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Immersive Videography of Ancient DNA Extraction for Community Engagement and Educational Initiatives by the Anson Street African Burial Ground Project

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ABSTRACT

Objective: Community engagement is an increasingly important component of ancient DNA (aDNA) research, especially when it involves archeological individuals connected to contemporary descendants or other invested communities. However, effectively explaining methods to non-specialist audiences can be challenging due to the intricacies of aDNA laboratory work. To overcome this challenge, the Anson Street African Burial Ground (ASABG) Project employed a GoPro camera to visually document the process of aDNA extraction for use in community engagement and education events.

Methods: A GoPro Hero 6 camera enclosed in a decontaminated underwater case was used to film multiple rounds of aDNA extractions from first- and third-person perspectives. The raw footage was edited into long (13-minute) and short (5-minute) format videos to summarize the steps of aDNA extraction for different educational aims.

Results: The videos were used at community engagement events, as well as in classrooms and other educational venues for students of different age groups. General feedback from the community was solicited at the events. We found that the use of videographic methods increased the transparency and accessibility of the aDNA research conducted by the ASABG Project team.

Discussion: Providing a visual guide to the often destructive nature of aDNA testing served as an important step in the continuing practice of informed (dynamic) consent with the descendant community. Future initiatives could expand these visualization efforts by illustrating other steps in the aDNA testing process, such as library preparation or sequencing, or incorporating approaches such as live streaming to foster trust and expand public science literacy.

1 | Introduction

Engaging descendant communities and other community groups is an increasingly critical component of ancient DNA (aDNA) research involving ancestral human remains (Kowal et al. 2023). Given that these remains represent persons who are no longer living, it is critical to engage with living descendants or the proxy communities who identify with

†Deceased.

them (Gibbon, Thompson, and Alves 2024). Different recommendations and guidelines regarding best practices for working with these communities have been developed over the past two decades, focusing specifically on topics such as informed consent, scientific feasibility, and data management strategies (Austin et al. 2019; Fleskes et al. 2022; Gibbon, Thompson, and Alves 2024; Kowal et al. 2023; Tsosie et al. 2020; Wagner et al. 2020). Implicit in these efforts is the concept of dynamic consent, which emphasizes that consent is not a one-time event but rather a series of evolving dialogs that take place throughout the research process (Budin-Ljøsne et al. 2017). Dynamic consent with proxy communities is predicated on effective public science communication of genomics with these community groups. In this way, science education has become a crucial component of the consent and community engagement process by ensuring that community groups understand the benefits and limitations of research.

Yet, it can be difficult to effectively communicate intangible or complex scientific processes, such as those used in aDNA research. The analysis of aDNA involves the extraction and sequencing of DNA from organic materials obtained from archeological sites, such as bone, coprolites, or soil (Orlando et al. 2021). The process is complex, involving multi-day protocols, and can be destructive to physical source material. It is also imperative to prevent contamination with DNA from modern or other archeological sources due to the low levels of endogenous genomic material. As a result, all pre-amplification laboratory processes must take place in separate International Standards Organization (ISO) rated clean rooms with high-efficiency particulate air (HEPA) in a positive-pressure environment. In addition, all personnel are required to wear full personal protective equipment (PPE), including masks, gloves, Tyvek suits, and shoe covers. This combination of stringent laboratory environment standards and elaborate protocols can make it difficult to effectively communicate aDNA methods to audiences interested in the research.

Visualization strategies, such as the use of metaphors, illustrative aids, and videos, have all been shown to increase learning comprehension and engagement in science education (Duit 1991; Luzón 2019; Mayer 2002). These strategies focus on translating abstract or intangible concepts into forms that are understandable to audience members. Images have been found to be an especially important modality for increasing genetic literacy or the general understanding of genetic concepts in relation to research processes (Yu 2014).

Videography presents a new way of illustrating complex scientific methods through visual storytelling about aDNA research (Marques et al. 2012; Riedlinger et al. 2019). Videos have served as educational tools for conveying information on subjects that may be distant or challenging to grasp, such as deep-sea biology (Hoeberechts et al. 2015) and climate change (DeCock-Caspell and Vasseur 2021). Thus, they can help increase the public understanding and awareness of science, thereby encouraging more direct and transparent involvement in it (Riedlinger et al. 2019).

GoPro action cameras (GoPro Inc.) are compact and resilient recording devices often promoted for adventure activities or video productions. These cameras are able to capture footage in locations that are otherwise difficult to access. The portability of the GoPro has fostered its use in instructional spaces, such as surgical wards for medical education (Moore et al. 2018) and chemistry and engineering labs for methods training (Fung 2016; Marques et al. 2012). The first-person perspective often captured using a GoPro camera allows viewers to visualize the demonstrator's perspective directly, which in turn enhances the learning experience (Fung 2016; Salamin et al. 2010). The use of a GoPro in laboratory settings offers the additional benefit of providing realistic views of instrumentation and laboratory set ups that may not be included when communicating research outcomes in peer-reviewed articles or public presentations (Fung 2016; Pasquali 2007).

In this paper, we describe the use of a GoPro for community engagement and education purposes for the Anson Street African Burial Ground (ASABG) Project. We used the GoPro to film the process of aDNA extraction during the Fall and Winter of 2018. Subsequently, we edited the raw footage and used the resulting videos for community engagement and classroom events. Based on these experiences, we discuss the ramifications of this work for science education in the context of community engagement, as well as processes of dynamic consent with proxy communities.

2 | Methods

2.1 | The ASABG Project and Community Engagement

The ASABG Project (previously known as the Gullah Society) is a community and grassroots endeavor focused on understanding the histories and lived experiences of 36 Ancestors of African descent whose remains were uncovered during construction in downtown Charleston, South Carolina (USA) (Gilmore et al. 2024). Archeological, archival, osteological, isotopic, genomic, and oral metagenomic research has indicated that the majority of these 18th-century individuals were likely second or greater generations of persons who were likely enslaved, with origins in West and West-Central Africa (Fleskes et al. 2023, 2024, 2021; Wang et al. 2023). The foundation of this research is rooted in community dialog and advocacy, following prior notable projects such as the New York African Burial Ground and its ethical clientage model (Blakey and Rankin-Hill 2009; LaRoche and Blakey 1997). As the Anson Street Ancestors represent archeological persons who are no longer living, permission and engagement with proxy communities or communities connected (e.g., culturally, racially, geographically, genealogically, or spiritually, etc.) to the archeological individuals was a critical step in obtaining research permission and co-creating a research program that maximizes the benefits for these connected communities while reducing any potential harms (Fleskes et al. 2021; Gibbon, Thompson, and Alves 2024; Gilmore et al. 2024; Zuckerman, Kamnikar, and Mathena 2014).

A critical component of the research effort and broader community engagement initiatives in the ASABG Project was our education and outreach programs. These served to engage attendees with the current and future research directions of our research, as well as communicate the project to individuals and groups outside of those attending our events. The latter included South Carolina residents and local officials, as well as elementary, middle school, high school, and university students in their classrooms.

2.2 | Ethics of Visualizing Human Remains and Permissions

The ethics of visualizing human skeletal remains is an important and emergent issue in biological anthropology and related fields (Squires, Errickson, and Márquez-Grant 2019). Spiros, Plemons, and Biggs (2022) have outlined how Errickson and Thompson's (2019) ethical principles of *permission*, *respect*, *justification*, and *education* can be used to center the visualization of human remains within a broader ethical framework for pedagogical contexts. These principles are derived from core bioethical principles of autonomy, respect, beneficence, and justice (Beauchamp and Childress 1994), which focus on the rights of individuals involved in research and the importance of doing no harm. Since the analysis of skeletal materials representing human ancestors can be a culturally sensitive issue (Fforde, Hubert, and Turnbull 2003), it is imperative to determine whether the use of images of human skeletal remains is beneficial or contributes harm to these skeletal individuals or to living connected communities. Spiros, Plemons, and Biggs (2022) specifically notes the importance of obtaining permission from connected individuals or communities and ensuring respect in the collection and curation of images. These criteria can be used to assess whether the imagery is necessary to meet the goals of the project in educational contexts.

We applied these ethical principles in the creation of the GoPro video. In early engagement events, community members expressed the importance of seeing images of skeletal samples to better comprehend the lab procedures being used to analyze them. After deliberation, we decided that visualizing aDNA extraction by showing bone and teeth samples being transformed into DNA samples was appropriate within the context of the ASABG Project. We maintained respect for the Ancestors by only showing necessary clips to illustrate how bone and teeth samples are sub-sectioned, decontaminated, and ground into a fine powder in preparation for DNA extraction, as explained below.

The skeletal samples used in the video come from Ancestors of European descent whose remains were recovered from the 17th-century site of Patuxent Point in Maryland (USA) (King and Ubelaker 1996). While it would have been ideal to capture the process of extracting DNA from the Anson Street Ancestors themselves, the idea of using a GoPro for recording lab work was developed after their DNA extractions had already taken place. Because of this fact, we chose to film DNA extractions for a research project that was currently underway and used skeletal materials similar to the samples obtained from the Anson Street Ancestors.

Permission to carry out aDNA extraction of Ancestors from Patuxent Point and to film the process was obtained from the Maryland Historic Trust, which is the responsible curatorial institution. There are currently no known descendants of these individuals, given that many historic documents associated with the site and its inhabitants were burned in the 19th century (King and Ubelaker 1996). At the beginning of the project, we consulted with the Maryland Historical Trust to determine if any proxy communities were associated with the Patuxent Point ancestral individuals. Since none were identified, the Maryland Historic Trust served as the primary proxy community through which we obtained consent and communicated the project results, including the resulting video described in this paper.

Disclosures to viewers that human remains would be shown in the video were given prior to its public presentation during ASABG Project events. For publication purposes, we elected to transform the footage that shows human remains into a cartoonized form to increase the level of abstraction in recognition of its potential broader public use outside of the ASABG Project. The animation effect was generated using Adobe Premier Pro through the StyleX plugin (Aescripts). Public use of the video is for educational purposes only.

2.3 | GoPro Videography

2.3.1 | Contamination Control in Filming

In 2018, a GoPro Hero 6 and underwater case was loaned to us by the National Geographic Society to create aDNA educational content by Fleskes in the Ancient DNA Laboratory at the University of Tennessee-Knoxville, a clean room lab dedicated to the analyses of degraded human DNA samples recovered from archeological contexts, such as human skeletal material. The lab incorporates structural safeguards such as the use of a multi-chambered design, overhead UV lights, a positive pressured environment, and HEPA-filtered air; these are all standard measures designed to reduce the risk for modern human DNA contamination within the laboratory space. These measures are necessary because DNA from archeological contexts is often highly degraded, fragmented, and available only in low concentrations (Llamas et al. 2017). Fleskes followed standard aDNA laboratory practice and wore PPE, including full-body Tyvek suits, gloves, masks, and dedicated clean room footwear during filming. In addition, all lab supplies brought into the inner chambers were wiped down with 10% household bleach solution or *DNA AWAY* (MBP), followed by a 70% ethanol solution, and then UV irradiated overnight.

The efforts to control DNA contamination from modern sources introduce challenges to filming in an aDNA laboratory context, as decontamination protocols could possibly damage electronic equipment. For this reason, we used a GoPro inside a durable plastic casing that is typically employed for underwater videography, as this setup allowed the camera to be decontaminated without risking damage to the underlying electronic components. To decontaminate the camera setup, we wiped down the GoPro inside the waterproof case and all attachments with *DNA AWAY* (MBP) followed by 70% ethanol. Following this step, all plastic attachments were UV irradiated for 10 min. The camera itself was not subject to UV crosslinking, given the unknown effects of irradiation on its internal electronics. After being brought into the aDNA lab space, the camera body, attachments, and charging devices were not removed from the lab until filming was completed.

The camera recording was controlled using the GoPro Quik (GoPro Inc.) app on an iPhone 6 (Apple Inc.) smartphone. The smartphone was placed in a plastic Ziplock bag that had been decontaminated with 10% bleach, followed by 70% ethanol, and left to dry. The smartphone was not removed from the bag while it was used in the lab, thus allowing the camera to be accessed without introducing contamination from the cellular device. After touching the camera for repositioning or the Ziplock bag containing the smartphone to begin and end recording, gloved hands were rinsed with 10% bleach, followed by 70% ethanol.

2.3.2 | Filming

Video footage was recorded for the purposes of illustrating the various steps involved in aDNA extraction. The goal of this process was to demonstrate how researchers go from a bone sample to a DNA sample. We focused exclusively on this part of the research process for two reasons. First, it was the process about which we received the most questions from community members during public outreach events. Second, the extraction of DNA is the most physically visible process in the aDNA method pipeline. The visible transformation of the tangible skeletal element to liquid DNA makes communicating this complex laboratory process easier for public audiences.

To demonstrate the DNA extraction process, bone or tooth samples were prepared for extraction as per Fleskes et al. (2019, 2021). Two sets of DNA extractions were filmed in real time. Each set of extractions was filmed from a different camera angle using multiple attachments from the GoPro camera kit. The primary footage angle was obtained by placing the GoPro on top of the researcher's head and tilting it slightly down to simulate a “first-person” view of the laboratory processes (Figure 1A). The camera was also placed along the inside walls of the dead air hood used for sample preparation and within the biosafety cabinet during DNA extraction (Figure 1B). These positions generated close-up shots of procedures that were obstructed by the enclosed plastic or glass walls of the laboratory equipment or otherwise difficult to visualize. A second person filmed lab gowning procedures to demonstrate how aDNA researchers enter the clean room lab space (Figure 1C). Different perspectives were obtained by changing the angle at certain vantage points to keep viewers engaged and allow the optimal perspective for each lab procedure. Specific action points showing key steps of the extraction process were filmed, resulting in a series of multiple short clips.

2.3.3 | Video Editing

The resulting footage was edited using iMovie v.10 (Apple Inc.). Video clips were labeled and organized by protocol step to allow for easier assembly. Clips were selected and organized, and overlaying audio was recorded to explain the process being shown. Afterward, the clips were trimmed to fit the audio length. This multi-step process allowed for finer control over video length.

In total, we generated over 12 hours of raw footage. From this total, we created 13-minute and 5-minute versions of the master video (Video 1; File S1). We wanted to distill the content to below 15 minutes to make certain that we held viewers' attention. The 13-minute version (File S1) afforded us time to discuss technical details about the process and show a more complete demonstration of all steps involved in sample preparation and extraction. This long form was also created for presentations where more time could be allotted, and when an audience was interested in more detailed explanations of what aDNA extraction processes entailed.

The 5-minute video was created to show in school settings or to audiences who wanted to get an impression of what the aDNA extraction processes looked like (Video 1). The short-form video presented limited technical detail about the aDNA analysis without overly distilling information so much as to make the process unclear to a non-scientific audience.

Furthermore, we created an audio-free version of the long-form film that could be used regardless of the academic level of audience members during presentations with live narration of the process. This version of the video was used specifically for younger audiences, as it allowed them to see what a science laboratory looked like without having to listen to the technical audio.

3 | Results

Using the GoPro Hero 6, we created a series of videos entitled “Understanding Ancient DNA Extraction” (Video 1; File S1). The long and short-form videos are available for download here through streaming on the Vimeo platform (https://vimeo.com/asabgproject) and are accessible on our project website (https://www.asabgproject.com/). In what follows, we discuss the resulting video content, as well as its use in community engagement events for the ASABG Project.

3.1 | Video Content

The generated videos were organized into six parts, which highlighted the main steps involved in aDNA extraction (*Entering into the Ancient DNA Lab*; *Sample Preparation*; *Bleach Decontamination and Sample Grinding*; *DNA Extraction: Incubation*; *DNA Extraction: Buffer Preparation*; and *DNA Extraction: DNA Isolation*) (Table 1). Each part was organized around educational aims, which guided the sequence of demonstrated steps and overlaying audio explanations.

We began from the point of *Entering into the Ancient DNA Lab*. This part provided an overview of the goals of the videos and allowed viewers to get a sense of the physical space and layout of an aDNA laboratory. We also demonstrated how PPE is used, including putting on gloves and Tyvek suits, while explaining why it is important for contamination control.

Next, we provided an overview of *Sample Preparation* to show how we prepare a bone sample for DNA extraction. We used a molar tooth for the film, which is a common sample for aDNA

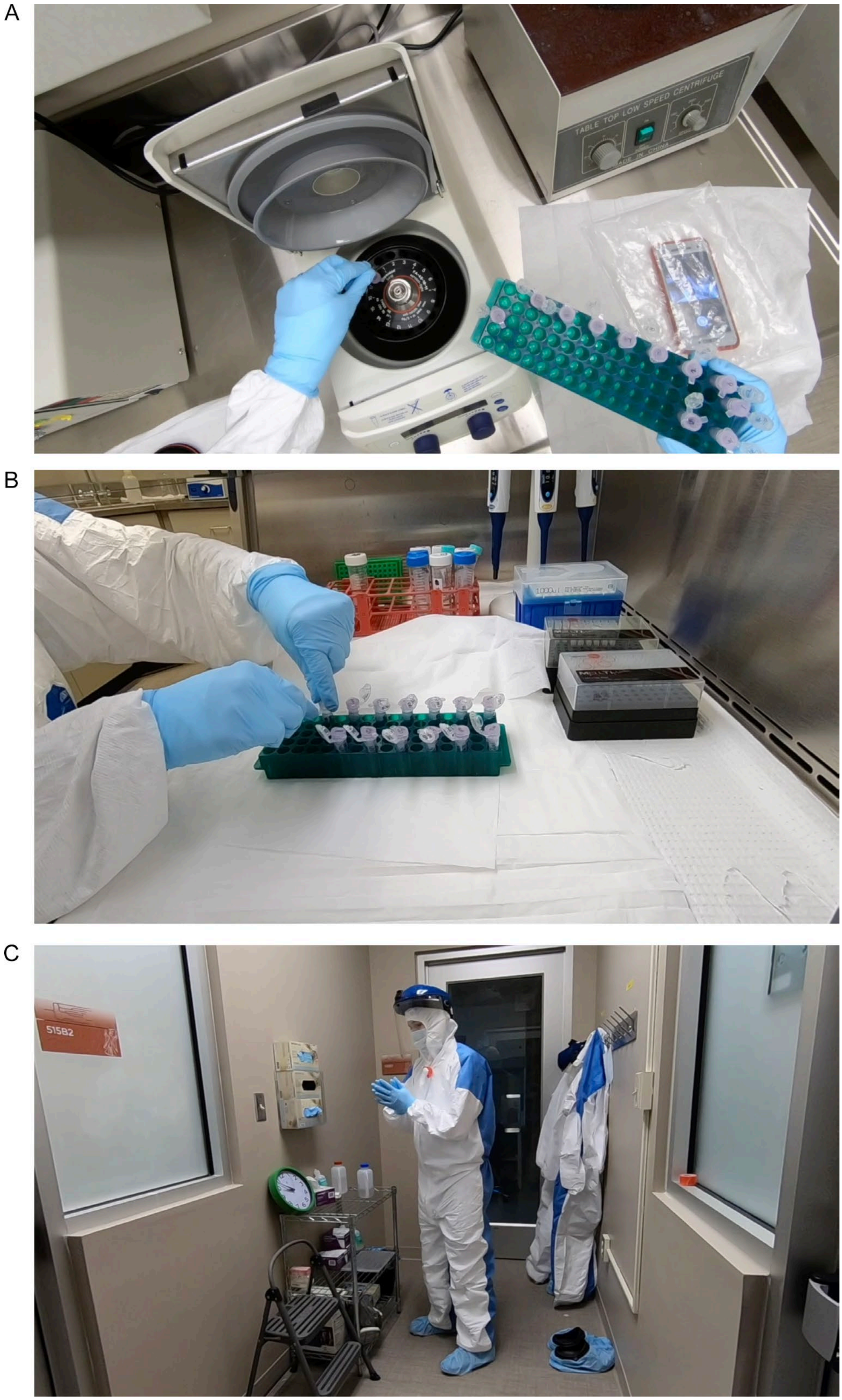

FIGURE 1 | (A) First-person view illustrating the action of placing silica spin column in a centrifuge. The view also shows the cellphone (right) controlling the GoPro in a Ziplock bag. (B) View from within the Biosafety Cabinet demonstrating the washing of the silica spin columns containing the extracted DNA. (C) Third-person view showing the individual in personal protective equipment (PPE) washing gloved hands with bleach solution.

analyses. We demonstrated how a portion of a tooth root can be removed using a Dremel handheld rotary tool. Given that this step requires training and experience to safely handle the Dremel tool, we placed a disclaimer at the bottom of the screen stating: “Do not attempt without proper training or wearing personal protective gear.”

VIDEO 1 | "Understanding Ancient DNA Extraction," short form video. Video is for educational purposes only. Video content can be viewed at https://onlinelibrary.wiley.com/doi/10.1002/ajpa.25055

This part of the video also showed the steps for *Bleach Decontamination and Sample Grinding*. We demonstrated a decontamination protocol involving wiping the tooth in 50% bleach solution using a Kimwipe, rinsing with ultrapure water (Invitrogen), and UV-irradiating the cleaned tooth for 10 minutes. During these clips, we explained why each of these steps was important for reducing surface contamination. We subsequently recorded sample grinding using a Freezer Mill (Spex) to transform the skeletal material into a fine powder for DNA extraction. The above parts focused on introducing the viewers to the aDNA laboratory context, discussing the importance of contamination control, and showing how the bone or tooth sample from an archeological individual can be processed to allow it to undergo DNA extraction.

The rest of the video demonstrated the process of DNA extraction using the Dabney protocol (Dabney and Meyer 2019). The first part, *DNA Extraction: Incubation*, began with preparing the Extraction (lysis) Buffer, where ETDA, Tween-20, water, and Proteinase-K were combined. While each reagent was being added to the buffer, its function was explained so the audience could understand its utility. We then showed the extraction buffer being added to the bone powder and placed on a heat block for incubation.

Next, *DNA Extraction: Buffer Preparation*, demonstrated how DNA extraction materials were prepared and decontaminated. In addition, we also showed how the Binding Buffer was made, while explaining function of guanidine hydrochloride, Tween-20, sodium acetate, and isopropanol, similar to how the Extraction Buffer step was shown.

In the last part of the video, *DNA Extraction: DNA Isolation*, we showed how spin columns were used to extract and isolate DNA. We began by removing the DNA samples from the heat block and used a centrifuge to separate the bone powder and extraction buffer. The extraction buffer liquid was then poured into larger volumes of binding buffer and together poured into a spin column. We then demonstrated the process of isolating the DNA from the initial spin, washing, and elution. We closed by transporting the extracted DNA samples to a refrigerator for storage.

In the concluding section of the film, we noted that the video only showed one of several different methods for extracting aDNA. Our purpose was to demonstrate to viewers that, while this was the method that we used for the aDNA analyses of the Ancestors, other researchers may take different approaches to obtaining aDNA for genomic analysis.

3.2 | Video Use in Community Engagement and Education Programs

The original intended audience for this video was Charlestonian African American community members who were attending events hosted by the extant Gullah Society concerning the research on and the reinterment of the Anson Street Ancestors. Most individuals had attended previous community engagement events about the aDNA research, and thus were already familiar with the project. However, we wanted to make sure that the video was accessible to all audiences and individuals, including those who had not previously attended our events.

In addition, the video was used during ongoing student educational initiatives by the Gullah Society. We used the video during presentations to elementary, middle, high school, and university student audiences in the Charleston area so that they could learn about our research with the Anson Street Ancestors. Thus, it was necessary to create multiple videos from the recorded footage that were each edited slightly differently to meet the needs and educational levels of each target audience.

The long (13-minute) version was debuted during the reinterment of the Anson Street Ancestors in May 2019. It was shown as the second event of a larger four-day program linked to the reinterment ceremony (Fleskes et al. 2021; Gilmore et al. 2024). As part of this program, Fleskes gave a presentation entitled "Understanding DNA Extraction" which communicated the results of the mitochondrial DNA (mtDNA) analysis that represented the first phase of aDNA testing. Shown before presenting the mtDNA results for the Ancestors, this video helped community members visualize the project's aDNA methods and ask questions about them.

Questions from the audience included topics such as how their DNA compared to the DNA extracted from the Ancestors, and how the Ancestors' DNA compared to that of other African American communities. Community feedback about the event collected through questionnaires (Gilmore et al. 2024) indicated positive responses about the presentation of the study. However, no specific feedback about the video itself was solicited. Consequently, our assessment of the video's impact was based on the generally positive impressions shared by audience members and on the fact that it provided a platform for them to ask deeper questions about the research process. Audience members were adults and children, including local community members, members of the media, representatives of local government, faculty at the College of Charleston, and other interested persons.

We additionally used the short (5-minute) video as a classroom tool to teach students at primary, junior, high school, and university levels about bioarchaeology, history, and DNA analysis related to African American populations in the Charleston area. The video also complemented other visual information about project research that had been previously presented through

TABLE 1 | Overview of the video "Understanding Ancient DNA Extraction." This provides the organizing outline for both the long (13-minute) and short (5-minute) form videos.

Part	Aims	Demonstrated steps
(1) Entering into the Ancient DNA Lab	• Provide overview and purpose of video • Illustrate and explain importance of contamination control in the aDNA laboratory • Demonstrate how personal protective equipment (PPE) is used	a. Entering into the aDNA Lab Foyer: Putting on gloves; removing outside shoes b. Entering into the gowning chamber: Putting on PPE; decontamination of hands
(2) Sample Preparation	• Show how a tooth sample are prepared and explain its purpose	a. Entering into the Sample Preparation Suite: showing the room setup; decontamination of hands b. Preparing the workstation and tools for drilling: setup and decontamination c. Sectioning a sample: Removing a subsection of tooth sample using a Dremel
(3) Bleach Decontamination and Sample Grinding	• Explain why decontaminating the bone sample is important • Show how bone is made into a powder for DNA extraction	a. Sample Decontamination: 50% bleach wipe down, water rinse, and UV crosslinker b. Sample Grinding: Placing sample into the Spex Freezer Mill grinding vials, removing bone powder, placing bone powder into sampling tubes
(4) DNA Extraction: Incubation	• Explain the utility of a multi-chambered aDNA lab design for contamination control • Demonstrate how bone powder is treated to solubilize DNA	a. Entering into the Sample Preparation Suite: Showing the room setup b. Prepare Extraction Buffer: Showing and explaining the function of EDTA and Proteinase-K c. Incubation: Placing Sampling on heat block
(5) DNA Extraction: Buffer Preparation	• Demonstrate how we prepare DNA extraction materials • Show how different chemical reagents are combined to create solutions	a. Extraction Set Up: Decontaminating tubes and spin column set up b. Prepare Binding Buffer: Showing and explaining function of guanidine hydrochloride, Tween-20, sodium acetate, and isopropanol
(6) DNA Extraction: DNA Binding and Isolation	• Illustrate how spin columns are used to extract DNA • Show how DNA samples are stored	a. Removing DNA samples from the heat block b. Separating the bone powder from the liquid using a centrifuge c. Combining the DNA extract with binding buffer d. Isolating the DNA using an assembled spin column: initial spin; wash; elution e. DNA storage

PowerPoint slides, poster boards, and photographs. We first used it for educational purposes during an elementary school assembly at Meeting Street Academy (Charleston, USA), where Fleskes and Schurr showed students what an aDNA laboratory looked like and how scientists are able to get DNA from skeletal remains. Given the early education level of these students, we did not play the audio with the video and instead relied on in-person narration by Fleskes and Schurr for explaination. The video was also used in 2019 at North Charleston High School during a Forensics class, as well as the College of Charleston in 2021 during a bioarchaeology class and at the student Anthropology Club meeting. Importantly, on all these occasions, we focused on showing young students the possibilities of developing careers in anthropology, archeology, and genetics.

Overall, class instruction with the video was well received, and stimulated interest in the research from both students and teachers. After watching the video, we were able to engage in discussions at different educational levels regarding working in a laboratory environment and how this process helped us learn more about the Ancestors. Although we did not collect survey data on the learning experience during these events, our general impressions were that students were engaged and that the video facilitated classroom discussions about the Anson Street Ancestors. Interestingly, elementary school children tended to ask questions about their experience working in a lab, while questions from high school and university students focused more on how the research could inform our understanding of the Ancestors.

Furthermore, when unable to meet Gullah Society supporters and community members in person during the COVID-19 pandemic, we shared the short video virtually on the 1-year anniversary of the reinterment (May 4, 2020) and during a series of

Community Conversation webinars recorded in the fall of 2020. The videos have been archived on our project website (www.asabgproject.com) to allow for continued accessibility.

4 | Discussion

Through the process of video recording laboratory work, we were able to communicate the highly technical process of aDNA extraction to community members and students. The production of the video was driven by the desire to illustrate aDNA methods more dynamically for community members attending our events and to break down access barriers between scientific research and interested community members. While having previously explained the process of aDNA extraction through the use of illustrations and verbal metaphors, we found that showing people a video recording provided a much more direct and powerful way to explain the intricacies of the aDNA research process. In what follows, we discuss the important implications of videography for increasing transparency in aDNA research, obtaining dynamic consent from proxy communities, and more effectively communicating complex research methods to the public.

The field of aDNA is inaccessible for many reasons, among which are the high costs of research, the need for specialized laboratory spaces, limited training opportunities, and the overall preciousness of samples—physically, culturally and spiritually—from the archeological individuals required for the analysis. This level of inaccessibility extends outside of the research process and can impact the effectiveness of community engagement (Fleskes et al. 2022; McKerracher and Núñez de la Mora 2022). For example, the high level of technicality in aDNA extraction protocols requires effective distilling methods for laypersons. If the distillation is not done correctly, then efforts to communicate the methods used can contribute to increased feelings of alienation and inaccessibility for community members (Wynne 2006).

In addition, the structural limitations of aDNA research, such as controlled access to spaces for contamination control, can physically limit the number of persons allowed into them. This constraint, combined with the fact that aDNA laboratories may not be in the same location as that of descendant communities, means that these research spaces are not commonly visited by community members. In the ASABG Project, we arranged a visit to the University of Tennessee-Knoxville lab by project leader Dr. Ade Ofunniyin in 2018. While this was a highly impactful way of demonstrating to him how aDNA methods were carried out and the level of care involved in sample analysis, we did not have the financial resources to bring other community members to the lab. However, this experience sparked discussions about ways we could help bring the lab to community members to better communicate the processes involved in aDNA research for the project.

To some degree, aDNA research can effectively be likened to a "black box" in situations where descendant communities are seeking a more comprehensive understanding of the treatment of their ancestors. The primary objective of filming the aDNA extraction process was to demystify the research process by situating viewers in the aDNA laboratory. We were able to visually show the laboratory environment and explain the careful and tedious methodology required for aDNA work without physically bringing community members into the laboratory. This approach helped to maintain the sterility of the labs by maintaining controlled access, while still increasing accessibility of the methods employed.

The use of a GoPro camera to film the processes of aDNA extraction builds upon pedagogical visualization techniques to improve effectiveness in communicating complex scientific concepts, both inside and outside classroom settings. Since 2018, GoPros and other immersive videography tools, such as 360° cameras, have emerged as key components of an instructional approach in science education spaces (Hernandez-de-Menendez, Escobar Díaz, and Morales-Menendez 2020; Shadiev, Yang, and Huang 2022). This approach centers around providing students with first-person experiences without having to leave the classroom, thereby empowering them to make observations about the experiences themselves (Schlosser, Aumell, and Kilkenny 2023). It also serves to illustrate more complex scientific concepts that can be further elaborated upon by the instructor through other means.

Besides expanding the transparency of lab research, increasing comprehension through immersive, first-person experiences in the classroom can be an important component of public science presentations. Effective public science communication in education and outreach initiatives often forms the core of community engagement efforts. Visualization methods help explain complex scientific topics to audience members and increase understanding of the research project. Overall, this approach provides audience members with a deeper understanding of the key methods employed in aDNA research.

The use of videography for community engagement also has important implications for issues surrounding informed consent in human remains research. Archeological individuals represent once-living persons who themselves cannot give consent to participate in research. For this reason, it is important to identify and engage proxy communities whenever possible to both obtain permission for the research and to ensure that research benefits and minimizes harm to these connected communities through the process of dynamic consent (Gibbon, Thompson, and Alves 2024; Kaestle and Horsburgh 2002).

Ways of engaging descendant communities in this manner have been demonstrated through archeological projects such as the ethical clientage model of the New York African Burial Ground and other Community-Based Participatory Research efforts (Atalay 2012; Atalay and McCleary 2022; LaRoche and Blakey 1997). These approaches emphasize the researcher's responsibility not only to avoid harm but also to actively benefit affected communities. Such frameworks also contribute to broader discussions on the ethical treatment of human remains by prioritizing the rights of descendant communities throughout the research process (Agarwal et al. 2024; Zuckerman, Kamnikar, and Mathena 2014). We further argue that these frameworks should apply to all stages of research, including the clear communication of complex scientific concepts. This effort can be assisted through the use of visualization techniques, such as the GoPro, in the communication of research results.

This is especially important when working in contexts with minoritized communities, as genetic research has a long and fraught history of harm (Roberts 2011). These inherited histories and lived realities make it even more critical to build and earn trust with descendant communities, which is a key component of relational ethics (Zuckerman, Kamnikar, and Mathena 2014). This was especially important for the ASABG Project, given the history of medical racism, abuse and the resultant distrust of African Americans of medical and scientific research conducted (Nuriddin, Mooney, and White 2020). For the ASABG Project team, particularly the anthropological geneticists coming from outside of Charleston, building trust was a gradual process. We prioritized holding regular in-person community meetings every few months in order to build relationships and make sure the project was attuned to the community's questions and needs, as detailed in Gilmore et al. (2024).

Videography became an extension of this trust-building process by providing a means of documenting the ways that the Ancestors' remains were being carefully handled and used for scientific research to audience members. By being able to visually document where the Ancestors' remains were being temporarily housed, the level of destruction involved in the testing, and the subsequent steps needed to obtain aDNA, we built trust with community stakeholders and enhanced our partnership with them in project work.

Videography methods in aDNA research represent an innovative approach to community engagement. The use of a GoPro camera to film the aDNA extraction process for the ASABG Project developed from a desire to communicate the intricacies of the research more effectively to descendant communities, which is in line with our efforts to increase transparency in scientific research. Such visualization methods can be creatively applied to fit the individual needs of different descendant communities, which are already developing in exciting directions for aDNA (Stjerna and Lankheet 2021; Zolic et al. 2023). In the future, next-generation library preparation, DNA quantification, and sequencing protocols that typically follow after aDNA extraction could also be similarly visualized. Moreover, platforms such as live streaming could further facilitate increased transparency and public engagement.

Author Contributions

Raquel E. Fleskes: conceptualization (lead), data curation (lead), formal analysis (lead), investigation (lead), methodology (lead), software (lead), visualization (lead), writing – original draft (lead), writing – review and editing (equal). **Joanna K. Gilmore:** conceptualization (equal), project administration (equal), resources (equal), supervision (equal), writing – review and editing (equal). **La' Sheia Oubré:** conceptualization (equal), project administration (equal), resources (equal), supervision (equal), writing – review and editing (equal). **Ade A. Ofunniyin:** conceptualization (equal), project administration (equal), resources (equal), supervision (equal). **Graciela S. Cabana:** resources (equal), supervision (equal), writing – review and editing (equal). **Theodore G. Schurr:** conceptualization (equal), project administration (equal), supervision (equal), writing – original draft (equal), writing – review and editing (equal).

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Data Availability Statement

The data that supports the findings of this study are available in the article as embedded media files, Supporting Information, or links on Vimeo (https://vimeo.com/asabgproject).

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.