is this congruence that creates greater accessibility between near peer and protégé, as the near peer is perceived as being "just like them," providing a foundation of shared experiences upon which

to build a meaningful relationship. It is in this sharing of social-cultural aspects of learning that can make the near peer relationship model so powerful.

Why Digital Storytelling?

DST is an inherently engaging medium for the "YouTube generation" of adolescents growing up in an increasingly digitally connected world (e.g., Robin, 2008). DST can be implemented in a wide variety of contexts using either high-end or accessible and inexpensive equipment. DST has the potential to promote deep reflection and activate identity formation that may be particularly salient in this developmental period (Meeus, van de Schoot, Keijsers, Schwartz, & Branje, 2010). By avoiding staging or scripting, DST adheres to bedrock journalistic design principles. Locations are not scouted, and words and actions are never rehearsed. This simple mandate is what makes the stories "ring true" for viewers. Because DST captures raw emotions and preserves the authenticity of interactions in the video, DST is likely to be more engaging and relevant for both producers and viewers alike (Zak, 2015). The digital and open-ended format of DST provides a unique space for students to engage in self-reflection and critical thinking on personally relevant ideas and topics. We know that encouraging students to connect science to their personal lives contributes to interest and performance in science (Hulleman & Harackiewicz, 2009). DST provides an opportunity for individuals to tell a candid, personal story that often involves overcoming a struggle or problem. Research demonstrates that students tend to feel more connected when exposed to stories that focus on struggles rather than achievements (Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016), and that these stories can also influence interest and learning in physics among high school students (Hong & Lin-Siegler, 2012).

Research Questions

For Phase 1, the video production pilot stage of the study, we posed the following research questions:

RQ1: What themes will emerge as salient and meaningful from the DST recorded one-on-one interactions between near peers and protégés?

RQ2: For the high school protégés, does near peer mentoring influence students' possible future selves as well as the proximal outcomes of (a) positive attitudes toward science, (b) greater interest in science, and (c) greater intentions to pursue science pathways?

Methods

Design 1: Mixed-methods case study design. The project employs two distinct study designs. Design 1, which is the focus of this paper, used a mixed-methods case study approach (Yin, 2003) to explore the processes and procedures associated with the production of the DST videos in the context of near peer relationships. This design allowed us to gather a rich set of qualitative (e.g., transcripts from pre-post interviews and dyad observations) and quantitative data (e.g., number of hours engaged in interactions based on fidelity checklist) that helped in understanding the dynamic nature of the near peer relationships and whether and how these dynamics affected the production of the DST videos.

In Design 1 (N = 12 students), we paired six high school students (protégés) with six undergraduate students (near peers). In collaboration with professional videographers, the protégés recorded first person narrative video that highlighted their interactions over a three day period with their science near peer. Through a combination of focus groups and interviews, we collected qualitative data regarding the frequency of near peer-protégé interactions, the quality

and substance of these interactions, and the nature of the DST video production experience across six near peer-protégé pairs.

Design 2: Small-scale group-randomized design. In the next phases, the three of the six videos produced will be used to explore whether and how the DST intervention affects the target processes and proximal outcomes for students in general science classrooms. In Design 2 (N = 540 students, based on an average of 30 students in each of six classrooms at two high schools), we will employ a small-scale group-randomized design in which science classrooms within each school will be randomized to one of two conditions:

• ***Full intervention:*** Viewing of a series of three DST videos selected at random—one per week for three weeks—with teacher-facilitated classroom reflection.

• ***Partial intervention:*** Viewing of three non-DST, informational videos—one per week for three weeks—that depict available supports to help navigate educational and career science pathways (e.g., financial aid support), along with teacher-facilitated classroom reflection.

Though we will apply an identical mixed-methods design in all phases of the project, this paper focuses on Phase 1, which is the DST video production stage.

Participants

Participants were recruited from two campus-based summer programs that occur concurrently at a university located in the Pacific Northwest. One program provides selected high school students of color with the opportunity to experience college life for a week by residing in campus housing and sampling a variety of academic disciplines. The second program is a fellowship for underrepresented undergraduate students who have already demonstrated STEM pathway related proficiencies.

Near peers and protégés were selected based on recommendations from their respective program's leaders, and based on our research team's intent that participants be personable, upbeat, and have a natural demeanor. We avoided selecting protégés or near peers who might come across as extroverts or overachievers, acknowledging that these are highly subjective judgments. A guiding word was *accessible*.

We paired near peers and protégés based on shared or similar interests. During the three-day intervention, the pairs engaged in semi-structured activities that lasted 2-4 hours each day. Activities followed a sequence that began with an initial meeting to establish rapport (connection), progressed to informal, unscripted conversations and interviews between protégé and near peer (inquiry), followed by observation of the near peer working in their respective labs (observation). This led into a participatory experience that involved the protégé in the near peer's research activities (collaboration), and ended with a deeper consideration of their time together (reflection).

Near peers and protégés reflections were captured through on-camera interviews following each day. Additionally, protégés recorded first-person video logs (vlogs) of the impressions. Protocols were approved by the appropriate Institutional Review Board (IRB) committees, which permitted use of subjects' first names.

Results

Protégés reported the highpoint of their mentoring experience was shadowing near peers in their respective labs. Whether wearing goggles and white coats to measure aluminum gallium minerals or peering through the lens of a microscope to sort worm embryos, the protégés described the experiences as immersive and memorable.

Navaeh, an African-American high school junior, had the opportunity to shadow Martha, a Latinx undergraduate who studies the biological processes of human development at the cellular level on her path to becoming a medical doctor and Ph.D. Their bond strengthened after discovering they were the first in their respective families to pursue college. In the lab, Navaeh was initially frustrated by her inability to isolate the worms. Further into the experience she reported, “At first it was kind of gross. I was just kind of oooh like it's moving. After I finally got over it I was really fascinated and I wanted to keep looking.”

Afterwards, Naveah shared that she had expected the lab would be larger, antiseptic, and have clear tabletops. The word she used to describe the room was “real,” which through further discussion translated to mean accessible rather than foreign. She elaborated, “Being in there made me feel ready to be a scientist and try new things.” Naveah's use of the words “made me feel ready” indicates a sense of suitability she had not anticipated.

Mateo, a Latinx high school freshman protégé, worked alongside Brantly, an African-American near peer who recently earned his Ph.D. in chemistry. Brantly’s area of research is materials science, and he is working to establish his own company. They connected over a shared interest in sports and video games, making it easier to later grapple with complex equations. Mateo reflected, “I felt like a scientist when we were measuring. And then putting it [aluminum] into the vial and mixing it around by hand a little bit.” For Mateo, handling scientific tools, working with real elements, and wearing the appropriate gear strengthened his sense of science identity.

Karen, is a high school sophomore protégé who identifies as Vietnamese. Her near peer was Francesca, a Latinx undergraduate student, also pursuing a medical degree. They also studied worm embryos. Karen recalled, “She made me feel like this is like my space as well. I

didn't feel like a foreigner, just walking into someone's lab and ruining their stuff. I feel like I was free to do whatever I needed to do to accomplish what my goal was which was to cut open worms and freeze their embryos." For Karen, it was important to feel welcomed, and that it was "my space as well." Her near peer's warm welcome gave Karen a sense of freedom to "do whatever."

Whether in the labs or over lunch, several themes emerged from what near peers and protégés shared with one another. A key anticipated theme was overcoming barriers including achievement gaps and socioeconomic limitations.

Brantly, Mateo's near peer, recalled:

> When I was in high school I was only a decent student. And I think only being decent at chemistry is what drove me to continue to pursue it where it seemed that the concepts were a little fleeting. I was always a step behind in understanding that concept. And I think that drove me to want to understand it better.

Brantley's willingness to share about his earlier personal academic struggles allowed Mateo to witness that successful scientists are not infallible. Struggling is a natural aspect of accomplishment, overcome by perseverance.

Martha, Navaeh's near peer, shared:

> My parents are both immigrants. They don't have a lot of like education in their background. As I got further up in my studies I was one of the only minorities if not only minority in my [AP] classes. There was definitely that aspect of should I really be here? Do I really belong here? I realized I needed

> to keep going in order for like more people like me to be able to have these opportunities.

Martha sheds light on a psychological state often referred to as *imposter syndrome,* which is questioning one's own capabilities or preparedness to succeed at the task at hand. Research indicates that feelings of deficiency and insecurity are common and normal (Kolligian & Sternberg, 1991).

Near peers and protégés bonded over common concerns about structural barriers, including institutional racism and gender biases. Navaeh shared about encounter with a high school teacher and a guidance counselor who questioned her prospects for forging a career in science. She reported:

> I started to fall behind and my teacher at one point was like, are you sure you just don't want to switch? And like telling me like you know science isn't for everybody… and like my counselor was like even asking me, are you sure you want to stay in this class. It is upsetting and it's really frustrating because it's like I don't like being told no… It made me want to keep going. So I just I kept persisting at it.

Karen shared, "I'm very much the minority. A female Vietnamese woman trying to pursue something that is also a very competitive field. I want teachers to treat me as an equal rather than someone's like, oh they're special, let's just give them the special treatment. I believe it's a barrier."

Francesca, Karen's near peer, had the fortune of finding role models but empathized with the others' sentiments. She shared "I think it would be really hard to try and go into a field that's

difficult as well as something that doesn't represent yourself. That would be extremely difficult and I feel like I'd be more discouraged and might even change my mind about it."

Diego, a 9th grade Latinx male protégé, noted the need for more global diversity in science, stating "We don't really see a scientist from Mexico or Africa or China. Anybody can be a scientist and like I don't really see science as being from one person or one culture."

Another barrier to diversity in STEM-related fields is the false perception that scientists are a distinct breed of people, often viewed as humorless loners. Nia, who identifies as African-American, is an undergraduate near peer who studies bone malformations. She noted, "One of the biggest misconceptions is like you have to be like a genius like super smart to be a scientist. But I honestly think if you're curious and just like you want to know more about something that you can really achieve or accomplish anything you want."

Ryan is a near peer who identifies as a Caucasian and Persian male, and he grew up in a socioeconomically challenged neighborhood Central Oregon. He studies neuropathology, and specifically Parkinson's disease. Ryan acknowledged some of the misconceptions shared by others, stating "I think the largest one is that scientists have all the answers. I think good scientists ask all the questions."

Diego, Ryan's protégé, observed that science benefits from teamwork. "It's all like a family. They're all trying to so solve one thing and they all specialize in different things. And it's like that puzzle…because there's a piece up here that you can't really reach. But if you have somebody else say hey this is the missing piece like, you'll solve something."

Protégés also reflected on how the near peer mentoring experiences influenced their attitudes, interest, and intention to pursue science. Several reported that they would enroll in more STEM-related classes. Navaeh stated, "I have all my science credits but, I'm going to try to

pick up another like technology class, maybe another math class… I'm just kind of like trying new things." Diego reported, "I came in here with science being locked away like something I wasn't interested in. But like I'm coming out of here giving it the chance like, Let me see what I can learn."

Karen has contemplated becoming a pharmacist, but acknowledged that it is difficult to fully commit to a career path while in high school . She shared, "Just being able to have first, like hands-on experience that really is like driving me forward towards what I want to do. And of course I can't say that I even want to become a pharmacist because there are so many variables that would change my path in life… Maybe I find something better that I like. Maybe I want to become like a lawyer and like forestry, or something, you know."

Discussion

In this qualitative study of the video production phase of our research, we paired career-curious high school students (protégés) with STEM-identifying college students (near peers), and provided mentoring opportunities—in labs and over lunch—and used digital storytelling (DST) to capture highlights of their interactions for future study of video as an intervention tool to motivate interest in STEM-related career paths. For this current stage of study, we sought to identify salient themes and to assess whether the near peer mentoring experiences influenced the protégés' attitudes, interest, and intention to pursue science.

Informed by *identity-based motivation theory* (Oyserman, 2015), through interviews, we looked for verbal indicators of connections being formed, and for instances of cognitive congruence that might influence the adolescents' identities. Protégés reported they felt like a scientist when they shared work spaces with near peers and had opportunities to actively participate in conducting experiments.

With regard to RQ1 and the "emergence of salient themes," near peers and protégés shared about socioeconomic constraints, institutional barriers, and overcoming gaps in their own achievement. Wrestling with self-doubts also arose as a common theme. Protégés heard candid stories from near peers who at times had struggled with math or harbored fears of failure. Near peers' willingness to candidly share their past, and specifically personal apprehensions and fears resonated with protégés and strengthened their cognitive congruence. Themes of tenacity and resilience resurfaced throughout the interactions. The importance of supportive teachers, advisors, mentors and family members also surfaced.

Dispelling many stereotypes, protégés discovered firsthand that most scientists work collaboratively rather than in isolation, and that many consider social interaction and life balance essential aspects of their ability to thrive.

With regard to RQ2, "attitudes, interests, and intentions," protégés reported that they "felt like a scientist" when they were in the labs alongside their near peers, were dressed for the occasion, and were handling scientific instruments. Protégés unanimously agreed that the experience "opened their eyes" in some meaningful way, and that they intended to inquire further about potential opportunities in science. Several stated that the summer program inspired them to consider adding more STEM-related classes to their schedules in the forthcoming academic year.

Protégés pointed to closeness in age as being a key factor in their positive perceptions about the summer program. Discovering common personal interests, whether it was video games or cultural values fostered a stronger sense of empathy. Protégés stated they could envision themselves in the shoes of their near peers. Likewise, several near peers stated how much protégés reminded them of their younger selves.

It is important to note that achieving sufficient "chemistry" between near peers and protégés is never a given. Unscripted interactions are by definition unpredictable, so there are no guarantees. For various reasons, including personality differences, energy, and comfort levels, inevitably there will be pairings that click more so than others. As anticipated, three of the pairings were stronger than the remaining three. The next phase calls for use of three videos, so this outcome was factored into the intended research design.

A limitation of this study is that the protégés' reflections were recorded within 24 hours of their time spent with near peers. While their memories were fresh and specific, it is not within the scope of this phase of the research to discern whether there will be lasting influence. While the protégés' reported significant benefits from the experiences, broader impact has yet to be assessed.

Though this is an early phase study, it indicates promise with respect to the potential of pairing near peers with protégés in immersive laboratory settings for concentrated periods of time. It findings are consistent with previous research on the efficacy of near peer mentoring (e.g. Lockspeiser et al., 2008; Schmidt & Moust, 1995). Should edited DST highlights prove effective in motivating underserved students in pursue STEM-related career paths, it will be possible to diversify science and have society benefit from contributions that would otherwise remain marginalized.

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