

Exploring Emerging ANR Issues: A Case Study of VR Tour Integration for Specialty Crop Communication

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Exploring Emerging ANR Issues: A Case Study of VR Tour Integration for Specialty Crop Communication

Abstract

Agricultural and natural resources (ANR) communication students must be prepared to engage diverse stakeholders in science-based dialogue about emerging topics. This study examined the integration of a virtual reality (VR) tour into two undergraduate ANR communication courses to enhance student awareness, perceptions, and knowledge of the specialty crops hemp and kratom within a land grant university research context. Guided by place-based education (PbEd), the VR tour featured immersive content from a land grant university research center in the southeastern U.S. and was followed by a post-retrospective questionnaire completed by 30 students. Quantitative results revealed significant increases in students' awareness of research, legality, and medicinal properties of both crops, with greater shifts observed for kratom. While perceptions of hemp improved modestly, kratom perceptions showed statistically significant positive changes across all measured dimensions. Open-ended responses emphasized learning about kratom's medical uses and hemp's legal status. The VR tour supported ANR literacy development by virtually connecting students with scientists and research environments. Findings suggest VR tours are effective tools for enhancing ANR communication competencies and engaging students with complex agricultural issues. Implications include the potential for VR to support interdisciplinary instruction, stakeholder engagement, and broader outreach. Recommendations for future research include exploring further VR integration into ANR communication curricula, long-term impacts, and the role of immersive technologies in supporting diverse learners.

Keywords

Virtual reality, kratom, hemp, communication, specialty crops

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Introduction

Agricultural and natural resources (ANR) communication faculty, programs, and curricula should implement innovative approaches to train upcoming professionals in the discipline to critically explore and engage in current scientific topics to effectively dialogue with stakeholders (Harsh et al., 2018; Leal et al., 2019; Leal et al., 2020; National Academies of Sciences, Engineering, and Medicine [NASEM], 2017). A significant need exists for ANR communication students to learn about interdisciplinary scientific techniques such as sustainable food, shelter, and clothing production (McKim et al., 2017; IAASTD, 2009). By understanding scientific concepts, contexts, and issues, communication and extension professionals have the potential to serve in the role of trusted messenger as they build relationships and assist stakeholders to make informed science-based decisions about ANR practices and products (Middleton et al., 2024; Sanders et al., 2024). ANR communicators can inform other members of society who may be disconnected from agriculture to gain knowledge of food and fiber production, agricultural marketing, distribution, nutrition, and conservation (Hubert et al., 2000; Reilly et al., 2022). Additionally, land grant universities can communicate ANR research to communities to advance the agricultural industry, protect the environment, and improve public health (Franz & Townson, 2008; National Research Council, 1996). An increase in societal ANR awareness and research-based solutions could then positively impact education systems, the economy, environment, and policy (Frick et al., 1991; Hubert et al., 2000; National Research Council, 2009).

ANR communication students must be multidimensionally literate in agriculture and the environment. They should understand the interrelationships of the land, social systems, and technology as well as human ANR impacts (Cardwell, 2005). To be a credible and trustworthy ANR communication professional, it is imperative to stay-up to date with current events, issues, and their complexities (Brossard & Nissbet, 2007; NASEM, 2017). ANR communication students should practice environmental scanning of media and organizations, information seeking, and critical listening and thinking to evaluate message frames, source credibility, and delivery channels (Fischhoff, 2013). They should also be able to engage in ANR locations and dialogue with experts and stakeholders in-person and via a variety of media formats (Fährnich et al., 2021; Leal et al., 2019). ANR communication programs should consider embedding media and science literacy lessons and activities into courses for students to practice and solidify these skillsets. An opportunity exists to leverage instructional and communication technologies such as virtual reality (VR) tours to foster communication students' ANR literacy skill development and understanding of current topics like specialty crops.

Specialty Crops as an ANR Issue Communication Context

The topic of specialty crops is one communication students could explore in a curriculum incorporating an ANR literacy skills focus. The demand for production of certain specialty crops in the United States has grown over time, but production of these specialty crops come with several risks traditional crops farmers may not encounter including production, financial, regulatory, marketing, and labor challenges (Neill & Morgan, 2021). Producing a specialty crop (e.g., hemp or kratom) can be profitable as the demand continues to increase. Hemp, hemp products, and professional development events focused on careers in hemp have gained attention

in recent years (Colclasure et al., 2023; Kim & Mark, 2023; Rampold et al., 2021). The 2018 Farm Bill legalized industrial hemp, a variety of the *Cannabis sativa* plant, at the federal level and removed it from the Controlled Substances Act (Kim & Mark, 2023). Hemp is grown worldwide and included in thousands of fiber and health products (Kim & Mark, 2023). Marijuana and hemp belong to the same plant species, but hemp has a different genetic and chemical makeup. Hemp has 0.3% or less tetrahydrocannabinol (THC) compared to marijuana, which can contain up to 20% THC (Adesina et al., 2020). Researchers have found hemp could fit well into a sustainable crop rotation and can be grown without pesticides to improve soil health (Adesina et al., 2020). In recent years, kratom has also gained attention as reports of people using and growing the medicinal plant in the U.S. have increased (Covvey et al., 2020). Kratom is widely found in Southeast Asia; however, its use is increasing in the U.S. as research has found it can be used as a substitute for other drugs to improve moods, manage pain, and minimize addiction to opioids (Rossheim & McDaniel, 2025; Smith et al., 2023). The Food and Drug Administration (FDA) has warned previous studies found kratom can have negative health effects (Rossheim & McDaniel, 2025). The Federal Kratom Consumer Protection Act was introduced to congress in 2023, and 13 states have passed a version of the act for safe regulation (U.S. Congress, 2023).

As some U.S. land grant universities study the viability of specialty crops increasing in popularity, there is also an opportunity for ANR communication courses to prepare students to explore the crops alongside scientists. Hemp researchers have determined communication and trust-building with farmers are key for them to adopt industrialized hemp and related technologies (Hopf et al., 2025). As kratom is early in adoption, it is imperative to follow and remain knowledgeable about policy developments as well as new scientific findings to communicate with stakeholders (Zhang et al., 2025). Because emerging specialty crop issues require students to understand complex scientific, policy, and societal dimensions within authentic contexts, engaging instructional approaches such as VR tours may be particularly well suited to prepare future ANR communicators.

Virtual Reality (VR) Tours for Immersive ANR Issue Engagement

Prior ANR communication research revealed VR tour creation and implementation can connect students and informal public audiences in dialogue about science topics (Stone et al., 2022). Immersive technology like VR tours can place instructors and students into new roles and provide opportunities and challenges when incorporated into teaching (Woerner, 1999). VR allows students to visit different locations without having to physically go to them. Virtual field trips also allow teachers to bring students to locations that may be difficult to physically and financially access with a group of students (Barnett et al., 2024; Stone et al., 2022; Woerner, 1999). Researchers have explored numerous aspects of VR in education such as educational effectiveness, the learning process, longitudinal exposure, and comparisons of currently available tools used to create virtual field trips (Heuke genannt Jurgensmeier et al., 2023; Makransky & Mayer, 2022; Petersen et al., 2022; Zhao et al., 2021).

With virtual technology becoming more accessible to teachers for educational use, researchers have explored feasibility, cost, necessary time commitment, student outcomes, and ease of usability for a variety of 360-degree cameras and image stitching software. The research

indicated that certain software and cameras are more appropriate depending on educational goals and budget (Heuke genannt Jurgensmeier et al., 2023). One study found that computer viewed virtual field trips were less immersive and had lower interaction than those incorporating a version of virtual goggles, including low-cost viewing hardware options such as cardboard glasses on a smartphone (Heuke genannt Jurgensmeier et al., 2023). Petersen et al. (2022) determined that high interactivity within VR is important to increase learner immersion in a virtual environment. For example, when using a computer screen (low immersion) rather than VR goggles (high immersion), if learners can interact with the content, the engagement will still lead to learning gains. Makransky and Mayer (2022) examined VR educational immersion in comparison to watching a video. The study separated 102 middle school students into either a virtual trip or video group to learn about the country Greenland, and those in the virtual trip group had higher scores in enjoyment, interest, and information retention (Makransky & Mayer, 2022).

VR tours are emerging as powerful tools in ANR education, offering immersive, site-based experiences that enhance science learning and agricultural literacy. These digital environments allow students to explore farms, conservation areas, and laboratories to support experiential learning and engagement with complex concepts (Pulley et al., 2025). Initiatives like *Streaming Science* (2025) and *The iVisit Project* (2025) have demonstrated how 360° VR tours can effectively communicate topics such as forest ecology, estuary systems, and sustainable agriculture to emphasize authentic, context-rich instruction. The VRFARM framework—Facilitation, Application, Reflection, and Measurement—provides a structured approach to integrating VR into agricultural education, promoting deeper reflection and assessment of learning outcomes (Greig et al., 2024). However, researchers have emphasized the need for continued investigation into the long-term impacts of VR tours, particularly regarding student engagement, knowledge retention, and equitable access across diverse educational settings (Pulley et al., 2025). Understanding these impacts is essential for optimizing VR's role in science communication and participatory learning. As VR technology becomes more cost effective and more VR tours are widely available, ANR communication scholars should consider evaluating the impacts of VR experiences. Despite growing evidence supporting VR in education, a research gap exists in understanding how low-immersion VR tours function as science communication tools within ANR communication education and how they shape students' awareness, knowledge, and perceptions of ANR issues and land grant university research.

Conceptual Framework

The pedagogical approach of place-based education (PbEd) guided this study. PbEd blends community involvement, experiential learning, and contextual teaching to enhance understanding and connection to local cultures, environments, and contexts (Gruenewald, 2003; Yemini et al., 2023). PbEd is essential to ensure that education directly contributes to the well-being of the social and ecological communities where people live (Gruenewald, 2003). Incorporating PbEd in educational settings recognizes that local communities hold intergenerational knowledge, skills, and systems of mutual support. The support can be found through ceremonies, art, civil liberties, and discussion (Yemini et al., 2023). The emphasis of place goes beyond what is defined as geographic and further encompasses politics, social networks, economics, and culture (Yemini et al., 2023). While PbEd can be seen as challenging

or unconventional when it comes to pedagogical approaches to education, it champions innovation in teaching and student learning objectives (Yemini et al., 2023). Youth demonstrate a natural curiosity for the natural world, and PbEd allows them to directly experience and investigate the community around them through the lens of education (Smith, 2002). By allowing students to identify, investigate, and engage with issues in their local community, teachers incorporate real-world problem solving through PbEd (Smith, 2002). In agriculture, scholars have applied PbEd to explore how place attachment can promote sustainability in a community food system (Henry-Stone, 2008). Also, Angstmann et al. (2019) implemented a PbEd framework and found undergraduate students working on a campus farm developed place-attachment and increased their scientific literacy.

PbEd should ideally occur in-person and fully immersed in an environment. However, due to time, budget, and travel, PbEd often is not possible for classes bound by these brick-and-mortar constraints (Loizzo et al., 2019; Yemini et al., 2023). Therefore, educators are finding VR tours can provide similar embodied experiences for learners to vicariously move around a space via navigable computer-generated visuals (Park, 2019). Educators can utilize VR tours to parallel the principles of PbEd to engage learners in virtual communities, environments, and issues (Wallgrün et al., 2022). In this study, a PbEd pedagogical approach was applied through a low immersion VR tour intervention to introduce students to a land grant university's specialty crops research context, related scientific concepts, and scientists.

Purpose and Research Objectives

This study examined ANR communication college students' experiences exploring a VR tour focused on hemp and kratom specialty crops. Specifically, we implemented the VR tour in two classes then students completed a post-retrospective questionnaire about their tour perceptions and learning. The following research objectives (ROs) guided the study:

- RO1: Examine the extent to which the VR tour increased students' awareness of hemp and kratom research conducted at a land grant university.
- RO2: Investigate students' perceptions of hemp and kratom following the VR tour experience.
- RO3: Assess changes in students' content knowledge related to hemp and kratom as a result of the VR tour.

Methods

Research Design

The study followed a quantitative case study survey research design (Mills et al., 2010). The purpose of the approach is to collect data from a specific selected sample through a questionnaire to describe trends in that particular case (Mills et al., 2010). In this study, a simple descriptive design was employed to pilot a VR tour about specialty crops and specifically examine ANR communication college students' perceptions and learning. The study received human subjects research approval from Texas Tech University's Institutional Review Board and companion approval from the University of Florida (IRB2023-671).

Context and Participants

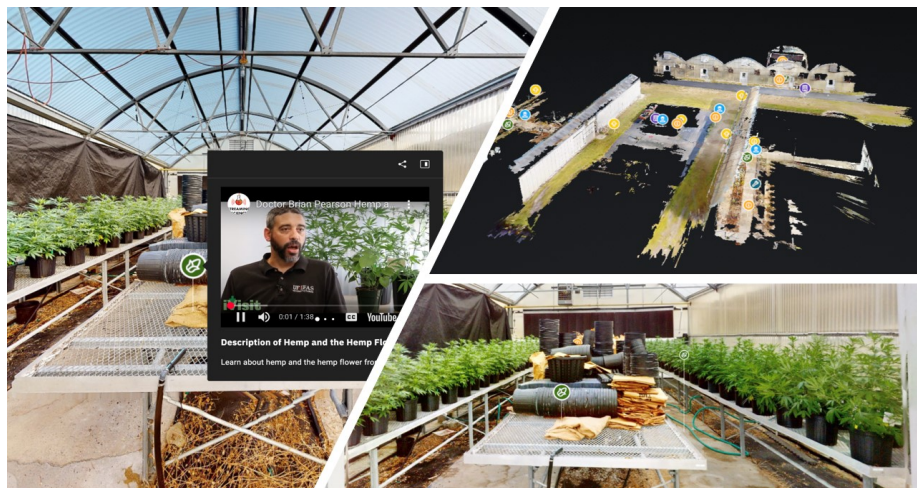
We recruited participants through convenience sampling of two courses at a land grant university (Dillman et al., 2014). The first author was a graduate teaching assistant for one of the classes, and the second and fourth authors were instructors for the courses. The classes were AEC 3065 Issues in Agricultural and Life Sciences, an undergraduate class for sophomore standing and higher, and AEC 4035 Communication Practices for Agricultural and Life Sciences, also an upper-level undergraduate course. Both classes were housed in the University of Florida's College of Agriculture in the Department of Agricultural Education and Communication (AEC). AEC 3065 focused on a broad range of issues that impact the agricultural industry and how to find, understand, and communicate valid information related to the issues. AEC 4035 focused on students working with science experts to develop online and print format photo essays featuring the experts' teaching, research, and extension programs. Across the two courses, students ($N = 30$) viewed the VR tour and completed a post-retrospective questionnaire during the Fall 2024 semester. One of the courses did not complete two of the questions due to an error with the questionnaire logic. This was fixed and the second course completed the entire questionnaire. The lead author visited each class, introduced the VR tour and study, discussed the specialty crop context, demonstrated tour navigation, and administered the questionnaire. Participants then viewed the tours via desktop computers and mobile devices for the remaining class time (approximately 35-45 minutes). They did not use headsets. Participants voluntarily consented to participate in the research.

VR Tour Intervention

The first and second authors created the VR tour implemented in this study as part of a United States Department of Agriculture (USDA) Higher Education Challenge grant (award no. 2021-70003-35432). The grant was a partnership between Texas Tech University (Principal Investigator Dr. Courtney Meyers), Kansas State University (Co-PI Dr. Gaea Hock), and the University of Florida (Co-PI Dr. Jamie Loizzo). *The iVisit Project's* purpose is to create virtual tours of ANR spaces to allow college students from all over the country to vicariously experience the places, learn about related ANR topics and issues, and discover related careers. The tour featured the UF/IFAS Mid-Florida Research and Education Center (MREC) in Apopka, Florida and showcased a scan of the hemp, kratom, and begonia greenhouses on the property. We embedded pop-up videos with soundbites from science experts and information points with images and text about the specialty crops grown in the greenhouses (see Figure 1).

Figure 1

Screen Captures of VR Tour Dollhouse View, Information Points, and Hemp Greenhouse



The featured scientist experts reviewed and approved the content for scientific accuracy. Tour learning objectives relevant to the study included:

- describe UF/IFAS MREC and its purpose.
- discuss research happening at MREC.
- define and explain the importance/purpose of hemp.
- discuss different uses for hemp.
- define kratom and discuss the reason it is outlawed in some areas.
- explain how individuals use kratom and the active compounds within the plant.
- name at least two different sections of a begonia plant that can be used for cuttings.
- present potential pathways to starting a career in ANR sciences.

We created the tour with an iPad Pro with the Matterport mobile application, the Matterport Pro 2 for indoor scans, the Leica BLK 360 for outdoor scans, a Canon DSLR camera, a Rode wireless lavalier microphone, a lighting kit, multiple tripods, and Matterport desktop VR tour cloud stitching and hosting software (Loizzo et al., 2023).

Data Collection and Analysis

We used a post-retrospective questionnaire containing Likert-type scale knowledge-based questions and sentiment scales to assess students' learning and perceptions. Post-retrospective questionnaires are ideal to examine participants' immediate change in perceptions and knowledge through self-reflection after a short educational intervention, since participants are most likely to report the same agreement levels in a pre/post-test design surrounding an intervention that is short in duration as they may not remember their pre-response and often do not reflect on changes from their initial response (University of Wisconsin–Madison Division of Extension, 2021; Kowalski, 2023). The instrument included 21 items. We constructed the first set of items to focus on hemp/kratom perceptions and awareness of the land grant university's research (ROs 1 and 2).

Participants were asked to respond to a 5-point Likert-type scale from *strongly disagree* to *strongly agree*. An existing published instrument informed the second set of items to measure

participants' hemp/kratom attitudes (RO 3). We applied Colclasure et al.'s (2021) bipolar semantic differential scale with antonym pairs of adjectives such as *good/bad* and *beneficial/not beneficial* with five points between the terms. Colclasure et al. (2021) used these items as part of an instrument to measure impacts of an educational campaign on students' hemp attitudes. We coded positive adjectives as five and negative adjectives as a one. We used IBM SPSS statistical software to analyze the questionnaire results through descriptive methods. To establish content validity, the instrument was reviewed by the research team for clarity, relevance, and alignment with the VR tour intervention. Revisions were made prior to administration. Because this study was designed as a pilot with a small sample ($N = 30$), formal construct validity analyses were not conducted.

Researcher Roles and Subjectivity

All the authors are connected to ANR communication and education departments at U.S. universities as instructors, teaching assistants, and social science researchers with interests in identifying and testing innovative teaching techniques to improve curricula. The first author is a supporter of the cannabis community and recognized this bias before VR content creation. To ensure his bias did not influence the research, co-authors on the team and participating scientist subject matter experts reviewed and assisted in the development of the VR tour and assessment. The second (Co-PI) and fourth authors taught the courses in which the study data was collected. To mitigate their influence on students' participation, the first author visited each class to recruit participation and implement the VR tours and students explored the tours at their own pace. The third author was a supporting graduate student on the grant project who assisted with manuscript development, and the fifth and sixth authors (Co-PIs) reviewed assessment development, results, and supported publication development. All authors of this study subscribe to a constructivist worldview (Mensah, 2015), which posits that learners actively construct their own understanding of reality through experiences, interactions, and reflection. From this perspective, learning is not a passive absorption of facts, but a dynamic process of meaning-making shaped by prior knowledge, cultural context, and social engagement.

Limitations

Limitations of the study included generalization (Maxwell, 2023), as the research team only conducted the study with student participants enrolled in ANR communication courses at a land grant university in the Southeastern U.S. and one of the courses missed two of the questions on the questionnaire due to an error in questionnaire flow logic. This study also had a relatively small population, and random sampling was not possible. Additional limitations were the short duration of the VR tour intervention, which may not have allowed for deep engagement or long-term retention of knowledge. The lack of a control group limited the ability to compare outcomes with traditional instructional methods. Furthermore, the absence of headset-based immersive VR may have reduced the overall impact of the experience. Finally, self-reported data may be subject to bias, and the retrospective survey design may not have fully captured nuanced changes in perception and learning.

Results

RO1: Examine the extent to which the VR tour increased students' awareness of hemp and kratom research conducted at a land grant university.

RO1 was assessed with two questions that had participants rank their level of knowledge before and after completing a virtual tour of hemp and kratom greenhouses. These questions were side-by-side matrix style multiple choice questions. The hemp matrix question contained five items, and the kratom matrix question contained four items. Items focused on legality, research happenings, medicinal components, and growing conditions.

Table 1 represents the results for matrix question one. Question one assessed participants' knowledge and experience with hemp in Florida, before and after completing a virtual tour of hemp and kratom greenhouses. All items were significant, with the largest mean increase from before to after for the statement "I have seen hemp grown in carefully controlled, warm, and humid conditions" with a mean increase of 1.70. The smallest mean change was for the statement "I know that cannabinoids found in hemp can have medicinal benefits" with a mean increase of 0.40.

Table 1

Hemp Awareness and Knowledge

<i>After the VR tour, I thought...</i>	Mean Before	Mean After	Mean Change	SD	p	Count
I am aware that UF/IFAS scientists research hemp.	3.50	4.60	1.10	1.30	<.001	30
I am aware of the current legal standing of hemp production in the United States.	3.13	4.03	0.90	0.96	<.001	30
I am aware of the current legal standing of hemp production in Florida.	3.03	4.03	1.00	0.91	<.001	30
I know that cannabinoids found in hemp can have medical benefits.	4.00	4.40	0.40	0.81	.012	30
I have seen hemp grown in carefully controlled, warm, and humid conditions.	2.87	4.57	1.70	1.42	<.001	30

Note. Real limits of the scale: 1.00 – 1.49 = *strongly disagree*, 1.50 – 2.49 = *disagree*, 2.50 – 3.49 = *neutral.*, 3.50 – 4.49 = *agree*, 4.50 – 5.00 = *strongly agree*

Table 2 represents the results for matrix question two. Question two assessed participants' knowledge and experience with kratom in the Florida, before and after completing a virtual tour of hemp and kratom greenhouses. All items were significant, with the largest mean change from before to after for the statement "I am aware that UF/IFAS scientists research kratom" with a mean increase of 2.52. The smallest mean change was on the statements "I am aware of the current legal standing of kratom in Florida" and "I know what part of the kratom tree has medical benefits" with a mean increase of 1.82.

Table 2

Kratom Awareness and Knowledge

<i>After the VR tour, I thought...</i>	Mean Before	Mean After	Mean Change	SD	p	Count
I am aware that UF/IFAS scientists research kratom.	1.96	4.48	2.52	1.28	<.001	27
I am aware of the current legal standing of kratom in Florida.	2.14	3.96	1.82	1.36	<.001	28
I know that compounds produced by the kratom tree can have medical benefits.	2.11	4.14	2.04	0.96	<.001	28
I know what part of the kratom tree has medicinal compounds.	2.04	3.86	1.82	1.12	<.001	28

Note. Real limits of the scale: 1.00 – 1.49 = *strongly disagree*, 1.50 – 2.49 = *disagree*, 2.50 – 3.49 = *neutral*., 3.50 – 4.49 = *agree*, 4.50 – 5.00 = *strongly agree*

RO2: Investigate students' perceptions of hemp and kratom following the VR tour experience.

RO2 was assessed with four questions on the instrument. Two questions focused on perception of hemp and two questions focused on perception of kratom. Each question set contained a question asking participants to rank their perception of hemp or kratom before completing the tour, and then another question asking them to rank their perception of hemp or kratom after completing the tour. These four questions were all bipolar matrix style questions with scales ranging from zero to five.

The highest possible mean score was five, reflecting the positive side of the scale, and the lowest mean score was zero, reflecting the negative side of the scale. None of results for these items were significant, but the largest mean change from before to after was "Unnecessary/Necessary" with a mean increase of 0.54, and the smallest mean change was "Not Beneficial/Beneficial" and "Unacceptable/Acceptable" with a mean increase of 0.23.

Table 3*Student Hemp Perspective*

<i>I think hemp is...</i>	Mean Before	Mean After	Mean Change	SD	p	Count
Bad-Good	4.15	4.54	.39	0.77	0.096	13
Not Beneficial-Beneficial	4.38	4.62	0.23	0.59	0.190	13
Unacceptable-Acceptable	4.15	4.38	0.23	0.83	0.337	13
Unnecessary-Necessary	3.62	4.15	0.54	1.05	0.089	13
Unimportant-Important	3.92	4.23	0.31	0.95	0.264	13
Not Essential-Essential	3.69	4.15	0.46	0.97	0.111	13

Table 4 represents data analysis of question five and six. Question five asked participants to rank their perception of kratom before completing the tour, and question six asked participants to rank their perception of kratom after completing the tour. The highest possible mean score is a five, reflecting the positive side of the scale, and the lowest mean score is a zero, reflecting the negative side of the scale. All the items were significant, with the largest mean change from before to after in “Bad/Good”, “Not Beneficial-Beneficial”, and “Unimportant-Important” with a mean increase of 1.33. The smallest mean change was “Unnecessary/Necessary” and “Not Essential/Essential” with a mean increase of 1.08.

Table 4*Student Kratom Perspective*

<i>I think kratom is...</i>	Mean Before	Mean After	Mean Change	SD	P	Count
Bad-Good	2.50	3.83	1.33	0.89	<.001	12
Not Beneficial-Beneficial	2.58	3.92	1.33	0.89	<.001	12
Unacceptable-Acceptable	2.67	3.83	1.17	1.12	0.004	12
Unnecessary-Necessary	2.42	3.50	1.08	0.99	0.003	12
Unimportant-Important	2.42	3.75	1.33	1.23	0.003	12
Not Essential-Essential	2.42	3.50	1.08	0.99	0.003	12

RO3: Assess changes in students' content knowledge related to hemp and kratom as a result of the VR tour.

RO3 was assessed using an open-ended question that asked participants to list the top three things they learned from completing the VR tour of the hemp and kratom greenhouses at the UF/IFAS MREC. We coded the data into categories and included representative participant responses from each group ($N=30$) (100% of respondents; see Table 5).

Table 5

Content Knowledge Categories For 'The Top Three Things I Learned...' Open-ended Prompt

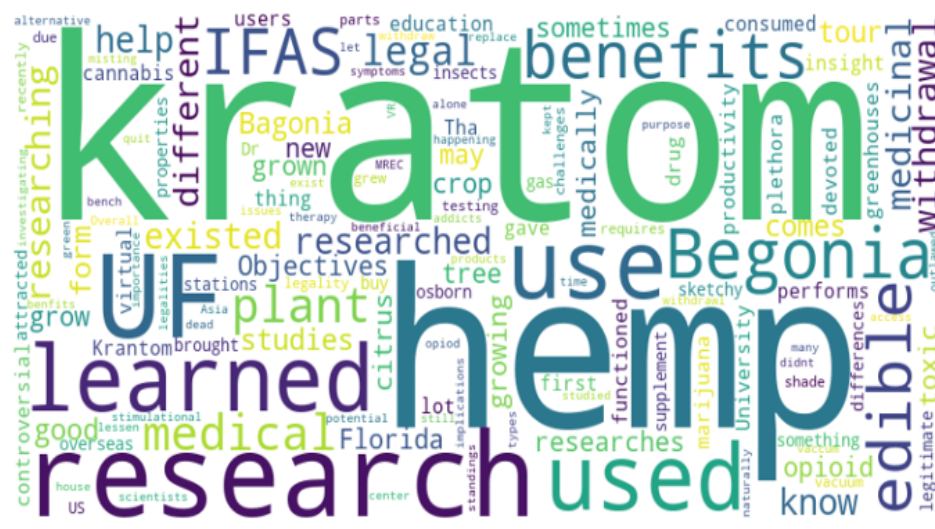
Category	Sample Responses
Understanding Kratom	· <i>What Kratom is.</i> · <i>Kratom has medicinal benefits and can help opioid withdrawal.</i> · <i>I did not know that kratom was not a form of marijuana.</i> · <i>Kratom has legitimate medicinal uses; it's not just a sketchy supplement you can buy at gas stations.</i>
Research on Hemp	· <i>UF/IFAS studies hemp.</i> · <i>Hemp was only recently legal to grow/research in Florida in 2018.</i> · <i>Hemp may replace citrus.</i> · <i>Hemp requires some shade.</i> · <i>Begonias can be edible.</i> · <i>Dr. Pearson's research on what insects are attracted to what plants.</i>
Research on Other Plants	· <i>Different research happening at MREC.</i> · <i>That we have access to these VR tours.</i> · <i>Why they are beneficial.</i>
Access and Benefits of VR Tours	

Participants' feedback about their learning predominantly focused on understanding kratom as 60% of their comments mentioned kratom and 40% of those comments highlighted its medical benefits. The second most listed learning topic was research on hemp as 50% of participants commented about the plant, and 30% of those comments included mention of its legal status and history. We used artificial intelligence (AI) tool Microsoft CoPilot to generate a visual word

cloud of participants' responses to the top three content items they learned from the VR tour, and the AI generated visualization appeared similar to our category coding results (see Figure 2).

Figure 2

Word Cloud of Participants' Top Three Content Items they Learned



The terms *kratom*, *hemp*, and *research*, occurred the most (as indicated by the large size), and terms such as *UF*, *IFAS*, *benefits*, *legal*, *edible*, and *Begonia*, appeared secondary (as shown in a medium size) as participants' described the land grant, characteristics and regulation of the specialty crops, and the additional plants such as *Begonias* shown in the greenhouses. Comments about the benefits, format, and accessibility of the VR tours themselves appeared the least. This word cloud provides an overview of the dominant themes, based on the frequency of words that occurred in participant responses. Word clouds function as a data reduction strategy to make results more visual for diverse groups to understand, as open-ended questions can produce large quantities of text, while also preserving participant voice and language by keeping the exact terms used by participants rather than researcher developed themes or labels (Bletzer, 2015; DePaolo & Wilkinson, 2014).

Discussion and Implications

The VR tour appeared to have increased participants' knowledge and positive perspectives of hemp, but there was a larger increase in knowledge and positive perspectives of kratom. This could be because kratom is a lesser-known and discussed specialty crop (Rossheim & McDaniel, 2025; Smith et al., 2023), whereas hemp and cannabis have been a point of controversy over the past decade, with many news outlets, policy makers, and politicians regularly discussing hemp (Adesina et al., 2020; Hopf et al., 2025). Participants may have held previous beliefs about hemp related to question response options (good vs. bad, beneficial vs. nonbeneficial, etc.) and a singular VR lesson on hemp research may not have been long enough in duration or depth to alter those beliefs.

VR tours can serve as a powerful tool to increase awareness of current ANR topics and events (Pulley et al., 2025), thereby preparing multidimensionally literate ANR communication students (Cardwell, 2005). By engaging with immersive content, students can better understand the complexities of agricultural systems and emerging issues. Table 5 also provided background into what participants recalled learning, and this kind of information can help guide future education and VR education on specialty crops. Topics surrounding true definitions, home state legality, medicinal usage, and agricultural considerations were all among the top three things participants learned. These concepts may have been the most memorable and useful for participants going through the tour. Determining what concept(s) participants might find the most interesting and intertwining those concepts with a VR tour lesson or purpose, could lead to better understanding and knowledge retention. The featured science experts in the tour may have also influenced learning outcomes, as students often relate more closely to peers (fellow students) than faculty, enhancing engagement and retention. This aligns with literature on peer role models in education, which suggests that relatable presenters can positively impact student learning and motivation (Gladstone et al., 2021; Hooper et al., 2025).

Overall, the VR tour supported ANR literacy development by providing contextualized, experiential learning aligned with place-based education (PbEd) principles. This VR tour provided students with the chance to identify, investigate, and engage with concepts that are within their academic “community” but not their physical location, and there were clear knowledge gains and changes in perspective on specific aspects of specialty crops. VR tours, while not traditionally thought of as PbEd, appear to elicit similar responses from participants as the more traditional in-person PbEd experiences. The VR tour allowed students to virtually engage with land grant university research and specialty crops, fostering important ANR communication professional skills of deeper understanding and critical thinking about ANR issues (Harsh et al., 2018; Leal et al., 2020; NRC, 2009; Sanders et al., 2024).

Recommendations and Future Research

Overall, the studied VR tour was an effective method to educate ANR communication students on hemp and kratom plant structure, legality, and research happenings. The tour also positively impacted participants' perspectives of the specialty crops explored through the tour. Similar VR tours should be created on other specialty crops like cannabis, hops, or mushrooms and coupled with questionnaires like the instrument developed for this study to better understand VR tours' ability to educate and alter perspectives on crops and concepts that may be new to students. Tours like these may be innovative ways for universities, research centers, or private industry to introduce their audiences to research happening at their facilities, or to present innovative ideas that may be new and different. Future studies should implement ANR VR tours as continuous lessons rather than one-off classes. This would allow students to become more familiar with how the VR software works, as well as give them the chance to fully immerse themselves in the virtual tour space. This may enhance learning and sense of place (Petersen et al., 2022; Smith, 2002; Yemini et al., 2023).

Using VR continuously rather than a one-off lesson may also be a key component to VR education and immersive learning. Considering Greig et al.'s (2024) VRFARM framework, “repetition” may be just as important as “reflection”, and “repetition” could be added in or used

interchangeably in the developed VRFARM educational framework. The framework could also be expanded to VRFARMER, which would add in “Enactment” and “Repetition”. After students go through the facilitation, application, reflection, and measurement, they could enact what they learned in the VR tour in the real world through research, physical action, or mock experiences, and then repeat the VR tour or a portion of the tour to reinforce the content, feelings, and knowledge gain. The addition of “Enactment” and “Repetition” also closely aligns with Kolb’s Experiential Learning Theory (Kolb, 1984).

Future research teams can also work with research centers or educators to create tours that have built-in lessons and assessments within the tours, so they are designed to educate and encourage student critical thinking and issue reflection concurrently while navigating the virtual environments. Educators should explore how VR tours can be integrated into broader ANR curricula to support interdisciplinary learning and science communication. Practitioners may consider using VR to engage stakeholders in agricultural innovation and policy discussions. Scholars should investigate the long-term impacts of VR on ANR communication students’ media and science literacy skills development. Additional research could examine the effectiveness of VR tours across diverse student populations, including underrepresented groups, and assess how different levels of immersion (e.g., headset vs. desktop) influence learning outcomes.

References

- Angstmann, J. L., Rollings, A. J., Fore, G. A., & Sorge, B. H. (2019). A pedagogical framework for the design and utilization of place-based experiential learning curriculum on a campus farm. *Journal of Sustainability Education*, 20, 1–14. https://digitalcommons.butler.edu/facsch_papers/1409
- Adesina, I., Bhowmik, A., Sharma, H., & Shahbazi, A. (2020). A review on the current state of knowledge of growing conditions, agronomic soil health practices and utilities of hemp in the United States. *Agriculture*, 10(4), Article 129. <https://doi.org/10.3390/agriculture10040129>
- Barnett, C. P., Loizzo, J., Bunch, J. C., Baker, S., & Anderson, M. P. (2024). Influence of charismatic animals on youths’ environmental knowledge and connection to water through the application of virtual reality tours. *The Journal of Environmental Education*, 55(5), 389–401. <https://doi.org/10.1080/00958964.2024.2349561>
- Bletzer, K. V. (2015). Visualizing the qualitative: Making sense of written comments from an evaluative satisfaction survey. *Journal of Educational Evaluation for Health Professions*, 12, Article 12. <https://doi.org/10.3352/jeehp.2015.12.12>

- Brossard, D., & Nisbet, M. C. (2007). Deference to scientific authority among a low information public: Understanding U.S. opinion on agricultural biotechnology. *International Journal of Public Opinion Research*, 19(1), 24–52. <https://doi.org/10.1093/ijpor/edl003>
- Cardwell, V. B. (2005). Literacy: What level for food, land, natural resources, and environment? *Journal of Natural Resources and Life Sciences Education*, 34, 112–117. <https://doi.org/10.2134/jnrlse.2005.0112>
- Colclasure, B., Mejia, R., Fritz, K., Sedia, E. G., & Duffey, M. (2023). Analysis of a professional development event on cannabis education for cannabis educators. *NACTA Journal*, 67(1), 11–19. <https://doi.org/10.56103/nactaj.v67i1.72>
- Covvey, J. R., Vogel, S. M., Peckham, A. M., & Evoy, K. E. (2020). Prevalence and characteristics of self-reported kratom use in a representative US general population sample. *Journal of Addictive Diseases*, 38(4), 506–513. <https://doi.org/10.1080/10550887.2020.1788914>
- DePaolo, C. A., & Wilkinson, K. (2014). Get your head into the clouds: Using word clouds for analyzing qualitative assessment data. *TechTrends*, 58(3), 38–44. <https://doi.org/10.1007/s11528-014-0750-9>
- Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The tailored design method* (4th ed.). John Wiley & Sons. <https://doi.org/10.1002/9781394260645>
- Fähnrich, B., Wilkinson, C., Weitkamp, E., Heintz, L., Ridgway, A., & Milani, E. (2021). RETHINKING science communication education and training: Towards a competence model for science communication. *Frontiers in Communication*, 6, Article 795198. <https://doi.org/10.3389/fcomm.2021.795198>
- Fischhoff, B. (2013). The sciences of science communication. *Proceedings of the National Academy of Sciences of the United States of America*, 110(Supplement_3), 14033–14039. <https://doi.org/10.1073/pnas.1213273110>
- Franz, N. K., & Townson, L. (2008). The nature of complex organizations: The case of Cooperative Extension. *New Directions for Evaluation*, 2008(120), 5–14. <https://doi.org/10.1002/ev.272>
- Frick, M. J., Kahler, A. A., & Miller, W. W. (1991). A definition and the concepts of agricultural literacy. *Journal of Agricultural Education*, 32(2), 49–57. <https://doi.org/10.5032/jae.1991.02049>
- Gladstone, J. R., & Chimpian, R. (2021). Which role models are effective for which students? A systematic review and four recommendations for maximizing the effectiveness of role models in STEM. *International Journal of STEM Education*, 8(1), 1–12. <https://doi.org/10.1186/s40594-021-00315-x>

- Greig, J. A., Colclasure, B., Rampold, S., Ruth, T., & Givens, R. (2024). Enhancing agricultural education through virtual reality: Facilitation, application, reflection, and measurement in the classroom. *Advancements in Agricultural Development*, 5(2), Article 353. <https://doi.org/10.37433/aad.v5i2.353>
- Gruenewald, D. A. (2003). Foundations of place: A multidisciplinary framework for place-conscious education. *American Educational Research Journal*, 40(3), 619–654. <https://doi.org/10.3102/00028312040003619>
- Harsh, J. L., Lamm, A.J., Abrams, K., Meyers, C., Telg, R., & Raulerson, B. (2018). Case study integration in the undergraduate classroom: Can we enhance willingness to communicate? *Journal of Applied Communications*, 102(3), Article 3. <https://doi.org/10.4148/1051-0834.2199>
- Henry-Stone, L. R. (2008). *Cultivating sustainability through participatory action research: Place-based education and community food systems in Interior Alaska* [Doctoral dissertation, University of Alaska Fairbanks]. https://ualaska.researchcommons.org/uaf_grad_indigenous_studies/26/
- Heuke genannt Jurgensmeier, N., Schmidt, R., & Stumpe, B. (2023). Creating virtual field trips for education: A comparison of software and tools for creating virtual field trips with 360° images. *International Journal of Technology in Education*, 6(3), 385–417. <https://doi.org/10.46328/ijte.441>
- Hooper, D., Egitim, S., & Hofhuis, J. (2025). Exploring the impact of near-peer role modeling on learners' basic psychological needs: Insights from English classes in Japanese higher education. *International Journal of Educational Research Open*, 8, Article 100429. <https://doi.org/10.1016/j.ijedro.2024.100429>
- Hopf, A., Watson, J. A., Swisher, M., Brym, Z., & Hoogenboom, G. (2025). Assessment of the knowledge landscape, information needs, and attitude towards decision support systems among hemp farmers in Florida. *Journal of Cannabis Research*, 7(1), Article 62. <https://doi.org/10.1186/s42238-025-00318-3>
- Hubert, D., Frank, A., & Igo, C. (2000). Environmental and agricultural literacy education. *Water, Air, & Soil Pollution*, 123(1), 525–532. <https://doi.org/10.1023/A:1005260816483>
- International Assessment of Agricultural Knowledge, Science and Technology for Development [IAASTD]. (2009). *Agriculture at a crossroads: Global report*. Island Press. https://www.fao.org/fileadmin/templates/est/Investment/Agriculture_at_a_Crossroads_Global_Report_IAASTD.pdf
- Kim, G., & Mark, T. (2023). What factors make consumers in the USA buy hemp products? Evidence from Nielsen Consumer Panel Data. *Agricultural and Food Economics*, 11, Article 5. <https://doi.org/10.1186/s40100-023-00245-y>

- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.
- Kowalski, M. J. (2023). Measuring changes with traditional and retrospective pre-posttest self-report surveys for a brief intervention program. *Evaluation and Program Planning*, 99, Article 102323. <https://doi.org/10.1016/j.evalprogplan.2023.102323>
- Leal, A., Telg, R. W., Rumble, J. N., Stedman, N. L. P., & Treise, D. M. (2019). Exploring beyond the obvious: Social skills needed for Agricultural Communication baccalaureate graduates. *Journal of Applied Communications*, 103(2), Article 4. <https://doi.org/10.4148/1051-0834.2188>
- Leal, A., Telg, R. W., Rumble, J. N., Stedman, N. L. P., & Treise, D. M. (2020). Technically speaking: Technical skills needed for Agricultural Communication baccalaureate graduates. *Journal of Applied Communications*, 104(3), Article 1. <https://doi.org/10.4148/1051-0834.2339>
- Loizzo, J., Harner, M. J., Weitzenkamp, D. J., & Kent, K. (2019). Electronic field trips for science engagement: The Streaming Science model. *Journal of Applied Communications*, 103(4), Article 2. <https://doi.org/10.4148/1051-0834.2275>
- Loizzo, J., Spandau, G., Barnett, C., Akers, A., Bolger, A., & Meyers, C. (2023). Streaming Science #5: Using virtual reality tours for engagement with your target audience. *EDIS*, 2023(5). <https://doi.org/10.32473/edis-wc440-2023>
- Makransky, G., & Mayer, R. E. (2022). Benefits of taking a virtual field trip in immersive virtual reality: Evidence for the Immersion Principle in multimedia learning. *Educational Psychology Review*, 34(3), 1771–1798. <https://doi.org/10.1007/s10648-022-09675-4>
- Maxwell, J. A. (2023). Why qualitative methods are necessary for generalization. *Qualitative Psychology*, 8(2), 111–118. <https://doi.org/10.1037/qup0000173>
- McKim, A. J., Velez, J. J., Lambert, M. D., & Balschweid, M. A. (2017). A philosophical review of science and society within agricultural education. *Journal of Agricultural Education*, 58(2), 98–110. <https://doi.org/10.5032/jae.2017.02098>
- Mensah, E. (2015). Exploring constructivist perspectives in the college classroom. *SAGE Open*, July–September, 1–14. <https://doi.org/10.1177/2158244015596208>
- Middleton, L., Shao, A., Cate, A., Haugen, J., & Li, N. (2024) An enthusiastic but uncertain welcome: Coverage of risks, benefits, and social contexts of CRISPR technology in U.S. agricultural news 2012–2022. *Journal of Applied Communications*, 108(2), Article 1. <https://doi.org/10.4148/1051-0834.2532>

- Mills, A. J., Durepos, G., & Wiebe, E. (Eds.). (2010). Case study surveys. In *Encyclopedia of case study research* (Vol. 0, pp. 125–126). SAGE Publications, Inc. <https://doi.org/10.4135/9781412957397>
- National Research Council [NRC]. (1996). *Colleges of agriculture at the land grant universities: Public service and public policy*. National Academies Press. <https://doi.org/10.17226/5133>
- National Academies of Sciences, Engineering, and Medicine. [NASEM] (2017). *Communicating science effectively: A research agenda*. The National Academies Press. <https://doi.org/10.17226/23674>
- National Research Council. (2009). *Transforming agricultural education for a changing world*. National Academies Press. <https://doi.org/10.17226/12602>
- Neill, C. L., & Morgan, K. L. (2021). Beyond scale and scope: Exploring economic drivers of U.S. specialty crop production with an application to edamame. *Frontiers in Sustainable Food Systems*, 4, Article 582834. <https://doi.org/10.3389/fsufs.2020.582834>
- Park, L. (2019). Virtual reality as a pedagogical tool for interdisciplinarity and place-based education. In *Springer eBooks* (pp. 35–51). https://doi.org/10.1007/978-3-030-32471-1_3
- Petersen, G. B., Petkakis, G., & Makransky, G. (2022). A study of how immersion and interactivity drive VR learning. *Computers & Education*, 179, Article 104429. <https://doi.org/10.1016/j.compedu.2021.104429>
- Pulley, J., Claflin, K., & Thompson, A. (2025). A review of virtual reality applications in agriculture education and recommendations for future research. *Journal of Agricultural Education*, 66(3), Article 15. <https://doi.org/10.5032/jae.v66i3.3195>
- Rampold, S., Brym, Z., Kandzer, M. S., & Baker, L. M. (2021). Hemp there it is: Examining consumers' attitudes toward the revitalization of hemp as an agricultural commodity. *Journal of Applied Communications*, 105(4), Article 2. <https://doi.org/10.4148/1051-0834.2385>
- Reilly, C., Stevenson, K. T., Warner, W., Park, T., Knollenberg, W., Lawson, D., Brune, S., & Barbieri, C. (2022). Agricultural and environmental education: A call for meaningful collaboration in a U.S. context. *Environmental Education Research*, 28(9), 1410–1422. <https://doi.org/10.1080/13504622.2022.2040431>
- Rossheim, M. E., & McDaniel, P. A. (2025). Public health researcher warns of the drug kratom's dangers and advocates for legislation governing this substance of concern. *University of North Texas Health Science Center*. <https://www.unthsc.edu/newsroom/story/public-health-researcher-warns-of-the-drug-kratoms-dangers-and-advocates-for-legislation/>

- Sanders, C., Lamm, K.W., & Ramsey, E. (2024). Identifying Key Competencies for Extension Communication: A Delphi Analysis to Guide Program Development. *Journal of Applied Communications*, 108(3), Article 7. <https://doi.org/10.4148/1051-0834.2537>
- Smith, G. A. (2002). Place-based education: Learning to be where we are. *Phi Delta Kappan*, 83(8), 584–594. <https://doi.org/10.1177/003172170208300806>
- Smith, K. E., Rogers, J. M., & Feldman, J. D. (2023). Kratom's emergence and persistence within the US polydrug epidemic. *Current Addiction Reports*, 10(2), 262–271. <https://doi.org/10.1007/s40429-023-00476-5>
- Stone, W., Loizzo, J., Aenlle, J., & Beattie, P. (2022). Labs and Landscapes Virtual Reality: Student-created forest conservation tours for informal public engagement. *Journal of Applied Communications*, 106(1), Article 8. <https://doi.org/10.4148/1051-0834.2395>
- Streaming Science. (2025). *Bringing the science directly to you!* <https://streamingscience.com/>
- The iVisit Project. (2025). *Take a trip without leaving your seat.* <https://theivisitproject.com/>
- University of Wisconsin–Madison Division of Extension. (2021). Using the retrospective post-then-pre questionnaire design. *Program Development & Evaluation*. <https://fyi.extension.wisc.edu/programdevelopment/files/2021/12/RetrospectivePost-then-Pre.pdf>
- U.S. Congress. (2023, October 6). *H.R. 5905 — Federal Kratom Consumer Protection Act* [All actions]. Congress.gov. <https://www.congress.gov/bill/118th-congress/house-bill/5905/all-actions>
- Wallgrün, J. O., Chang, J. S., Zhao, J., Trenham, P., Sajjadi, P., Simpson, M., & Klippel, A. (2022). Place-based education through immersive virtual experiences — Preparing biology students for the field. *Journal of Biological Education*, 58(2), 406–429. <https://doi.org/10.1080/00219266.2022.2067580>
- Woerner, J. J. (1999). Virtual field trips in the earth science classroom. In Rubba, P. A., Rye, J. A., & Keig, P. F. (Chairs & Eds.), *Proceedings of the annual conference of the Association for the Education of Teachers in Science*, Austin, TX. <https://files.eric.ed.gov/fulltext/ED446901.pdf>
- Yemini, M., Engel, L., & Simon, A. B. (2023). Place-based education—A systematic review of literature. *Educational Review*, 1–21. <https://doi.org/10.1080/00131911.2023.2177260>
- Zhang, M., Li, Y., Chen, J., & Pearson, B. J. (2025). Aeroponics enables consistent cutting propagation of kratom (*Mitragyna speciosa*): Impacts of photoperiod, cultivar, and rooting hormone. *Frontiers in Plant Science*, 16, Article 1650327. <https://doi.org/10.3389/fpls.2025.1650327>

Zhao, J., Wallgrün, J. O., Sajjadi, P., LaFemina, P., Lim, K. Y., Springer, J. P., & Klippel, A. (2021). Longitudinal effects in the effectiveness of educational virtual field trips. *Journal of Educational Computing Research*, 60(4), 1008–1034.
<https://doi.org/10.1177/07356331211062925>