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EDITED BY
Will Valley,
University of British Columbia, Canada

REVIEWED BY
Pablo Torres-Lima,
Metropolitan Autonomous University, Mexico
Alexandra Lyon,
Kwantlen Polytechnic University, Canada
Kent Mullinix,
Kwantlen Polytechnic University, Canada

*CORRESPONDENCE
Jennifer A. Nicklay
✉ nick0135@umn.edu

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Becoming agroecologists: A pedagogical model to support graduate student learning and practice

Jennifer A. Nicklay[1]*, Sharon V. Perrone[2,3] and Vivian M. Wauters[2,4]

[1]Department of Soil, Water, and Climate, University of Minnesota – Twin Cities, Saint Paul, MN, United States, [2]Department of Horticultural Science, University of Minnesota – Twin Cities, Saint Paul, MN, United States, [3]Soil and Plant Science Division, USDA-NRCS, Washington, DC, United States, [4]Department of Plant Sciences, University of California, Davis, Davis, CA, United States

Introduction: Agroecology has multiple beginnings in diverse knowledge systems, growing practices, and social movements which, as a whole, seek systemic transformation to build just food system futures. As graduate students, we have been inspired by agroecological movements and practitioners and endeavored to build our knowledge and capacities as agroecologists. Over the course of seven years, we have worked collectively with an evolving cohort to build relationships, understand critical lineages, and practice participatory processes that we found necessary for our development as agroecologists at the University of Minnesota-Twin Cities. Building on this work, we sought to refine an emergent understanding of the necessary components of an agroecological pedagogy.

Methods: We thus hosted a series of workshops in summer 2019 to facilitate collective reflection and development of a pedagogy, which we further refined through collective autoethnography.

Results: The resulting model contains five key components: a cohort at the heart of the model to facilitate collective learning; critical inquiry as the foundation of knowledge production; relational centering as the basis for building and maintaining care-based relationships with self and others; participatory practice as a space for taking action through and within relationships; and situated knowledge to recognize the unique and incomplete knowledge that each individual brings to their work.

Discussion: We imagine this model as the basis for a dedicated agroecology graduate program, and we close by sharing ongoing implementation efforts, key areas for further development, and our hopes for continued integration with broader movements. Ultimately, we have experienced this process as a transformational agroecological space and hope others are inspired to adapt, imagine, and enact the process, model, and principles in their own places and communities.

KEYWORDS

participatory practice, critical theory, Communities of Practice (CoP), agroecology, sustainable agriculture, graduate education, situated knowledge, cohort learning

1. Introduction

Agroecology is often described as the "ecology of whole food systems" (Francis et al., 2003), a holistic approach to exploring social, ecological, and political relationships that is transdisciplinary, participatory, and action-oriented to create sustainable socio-ecological relationships (Gliessman, 2018). Integrative agroecology emerges at the nexus of science, movements, and practice, which interact in different ways depending upon the specific place, social relationships, and ecological context (Wezel et al., 2009, 2020; Montenegro de Wit, 2014; Rivera-Ferre et al., 2021). Political agroecology acknowledges that collective action is necessary to enact structural change and create institutional frameworks that reproduce agroecological

systems (Gonzalez de Molina, 2013). Integrative and political agroecology, combined, focus on the need for multiple, interconnected systemic transformations to address the colonialism, racial capitalism, and globalization at the root of ongoing food systems crises (Andreotti et al., 2018; Montenegro de Wit, 2021); the goal of such transformative agroecologies is to create and sustain emancipatory and liberatory food systems (Gonzalez de Molina, 2013).

Each of us—Vivian, Sharon, and Jennifer—were drawn to pursue agroecology in our graduate education because of previous experiences with transformative agroecological efforts in community gardens, farms, farmers markets, community arts programs, policy networks, and social movements. Our graduate programs in the agricultural sciences, however, were grounded in Western scientific norms (e.g., reductionism, objectivism, top-down knowledge transfer, technological interventions); as a result, they largely failed to implement pedagogies that aligned with agroecological principles, which is a common challenge in university agroecology programs (Altieri and Francis, 1992; Rivera-Ferre et al., 2021). Yet, the informal spaces in our program, the "hidden curricula" (Rivera-Ferre et al., 2021), created with fellow students, faculty, and practitioner partners facilitated relationships with places and people, both within and beyond academia, that embodied agroecological values such as multiple ways of knowing and horizontal learning. Over the last seven years, we have explored how the "hidden curricula" could move beyond the margins/interstitial spaces, posing the question: "What relationships, values, and experiences are vital in a pedagogy for transformative agroecology learning in our graduate programs?"

In this paper, we present a pedagogy for graduate agroecology education that we collectively developed with students, faculty, and staff at the University of Minnesota—Twin Cities (UMN-TC), as well as the multi-year process from which it emerged. We share both pedagogy and process because, as David and Bell (2018) aptly observe, "agroecological education is not only about content; it is also about process." We begin with an overview synthesizing key pedagogical frameworks for agroecology learning. We then describe our specific context at UMN-TC, focusing on graduate student-led efforts through which key pedagogical needs were identified and later refined in a series of participatory workshops. Ultimately, the proposed pedagogy affirms the need for critical, relational, and participatory pedagogies that are implemented through collective learning structures. We present this pedagogy as a work in progress, and we hope others are inspired to adapt, imagine, and enact the process, pedagogy model, and principles in their own groups, programs, institutions, and communities.

2. Overview of university agroecology pedagogies

While agroecology learning takes place in many contexts, from farmer networks to high school programs, we focus on university-level education. Undergraduate and graduate programs studying whole food systems are located around the world, including North America (Jacobsen et al., 2012; Galt et al., 2013; Hartle et al., 2017; Valley et al., 2018), Central and South America (Intriago et al., 2017; Sarandon and Marasas, 2017), Europe (Code, 2017; Francis et al., 2018; Migliorini et al., 2018; Wezel et al., 2018; Ingram et al., 2020; Rivera-Ferre et al., 2021), and Australia (Bawden, 2016).[1] These programs are known by a variety of names (e.g., sustainable agriculture), but we collectively refer to them as agroecology education programs because they are connected by an explicit goal to support food system transformation.

2.1. Epistemological conditions and innovations in agroecology programs

Many agroecology programs emerged from and/or are housed within agronomic or agricultural science departments or colleges (Altieri and Francis, 1992; Francis et al., 2003; Intriago et al., 2017; Sarandon and Marasas, 2017). Because of this institutional positionality, Classens et al. (2021) argues that "we make food systems pedagogy, but we do not make it under conditions of our own choosing." Thus, it is important to consider the ways in which agronomic paradigms set the conditions from which agroecological pedagogies emerge (Rivera-Ferre et al., 2021). Many educators have emphasized the particular importance of epistemological awareness to reexamine dominant ways of knowing in sustainable food systems work (Jordan et al., 2008; Code, 2017; Andreotti et al., 2018; Dring et al., 2022).

Epistemologies can be described as our ways of knowing (Dring et al., 2022) and habits of mind (Andreotti et al., 2018; Dring et al., 2022); epistemologies are the rules that shape how we know what we know (Galt et al., 2012), what is defined as knowledge, and who holds or generates that knowledge (Wilson, 2009; Galt et al., 2012; Walter and Andersen, 2013). There is a broad body of scholarship interrogating agronomic epistemologies, and here we provide a brief overview based on prior work by agroecology educators (Altieri and Francis, 1992; Parr et al., 2007; Østergaard et al., 2010; Galt et al., 2012; Rosset and Martínez-Torres, 2012; Montenegro de Wit and Iles, 2016; Code, 2017; Andreotti et al., 2018; Francis, 2020; Bowness et al., 2021; Dring et al., 2022; Shanahan, 2022). Agronomic epistemologies typically approach food systems through reductionism, by breaking them down into individual components that are studied through specialized disciplines. Knowledge is framed through positivism, in which what we know is generated through logical and objective processes that are separate from values/bias and can be replicated across situations. The resulting knowledge is held by expert specialists and transferred to others *via* top-down approaches. Problems are solved by leveraging technological, capital-intensive interventions. Within food systems broadly, these epistemologies are enacted through industrial agriculture and Western agronomic science, which possess "thick legitimacy;" in other words, Western technologies, knowledge, and norms are accepted as credible and supported by science, policy, practice, legal systems, and civil society (Montenegro de Wit and Iles, 2016).

As a result of these epistemological conditions, many argue that agricultural science programs do not—and cannot—provide the holistic and political training necessary to address complex food systems challenges (Altieri and Francis, 1992; Lieblein and Francis, 2007; Francis et al., 2011, 2018; Intriago et al., 2017;

1 It is important to note that because of our language proficiencies (English, Spanish, and Italian), there are likely gaps in our review of programs in Africa, Asia, and the Middle East.

Sarandon and Marasas, 2017; Ingram et al., 2020; Rivera-Ferre et al., 2021). Agroecology programs, therefore, must enact alternative epistemologies in order to counter dominant agronomic paradigms and prepare students to engage with food systems work. Prior scholarship has identified four main agroecological epistemologies: holistic systems, action learning, horizontal learning, and multiple ways of knowing (Jacobsen et al., 2012; Hilimire et al., 2014; Horner et al., 2021).

Holistic systems includes multiple frameworks and approaches to understand food systems as whole, connected, and socially constructed. A common approach used in agroecology is systems thinking (Hilimire et al., 2014), which includes methodologies that connect landscapes and social systems to underlying processes and mechanisms (Jordan et al., 2014). It resists reductionism and positivism by accounting for complex and dynamic linkages/relationships (Meadows, 2008; Ingram et al., 2020). Systems thinking is a core component of undergraduate agroecology programs (Galt et al., 2012; Bawden, 2016; Valley et al., 2018; Ebel et al., 2020) and individual courses/certifications at both graduate and undergraduate levels (Jordan et al., 2005; Galt et al., 2013; Runck et al., 2015; Francis et al., 2018; Ingram et al., 2020).

Action learning includes both experiential and participatory learning. Both represent ways to learn through doing, in place-based, context-rich settings where learners experience the complexities and uncertainties of food systems (Lieblein et al., 2004; Valley et al., 2018; Jelinski et al., 2020). However, experiential and participatory learning differ in the learner's level of embeddedness. Experiential learning often involves activities such as field trips, open-ended case studies, internships, farm visits, etc., which are implemented in both undergraduate programs (Galt et al., 2012; Valley et al., 2018; Ebel et al., 2020) and individual undergraduate/graduate courses (Wiedenhoeft et al., 2003; Jordan et al., 2005; Francis et al., 2018; Horner et al., 2021). In participatory learning, students are embedded in collaborations with community partners, which is often used in graduate programs with thesis or dissertation projects (Migliorini et al., 2018; Rivera-Ferre et al., 2021) or in undergraduate research experiences (Parr and Van Horn, 2006; Salomonsson et al., 2009).

Horizontal learning facilitates knowledge sharing between people with different experiences, practices, beliefs, and knowledge systems (Hilimire et al., 2014). The goal is to adapt and apply knowledge and practices in different contexts and places. It resists the "banking model" of education in which knowledge is transferred from an expert teacher to student (Freire, 2000). University programs often leverage dialogue for students, faculty, and practitioners to learn from and with each other (Galt et al., 2012; Domené-Painenao and Herrera, 2019). It is a core component of courses based on the agroecology pedagogy developed at the Norwegian University of Life Sciences (Wiedenhoeft et al., 2003; Jordan et al., 2005; Runck et al., 2015; Migliorini and Lieblein, 2016; Francis et al., 2018). Horizontal learning builds appreciation, empathy, and respect for others; develops abilities to engage with uncertainty; and supports a holistic approach to understanding complexities in food systems (Francis et al., 2018; Ebel et al., 2020).

Multiple ways of knowing enacts the understanding that expertise does not fall within disciplinary boundaries and diverse knowledge and experiences are necessary to address complex food system challenges. As a discipline, agroecology often integrates multiple ways of knowing through transdisciplinarity, which recognizes that knowledge exists beyond and across the confines of academic disciplines (Méndez et al., 2015; Gliessman, 2018). Inter-, multi-, or transdisciplinary learning are key components of university agroecology programs and courses (Parr and Van Horn, 2006; Galt et al., 2012; Hilimire et al., 2014; Francis et al., 2018; Valley et al., 2018; Ebel et al., 2020; Ingram et al., 2020; Horner et al., 2021). While there can be important distinctions between inter-, multi-, and transdisciplinary learning (Francis et al., 2011; Hilimire et al., 2014), some differences reflect evolving language (Parr et al., 2007).

Agroecological pedagogies incorporating holistic systems, horizontal learning, action learning, and multiple ways of knowing have opened important space to contest and create alternatives to agronomic epistemologies. Yet, Dring et al. (2022) argue that it is also important to consider the ontologies that create the foundation for epistemologies.

2.2. Ontologies shape agroecology epistemologies

Because Western institutions and agronomic paradigms set the "material and ideological conditions" (Classens et al., 2021) for university agroecology programs, it is possible that agroecological epistemologies may still perpetuate agronomic ontologies. Epistemologies enact ontologies—our habits of being (Dring et al., 2022) and understanding of what is real (Jordan et al., 2008; Wilson, 2009), which frame how we relate to each other and the planet (Andreotti et al., 2018). Agronomic ontologies, and Western scientific disciplines more broadly, developed with and as a tool of racial capitalism and colonialism (Andreotti et al., 2018; Bowness et al., 2021). Industrial agriculture—the focus of most agronomic research and education—emerged from racial capitalism and the U.S. plantation system, in which unlimited economic growth from monoculture production systems depended on kidnapping, displacing, torturing, and enslaving Africans and their descendants (Perfecto et al., 2019; Robinson, 2020; Montenegro de Wit, 2021). Colonialism is infused in land-grant universities, where much agronomic research is conducted, which were built on and continue to profit from land, resources, and knowledge extracted and stolen from hundreds of Indigenous nations (Lee and Ahtone, 2020). Universities and agronomy programs facilitated the introduction of agrochemicals as part of the Green Revolution, which further disenfranchised Indigenous knowledge/production systems around the world (Intriago et al., 2017). Grounded in assumptions that progress is linear, unlimited economic growth is possible and desirable, and relationships are hierarchical and inequitable, these histories have shaped the ways we understand food systems and the transformations and futures we can imagine (Andreotti et al., 2018; Rivera-Ferre et al., 2021; Shanahan, 2022).

There are several ways that the agroecological epistemologies described earlier may still perpetuate these dominant ontologies. One of the most common emerging critiques of agroecology curricula is that prior scholarship over-emphasizes skill/competency development and professionalization, which perpetuates a neoliberal emphasis on market-based interventions (Classens et al., 2021; Horner et al., 2021; Dring et al., 2022). Emphasizing skills and tools is also more likely to focus on scientific or technical solutions, such as replacing chemical inputs (Migliorini et al., 2018; Rivera-Ferre et al., 2021), resulting in academic and Extension programs that separate

agroecological science from social/political movements (Wezel et al., 2009; Gonzalez de Molina, 2013; McCune and Sánchez, 2019; Rivera-Ferre et al., 2021). Code (2017) further argues that systems thinking can reduce the fullness and complexities of relationships to a focus on elements and linkages. Finally, agroecology programs may perpetuate extractive patterns. In experiential learning, this may result from a lack of attention to the ways in which race, gender, nationality, and ability shape student and community relationships (Newbery, 2003; Lake, 2021; Simmons., 2021). Similarly, integrating non-Western knowledge systems in agroecology programs—without attention to the worldviews, traditions, and relationships underlying those knowledge systems—can perpetuate extractive patterns such as appropriation and romanticization.

In other words, universities enact racial and colonial ontologies, and these material and ideological conditions exist in tension with the agroecological way of knowing and being that agroecology programs are trying to create. This institutional positionality shapes and constrains what is possible (Meek and Tarlau, 2016), and Rivera-Ferre et al. (2021) argue that the result is a type of "reformist agroecology" that maintains current food and agricultural systems instead of transforming them. In other words, though agroecology programs seek to change our ways of knowing and being, they may still fail to address the root causes of "systemic oppression, marginalization, dispossession, and ecological destruction" because they are embedded within institutions that are grounded in racial and colonial ontologies (Dring et al., 2022).

2.3. Toward transformative agroecology learning pedagogies

Tarlau (2014) proposes that while "schools may never be completely emancipatory spaces," we can approach them as "terrains of contestation, where repressive and liberatory processes" exist simultaneously. While reformist approaches can serve as important strategies to reduce harm and open space for contestation, recent scholarship connecting agroecology with anti-colonialism (Andreotti et al., 2018; Dring et al., 2022) and abolition (Montenegro de Wit, 2021) have highlighted the need for continued efforts to enact transformative agroecology learning pedagogies. Meek and Tarlau (2016) argue that critical pedagogies are necessary to connect education with social transformation. In their Critical Food System Education (CFSE) model, they leverage Freire (2000)'s model of popular education to build critical consciousness, a process in which people learn "to perceive social, political, and economic contradictions and to take action against the oppressive elements of reality" (p. 35). This critical approach fundamentally shapes how epistemological structures and pedagogies are enacted.

Critical agroecology education is an emerging area in university programs. An early example of a critical pedagogy in North America is the Sustainable Agriculture and Food Systems program at the University of California, Davis, which incorporates critical theory, community building (on and beyond campus), and civic engagement alongside systems thinking, interdisciplinarity, and experiential learning (Galt et al., 2012). More recently, critical reflection and collective action were included as implicit values in the proposed signature pedagogy for undergraduate Sustainable Food Systems programs (Valley et al., 2018; Ebel et al., 2020). Ebel et al. (2020) explain critical reflection develops "a habit of mind that recognizes historical and current power differentials within society and their resulting uneven distribution of benefits and harms related to food systems." Habits of mind are the habitual and automatic ways in which we think, so developing new habits of mind builds a set of mental responses to new situations or knowledges. Furthermore, analysis of student artifacts from courses at the University of Minnesota (Jordan et al., 2008), UC Davis (Galt et al., 2013), Trent University (Classens et al., 2021), and the University of Vermont (Horner et al., 2021) have all affirmed that critical reflection can result in transformative learning experiences that shift how students engage with individual and collective action.

But food justice and sovereignty movements have a long history leveraging critical pedagogies to facilitate "collective experiences of learning, organization, exchange, and life" (Casado et al., 2022) and build capacity for collective action (McCune et al., 2014; Migliorini et al., 2018; Anderson et al., 2019; McCune and Sánchez, 2019; Meek et al., 2019; Black Dirt Farm Collective, 2020; Rivera-Ferre et al., 2021). Of particular relevance are two formal, advanced agroecology learning programs that are centered around developing critical consciousness. The Latin American Agroecological Institutes (IALA) are a network of autonomous movement agroecology schools located throughout Central and South America, and food sovereignty organizations select members to attend and study at the IALA for 3–5 years (McCune et al., 2014; McCune and Sánchez, 2019). The Baserritik Mundura extension degree program at the University of the Basque Country in Spain was a 1-year program, and it was implemented twice between 2016 and 2018 (Casado et al., 2022). Both programs emerged from movement-led efforts—specifically La Via Campesina (LVC), a transnational movement for peasants' rights, and its member organizations; this differs from the undergraduate and graduate programs discussed earlier, which emerged from Western university and agronomic contexts. Below, we provide a brief overview of the key epistemologies that structure the critical pedagogies in these two programs.

A key goal of both the IALAs and the Baserritik Mundura program is to facilitate *formación*, which is "the construction of a better human being…through critical reflections and actions" (McCune et al., 2014). It includes building capacity for both self and collective organization (Rosset, 2015; Black Dirt Farm Collective, 2020), representing the interconnected and dialectical relationship between transformation of the individual and transformation of the world (McCune and Sánchez, 2019). Toward the goal of *formación*, both schools enact collective organizational structures to center the educational process on the collective (Casado et al., 2022). Similar to LVC more broadly (Tarlau, 2015), teachers and learners work together in *núcleos de base* (NBs) at IALAs and territorial nuclei (TNs) in the Baserritik Mundura program to make decisions about all aspects of the education process. The schools are guided by Political-Pedagogical Coordination (PPC) groups that include representatives from social movement organizations who support program-level reflection, development, and iteration (McCune and Sánchez, 2019; Casado et al., 2022).

To connect the schools with their broader territories, *diálogos de saberes* (wisdom dialogues) are conducted between cohorts in the schools and with the communities in which they are embedded. *Diálogos de saberes,* a foundational structure in LVC, occur "between people with different historically specific experiences, cosmovisions, and ways of knowing" (Martínez-Torres and Rosset, 2014). Within

IALAs and the Baserritik Mundura program, one of the emergent outcomes of dialogue is to develop participatory action research (PAR) projects (McCune and Sánchez, 2019). Students then conduct the PAR projects *via alternancia*, in which students alternate between "community" and "study" periods. During community periods, students conduct projects directly related to community needs while learning about the place-based political, economic, cultural, and ecological contexts. When students return to campus, they have dedicated time to deepen their study and reflect on their participatory projects with other students and teachers (McCune and Sánchez, 2019; Casado et al., 2022).

Through both critical and collective epistemological structures, McCune and Sánchez (2019) argue that learning moves beyond individual or student-centered goals to instead center on territories, which are places grounded in relationships between land, people, and histories that create specific movement contexts for enacting and scaling out agroecological practices and transformations. There are very few university agroecology programs, however, that pair both critical and collective structures. At the undergraduate level, a notable exception is the agroecology program at the Bolivarian University of Venezuela (UBV), which uses a collective and territorial framing to implement popular education, *diálogos de saberes,* and *alternancia* in coursework and participatory projects (Domené-Painenao and Herrera, 2019). At the graduate level, El Colegio de la Frontera Sur (n.d.) and the University of Córdoba in Spain (Migliorini et al., 2018; Rivera-Ferre et al., 2021) both offer MSc programs that leverage critical approaches, participatory research methodologies, and *diálogos de saberes*.

There is, however, a significant need to develop critical and collective pedagogies for graduate agroecology programs. Much of the existing literature on graduate education focuses on the model developed for a one-semester course in the MSc in Agroecology at the Norwegian University of Life Sciences (NMBU) (e.g., Lieblein et al., 2004; Lieblein and Francis, 2007; Østergaard et al., 2010; Francis et al., 2015, 2018). The course is oriented around open-ended case studies for students to develop skills in observation, participation, dialogue, reflection, and visioning (Francis et al., 2015, 2018). Critical and collective pedagogies, however, are not explicitly addressed in the NMBU model. Furthermore, there is limited scholarship, in general, that expands beyond individual courses to instead explore how to implement an entire master's or doctoral program grounded in agroecological paradigms. As a result, there is a particular need for pedagogical development in graduate agroecology programs. This is a key opportunity because graduate program structures, expectations, and responsibilities differ from undergraduate programs (Francis et al., 2011; Basche et al., 2014; Code, 2017), and those differences represent rich opportunities to adapt collective and critical pedagogies to university agroecology education. Thus, in this paper, we share a pedagogy for graduate agroecology education that emerged from multi-year, student-led efforts at the University of Minnesota—Twin Cities.

3. Institutional context: Building our agroecology education at the University of Minnesota—Twin Cities

When we began our graduate journeys, we knew little about the agroecological learning approaches discussed in the previous section. Instead, the pedagogy for graduate agroecology learning that we share in this paper emerged over seven years of student-led organizing and collective action at UMN-TC. Our masters and doctoral programs consist of both research and coursework requirements; while our research collaborations require us to engage with the political, integrative, and relational aspects of agroecology, most of our required coursework focuses on technical knowledge, such as statistics or sub-disciplinary specialization classes. In this section, we share an overview of the agroecology courses available in our programs and the student-led efforts to pursue opportunities, address obstacles, and create/demand space for transformative agroecological learning.

There is a long history at UMN-TC of innovative agroecology and sustainable food system course development, largely through *faculty-led* efforts, particularly in undergraduate programming (Jordan et al., 2008, 2014; ASA, 2010; Porter et al., 2015; Runck et al., 2015; Valley et al., 2018; Ebel et al., 2020). However, there are two courses specifically aimed at graduate students. "Ecology of Agricultural Systems" is a one-semester, 3-credit course that covers systems thinking, agroecosystem analysis, dialogue, and critical reflection through both didactic lectures and experiential, community-engaged team projects, with the goal to prepare students with tools/skills to participate in collective action (Jordan et al., 2005). It is required for the formal agroecology track in the agronomy program and open to students from other programs. An optional, 8-day summer short-course was also available until recent years, in which student teams visited farms across the Upper Midwest. Course activities facilitated observation through farm tours, dialogue through interviews with growers and other stakeholders, reflections with other students and professors, and visioning futures through a comparative analysis and evaluation of sustainability at different farms (Wiedenhoeft et al., 2003). Despite these efforts, the bulk of our required graduate coursework utilized instruction strategies, content curation, evaluation practices, and outreach training grounded in Western agronomic paradigms that focused on specialized and/or technical knowledge.

In the absence of comprehensive agroecology coursework, *student-led* cohorts emerged as important spaces for agroecology co-learning. Faculty and mentors encouraged students to leverage student cohorts to engage in transdisciplinary learning; the goal was to learn skills and methods from multiple disciplines to explore the relationships between agronomy, research, and broader food systems. Starting in 2015, a small group of students in the Applied Plant Sciences graduate program formed the Food, Environment, and Agricultural Studies (FEASt) graduate student group, which quickly expanded to include students from multiple disciplines, including Sharon, and several faculty allies. FEASt initiatives have included conversation groups, seminars, reading groups, and a symposium (Table 1).

Beyond developing a broader set of skills, FEASt members identified the need to critique, address, and reimagine the political landscapes in which we apply transdisciplinarity. In other words, we needed skills to ask questions such as: Why are we asking our research questions, and what socio-political systems are supported or challenged by this research? Who is generating the questions, and who is ignored? How do our research methods perpetuate or question broader systems? What assumptions are we making and why? These questions can be addressed by using critical theory and related critical approaches to frame transdisciplinarity, yet FEASt members

TABLE 1 Summary of student-led organizing that informed workshop series and pedagogy model development.

Format	Active	Outcomes	Challenges
Food, Environment, and agricultural Studies (FEASt) graduate group	2015–2016	• Horizontal learning • Cohort building • Transdisciplinarity • Shared understanding of critical theory • Community-university connections • Student-led	• Labor limitations • Members adjusting to horizontal management structure
Symposium—"Critical Visions for an Abundant and Just Food System in the 21st Century"	2016	• Relational networks • Critical reflection and inquiry • Community-university connections • Student-led	• Labor limitations • Harassment • Funding
Class—Orientation to Scientific Thought	2016	• Boundary space • Co-learning between students • Cohort building • Student/faculty horizontal learning	• Labor limitations • Bureaucratic resistance • Faculty lack of confidence • Culture of impossibility—repeated claims that class was not relevant to "real" work • Advertising/engagement
Seminar—Participatory Action Research (PAR) reading group	2017	• Interest in focusing on agroecology • Student/faculty horizontal learning • Relational politics • Critical reflection • Praxis • Preliminary model of graduate education • Visioning	• Labor limitations • Lack of clear direction/goals • Barriers to implementing PAR strategies in projects (e.g., limited time in program to form community relations, concerns about project sustainability after graduation)
Conference presentations	2017–2018	• Exposure to Indigenous and intergenerational ways of knowing, along with the importance of care • Accessing (or learning about) decision-making circles at UMN that we didn't previously have access to • Renewed motivation to document and share process as a result of engagement • Identifying institutional barriers, opportunities, and bureaucracies	• Financial costs • "Preaching to the choir" • Bureaucratic obstacles and institutional culture of impossibility

identified that critical theory was almost entirely absent from our programs.

FEASt members with backgrounds in social movements and/or social science disciplines shared their knowledge of critical theory with others in the group by practicing horizontal learning. Initially, FEASt hosted two-part conversations on agricultural case studies; FEASt members discussed the case with each other during the first part and then invited a local expert to the second part. Building on this foundation, FEASt coordinated a symposium in 2016 entitled "Critical Visions for an Abundant and Just Food System in the 21st Century," which was attended by 96 student, faculty, and community participants from across the Midwest. Subsequently recognizing the need for ongoing training in critical approaches, FEASt members designed a colloquium-style graduate course entitled "Orientation to Scientific Thought," proctored by a faculty ally, to explore topics such as ways of knowing, philosophy of science, political economy, intersectionality, and capitalism in food systems. Through these activities, students developed strong relationships, enacted horizontal learning structures, and built capacity for critical, transdisciplinary scholarship. However, FEASt members also faced significant burnout. Though FEASt went into hibernation following the course in 2016, student-led efforts to pursue agroecology learning continued.

While the conversations, symposium, and course helped create new habits of mind, students recognized the need to apply critical theory to practice. Having taken "Orientation to Scientific Thought," Vivian was specifically interested in PAR as a practice that deliberately integrates research, knowledge from multiple ways of knowing, and grower needs (Méndez et al., 2017). Our programs, however, did not include PAR coursework or training. Thus, in spring 2017, Vivian initiated a 1-credit seminar about the theory, process, and practice of PAR. The seminar participants were students (including Sharon and Jennifer) and faculty involved in projects that worked directly with farmers in a consultative capacity, through on-farm research sites, or as co-developers of research questions and design.

Seminar participants continually returned to the intersection of critical theory and PAR, given that our participatory work is part of political systems and that actions (or inactions) have political consequences. Within this context, PAR requires us to be in relationship with and work with people or organizations who have different worldviews, backgrounds, and positionalities. To facilitate dialogue across difference with growers, policymakers, and others, seminar participants identified the aptness of relational politics, a concept developed by UMN public policy faculty. Relational politics is a framework for people to "interact on public matters in carefully designed processes in which participants use not only their minds and heads but also their bodies and emotions" (Levine, 2016). Dialogue and deliberation in relational politics builds mutual understanding, develops empathy and respect between people, and illuminates areas of alignment to recognize opportunities for collective action (Jordan et al., 2021). By the end of the seminar, the course participants began to imagine a holistic agroecology program at UMN-TC, building a draft pedagogy model that included the emergent themes from our collective learning—critical theory, relational politics, and participatory action research.

Though the draft pedagogy was developed in interstitial spaces that ran parallel to our graduate programs, this structure was ultimately not sustainable. First, the labor burden on graduate students—who led content curation, planning, and implementation for all activities—was significant. While this level of student agency can be beneficial, it can also become extractive; course and syllabi development, in particular, was an example of students taking on responsibilities that generally fall under faculty roles. Students took on these roles because faculty allies articulated discomfort with facilitating courses that were outside their area of expertise or required critical, dialogue-based approaches—which is a broadly recognized challenge in university agroecology programs (Lieblein and Francis, 2013; Hilimire et al., 2014; David and Bell, 2018; Rivera-Ferre et al., 2021). Additionally, student-led activities leveraging critical approaches also faced institutional resistance. While planning the symposium, FEASt members encountered resistance from faculty and administration; some fellow students also publicly mocked the symposium using sexually suggestive and derogatory language.[2] Later, when FEASt members were developing the 2016 class, program leadership described it as too "anti-establishment" and only approved the course after a tenured faculty-ally agreed to proctor the course; we (the authors) faced similar resistance when planning the 2019 workshop series described later in this paper. Thus, institutional barriers, harassment, feelings of inadequacy, and pressure to focus on "real" work (e.g., data analysis, publications) contributed to a general culture of impossibility that made it difficult for students to self-sustain their work.

Reflecting on these challenges, we realized staying in interstitial spaces was limiting our potential for growth. To begin exploring processes to move our pedagogy from informal to formal spaces, we first shared the proposed model through conference presentations (Wauters et al., 2017, 2018; Nicklay et al., 2018). In the resulting discussions, it became clear that (1) there were still under-developed areas, such as how to approach relationships and integrate multiple ways of knowing, (2) implementing the model within the structure of our own university would require building broader networks of individual and institutional allies, and (3) colleagues across North America were interested in using the student-led process to adapt the model to their own contexts. To address these needs, we created and facilitated a three-part summer workshop series in 2019 to refine our pedagogy model, which was an important step toward our long-term goal of creating collaborative, iterative, and collective learning spaces where we can immerse ourselves in agroecological paradigms.

4. Methods

To refine the draft pedagogy, we hosted a series of three workshops during summer 2019 (Table 2) to engage a broader community of agroecologists, largely from UMN-TC. We structured the workshops around three assumptions, inspired by agroecology movements generally and, more specifically, the Sustainable Agriculture Education Association (2018)'s equity statement:

1. At the most basic level, we believe that agroecology is not value-neutral.
2. We believe agroecology should prioritize action-oriented, applied approaches to problems.
3. As a value-driven model, agroecology learning should reject exploitation, making it anti-racist and anti-colonial.

These assumptions were used to design the workshop experience, from activities to food choice. The full workshop facilitation plans, activity instructions, and summaries are provided in Supplementary material. Workshops were attended by 24 unique participants representing 13 departments, including 11 graduate students, 12 faculty/staff, and 1 undergraduate student. The University of Minnesota Institutional Review Board determined this work was not human subjects research.

During each workshop session, participants engaged with all components of our draft pedagogy model and proposed changes. After each session, summaries were sent to participants and members of the broader UMN-TC agroecology community. We included activity instructions, notes, and insights about or revisions to the model so people who could not attend in person were able to complete reflection activities and share their insights, and people who did attend were able to add additional feedback or context. Through this process, students, faculty, and staff working in agroecology spaces were able to "member-check" (Caretta and Pérez, 2019; Horner et al., 2021) the model as it developed, which was an important way to validate our interpretations and analysis.

After the workshop series, further refinements and changes to the model were completed by analyzing planning meeting notes and artifacts from the workshop activities (e.g., pictures, concept maps, notes) through a combination of collaborative autoethnography (Chang et al., 2016) and inductive coding (Lofland et al., 2006). Drafts of the manuscript were shared with the PAR seminar and workshop series participants *via* email to ensure that continued development of the model remained consistent with their experiences. Finally, the manuscript draft was used for reading discussions at a FEASt student group meeting and a laboratory group meeting. Feedback from these ongoing member-checks was incorporated into model and manuscript revisions. This process reflects our commitment to articulating an iterative and reflective learning framework that emerges from and responds to student needs.

5. Results: Building a pedagogy for agroecology learning

Building on years of relationships and collaboration among many students, faculty, and community members, a pedagogy for graduate agroecology education was developed during the summer 2019 workshop series (Figure 1). Focusing on epistemological structures for the pedagogy, workshop participants highlighted the importance of horizontal learning with a cohort, affirmed the value of critical inquiry, and deepened our understanding of the roles of relationships, participatory practice, and knowledge (both individual and collective) in agroecology education.

Participants also engaged in deep discussions to define the purpose of an agroecology program grounded in this pedagogy. Initially, there was a clear tension between focusing on developing broader skill sets or developing new habits of mind:

2 We share this to highlight that retaliation, in our experience, is often gendered. For a more in-depth discussion of gender discrimination in the sciences, see the reports by Clancy et al. (2017) and Committee on the Impacts of Sexual Harassment in Academia (2018) or the documentary *Picture a Scientist* (Cheney and Shattuck, 2020).

TABLE 2 Overview of goals and activities for the "developing a model of agroecology training for graduate students" workshop series.

Workshop	Goals	Activities
1	• Reflect on and articulate the important experiences and skills that have supported their agroecology work • Engage with the draft model for agroecology pedagogy developed following the spring 2017 seminar • Begin articulating values that inform their work as agroecologists	• "I am an agroecologist because…" reflection, conceptual diagramming, and pair-and-share • "Engaging with the Model" activity to physically embody the model and process with a cohort • Large group discussion
2	• Articulate the assumptions that underlie our work as agroecologists through identification and placement of skills and values within the updated model • Identify the goals for an agroecology program our model proposes. • Evaluate whether the revised model adequately encompasses participant value-driven skill sets	• Skills: Individual free-write • Values: Retirement Party Activity and group discussion • Pair and small-group discussion of personal and program goals. • Group discussion and workshop evaluation analysis
3	• Identify existing opportunities and gaps for implementing our model at UMN-TC • Brainstorm next steps to overcome barriers and identify opportunities for further action—individually and collectively—toward implementing the pedagogy model	• Collaborative mapping of existing agroecology education • Group prioritization of gaps to address and individual reflection activity to envision personal role in moving forward

See Supplementary material for full details regarding communications, facilitation plans, and activity instructions.

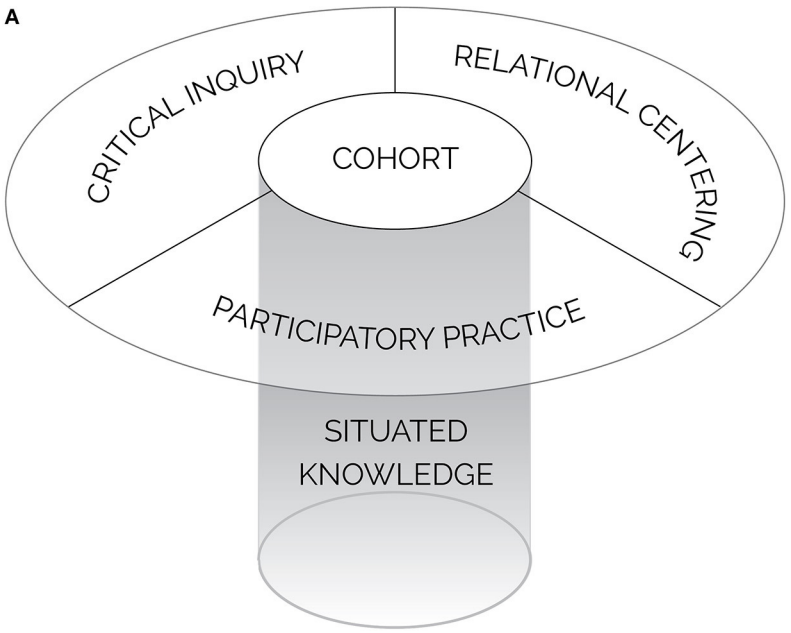

FIGURE 1
Pedagogy model for graduate agro ecology learning at the University of Minnesota-Twin Cities **(A)** and associated definitions **(B)**. The learning cohort is at the heart of our model, serving as a space to synthesize critical inquiry, relational centering, and participatory practices and supported by the situated knowledges of learners.

> *Faculty participant #1: Is the goal training? Or is the goal transformation? Do we want to look at discrete agroecological packets, or some larger transformation in the world? And how are they related?*
>
> *Student participant #1: It should be baseline training to give you the tools to apply to whatever challenge you're interested in.*
>
> *Student participant #2: Is having the toolbox then the transformation?*
>
> *Faculty participant #2: I like the idea of a toolbox.*
>
> *Faculty participant #1: I always think of the word change-maker. I love the idea that in my teaching, I'm facilitating students becoming change-makers.*

Over the course of two workshops, participants ultimately resolved this tension through collective reflection, and the purpose that emerged was that an agroecology program should facilitate a learning community where:

> *Agroecologists develop knowledge, habits of mind, and skills to be motivated and capable to plan, implement, and evaluate sustained action in collaboration with others, for the purpose of catalyzing transformational change.*

It is important to note that participant language around transformational change, broadly, rather than food systems transformations, specifically, was intentional. This choice reflected

an explicit recognition that work in building sustainable food systems will be interconnected with broader movements for justice. The following sections describe the five pedagogy components—cohorts, critical inquiry, relational centering, participatory practice, and situated knowledge—and how they contribute to enact this purpose.

5.1. Cohort

> *A cohort is a group of people who learn together by reflecting on experiences, practicing vulnerability, cultivating inspiration and joy, and building collective agency.*

The cohort is at the heart of our model (Figure 1). However, it was not *explicitly* included in the draft model that emerged from the PAR seminar. Cohorts, instead, were *implied* or *assumed* in the language we used. During the first workshop, we explained that the proposed model of agroecology learning "happens collectively; it should not be individual students taking individual classes and then maybe talking to their advisors, maybe to their committee. You need to have someplace to go to, to go back to, to work through things. You need to do it in and out of the class. To have time to practice and step back and reflect." Workshop participants pushed us to explicitly name the cohort because the model "doesn't *become* until it's collective" (emphasis added), particularly highlighting the role of cohorts to support intellectual and emotional development by creating space for patience, courage, honesty, compassion, heart, and joy. Workshop participants ultimately proposed a three-tiered structure consisting of peer, program, and practitioner cohorts (Table 3).

Building on past informal cohorts (Table 1), the Peer and Program Cohorts would create continuity for support to span beyond single semesters or individual efforts. Through horizontal learning, both were imagined as compassionate spaces to process experiences—"a place to share your errors and [also] what worked." There was particular focus on the potential for the Program Cohort to build faculty capacity, especially as they engage with skills or ways of knowing that were not included in their own discipline-specific training (see Institutional Context). Finally, both Peer and Program Cohorts could continue to facilitate iterative pedagogy and program development.

The Practitioner Cohort, however, represented a new meeting place for people inside and outside university to build relationships, dialogue across multiple ways of knowing, and support collaboration. It addressed a key challenge faced by many student workshop participants: the difficult (and sometimes impossible) task of establishing, building, and maintaining relationships with growers or community partners in the short duration of their program. One participant emphasized that "it seems almost unfair to put this on a graduate student…and it seems *so important* then that this be institutionalized." By building and maintaining relationships within a collective that includes faculty and community practitioners, both of which often have more long-term tenure than students, that burden is removed from graduate students.

Finally, one participant highlighted that cohorts were the most "radical idea" presented, specifically because they are collective structures that resist the individualism that is so heavily prioritized within academia. Many participants identified that cohorts are an important strategy to minimize risk for participants with different identities/positionalities and build solidarity. Early in workshop 1, students and faculty discussed the pushback and retaliation they had experienced as a result of their work:

> *Faculty participant: Remember that students may be low in bureaucratic power, but they likely have more political power within the university because faculty could get fired for this.*
>
> *Student participant: But students can also experience career consequences too. So it's really about making sure that we minimize risk for everyone.*
>
> *Faculty participant: You're describing movement building!*

This was echoed by a participant who said, in a later workshop, that they were beginning to realize that one of their roles was to "build the capacity of scientists" to engage in action. During our writing process, we realized that "building a transformative program is about us realizing that we need to build up *everyone's* capacity and confidence" (notes from June 2, 2021). The cohorts, therefore, create collective structures through which to enact agroecological paradigms.

5.2. Critical inquiry

> *Critical inquiry is an analytical approach to identifying and critiquing the social, political, and environmental foundations, histories, and assumptions upon which agriculture and food systems are built, with the goal of re-imagining more just food system relationships.*

Critical inquiry includes both reflection and action in an iterative process of learning and unlearning, a process driven by an underlying commitment to justice and community. The move from "critical theory" in the original model to "critical inquiry" represented an attempt to encompass a broader range of critical approaches. "Critical theory" is grounded in a specific academic lineage that emerged from the Frankfurt School and Marxism (Bohman, 2021). While we wanted to maintain its emphasis on emancipation and liberation, FEASt participants had brought experience in many critical approaches, including critical physical geography, feminist geography, critical pedagogy, critical race theory, and critical environmental justice. We began to use "critical inquiry," which is drawn from social studies education scholarship; it maintains a focus on liberation through inquiry-based experiences where learners can explore the processes and practices that undergird a broad range of critical approaches (Crowley and King, 2018).

Space to learn and practice critical inquiry is vital to grapple with the discomfort of unlearning assumptions. A workshop participant from extension observed that when Extension educators don't have space to learn critical inquiry, they continue to implement programming that lacks attention to systems of power/oppression and relies on one-way knowledge transfer; as a result, programs perpetuate inequitable access (e.g., excluding Black and Indigenous growers) and stunts relationships between universities and agricultural communities. Conversely, a student who conducted international research shared that critical inquiry helped them recognize how past extractive research programs and

TABLE 3 Brief overview of cohort groups, participants, and purposes.

	Participants	Purposes
Peer cohorts	Students in a similar phase of their degree (e.g., incoming students each year enter as a cohort)	• Low-stakes space for co-learning, giving/receiving feedback, addressing challenges, and processing experiences • Explore topics, ideas, and strategies not yet included in program coursework/research requirements
Program cohort	• Peer cohorts • Faculty, staff, and Extension educators working in agroecology	• Horizontal learning between people who share an institutional positionality (university employees) but have different ages, knowledge, experiences, and identities • Challenge academic hierarchies • Collaborate to implement reflective, iterative program, updating program course/research requirements and pedagogy as needed • Build capacity for collective action, minimize risk to individuals
Practitioner cohort	• Peer cohorts • Program cohort • Practitioners from communities beyond academia (e.g., growers, organizers, policymakers)	• Dialogue across multiple ways of knowing • Horizontal learning between people with different roles in the food systems; intergenerational learning • Build and maintain long term community-university relationships and collaborative projects • Create processes to increase practitioner input/control over research projects and Extension programming • Facilitate solidarity across different collective efforts and actions

colonialism had impacted the social and environmental relationships in their research area; this perspective shaped their approach to working supportively and ethically with farmers. Critical inquiry, therefore, is necessary to iteratively reflect on situations and change our actions as we enter relationships and approach our participatory practice.

Workshop participants acknowledged that there would be risks or challenges to move critical approaches from the "hidden curricula" into formal agroecology coursework and programs. Several participants shared ways in which practicing critical approaches in agricultural spaces had negatively impacted their careers. In addition to pushback previously described in Institutional Context, one faculty participant shared that they had faced coordinated retaliation against the use of critical theory in their work—which ultimately contributed to their decision to leave UMN-TC. Some participants theorized that the name "critical theory," specifically, would be more likely to face retaliation due to its intellectual roots. Despite, and because of, these concerns and risks, workshop participants believed it was important to keep this component in the model.

5.3. Relational centering

> *Relational centering is an orientation toward connection that is grounded in a recognition of positionality, power, and values in order to build, maintain, and deepen generative relationships.*

Relational centering foregrounds the importance of *relationships as their own end*. Participants associated humility, engaging with difference, patience, empathy, loyalty, respect, fairness, listening, passion, and love with this model component—all of which go beyond the resources and conditions needed to collaborate on a specific project. The move from "relational politics" in the original model to "relational centering," therefore, represented an important shift from a framework to *work together* toward an orientation to *live together* (notes, January 12, 2022). Relational centering encompasses three types of relationality identified by workshop participants: deepening one's relationship with self, connecting through relationships with others, and expanding relationships to include the more-than-human world.

Workshop participants all expressed relief and excitement that deepening relationships with self through critical self-reflection broke from agronomic epistemologies of objectivity/neutrality. Critical self-reflection helped them understand how their work was shaped by their positionalities, which encompasses a person's identities and how those identities shape their relationship to others and the broader systems in which we exist. For example, participants discussed the ways in which their identities as researchers and position in academia constituted a position of power and authority within dominant political systems. Strategies to engage with this identity in their work, however, depended on their experience with critical self-reflection. One faculty participant, for example, in talking through their relationship with growers, expressed that "there's a distribution of power, and you want people to relate to you as a person rather than as your position, so you want to erase that power difference." A graduate student participant, however, argued that this desire to erase power differences to assuage our individual discomfort could be harmful by erasing people's very real experiences with structural oppression and the transformative possibilities that they are uniquely positioned to imagine.[3] Through this interaction, we see the ways in which cohorts could support individuals as they develop resilience through learning, making mistakes, and working toward change. As one participant noted, "there's an aspect of cracking open and internal transformation that's required" to participate in broader social and food system transformation.

A deeper understanding of our individual values and positionalities prepares us to be in relationship with others. Students and faculty who provided feedback on early drafts of

3 The student compared the inclination to erase power difference in research relationships to a "color-blind" approach to racism, which is when white people say they do not see race to avoid discomfort about the ways they benefit from white supremacist systems. The specific example was attributed to an anti-racism training, based on the work of Minnesota social worker and somatic therapist Menakem (2017), that the student had completed outside the university.

this article emphasized that when working across differences, they wrestled with the tension between their own values and those of their partners. As one participant shared,

> *There's a narrative of good people and bad people. I think it's important to see people as allies, who we may not see as on our "side." It's important to see people we work with [and ourselves] as complex people that are impacted by systems.*

During our writing meetings, we realized that this tension manifested differently depending on the context in which the individual was working, as illustrated by Sharon and Jennifer's research experiences. Sharon often worked "up" the power structure with people who, because they were entrenched in the status quo, did not share her core values; centering in self, then, provided an important space to honor her own values, hold space for others' values, and find ways to move forward together. Jennifer worked with urban growers in predominantly Black and refugee/immigrant communities; she had many values in common with her partners, so possessing a strong sense of her positionalities, as a white woman and researcher, helped her identify ways to mitigate, leverage, or cede power, depending on the situation, and move forward with her partners (notes, February 4, 2021). Vivian highlighted the commonality through these experiences: agroecologists "learn why people care about what they care about, and how to work with them given the things you care about, and in doing so, to care about things together."

Relationships with others, however, also require an openness to be changed by the relationship. During the activity in workshop 1 when we asked participants to engage with the model, a participant doing international research shared that:

> *I started out with big community meetings, but they totally failed. So starting with relationship building is really the big thing that should have been done before the needs assessment. Being humble and understanding their way of life. This might have helped me more effectively identify what reciprocity looked like when asking farmers for their time and knowledge.* ***Centering your social relationships as the basis for your professional objectives*** *(emphasis ours).*

In feedback on early drafts of this paper, we saw faculty grappling with the idea of relationships as "THE basis" of professional pursuits, which led us to realize that this example represents a critical reorientation away from individual-focused and toward collective-focused work. A collective focus recognizes that needs and priorities only emerge through robust relationships with others—and that individual pursuits can, and perhaps should, be guided by these collectively-identified priorities.

The workshops also expanded our understanding of who and what we are in relationship with to include the more-than-human world, which encompasses plants, animals, water, and soil. We saw participants include more-than-human relationships both in concept maps and conversations (Figure 2). Since the participants in our workshop were predominantly white, this was often paired with an acknowledgment of or gratitude for the Indigenous mentors or knowledge systems from which these ways of being in relationships with the world originated. Overall, relational centering—by spanning relationships with self, others, and the more-than human—connects individual transformation to broader social and ecological transformations.

5.4. Participatory practice

> *Participatory practice is a set of activities in which individuals and communities work together to enact their agroecological research, movement, and practice goals.*

Participatory practices bring together multiple people with multiple ways of knowing to address food system challenges (Figure 1). It is where cohorts put critical inquiry and relational centering into action through place-based projects with communities. As a result of the workshops, we broadened the scope from "participatory research" in the original model to "participatory practice." Workshop participants emphasized that not all work in agroecology is research-focused and highlighted participatory projects in Extension, farm planning, and city/regional policy. One graduate student further observed that choosing "practice" over "research" implicitly opens space for and honors multiple ways of knowing in knowledge production—a key tenet of agroecology.

Yet, participants affirmed that training in participatory practices, research or otherwise, was largely absent from biophysical science coursework. A participant who worked in Extension gave an example of how lack of training and confidence in participatory processes could perpetuate agronomic epistemologies of top-down knowledge transfer:

> *There's this general eroding trust in institutions. So in the crops faculty I worked with, there's this fear that if we open ourselves up to participatory work and admit that we don't have all the answers, then the trust will further erode and people won't come to us as experts. I think there's a lot of fear in opening ourselves up to critique.*

In other words, this participant observed that when academics do not have experience navigating critique through learning and unlearning in critical inquiry, they are unprepared to conduct participatory projects. Other workshop participants offered examples of the importance of humility in participatory work; being open to critique and adjusting their actions based on that feedback actually served to build trust and led to stronger relationships with partners and communities.

Many participants had sought training in participatory approaches through other UMN-TC programs, such as public health.[4] A graduate student shared that while completing this public health course was a rich experience, it was framed around "'what's your interaction with public health?' but [as an agroecologist] you're

4 PUBH 6815: Community Based Participatory Research is a one semester course that was co-developed by a UMN researcher and a community leader who were engaged in participatory research together. It is currently taught by community leaders who conduct participatory research. Graduate students can complete the course for credit, and community members can take the course for free. The course description is available through the UMN Course Catalog (https://onestop2.umn.edu/pcas/viewCatalogCourse.do?courseId=814654).

10.3389/fsufs.2023.770862

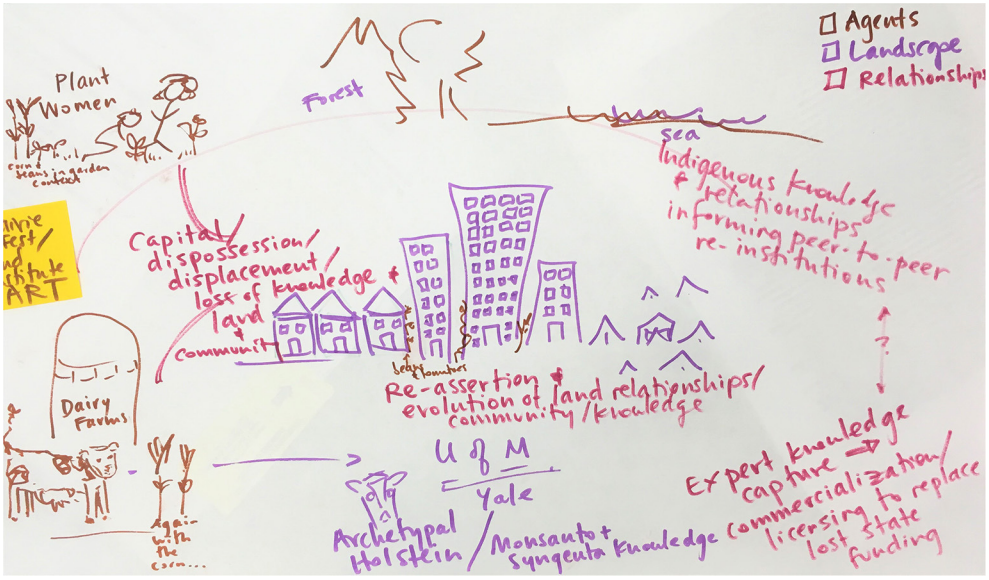

FIGURE 2
Expanding our conception of relationships. During workshop 1, participants were asked to draw conceptual maps of their agroecology practice, including the people, groups, and beings involved in that practice. In this concept map, we see the ways that the more-than-human—beings (such as plants, forests, and animals) and land, water, and air—are being incorporated into the understanding of relationships, as well as the attribution of their inclusion to Indigenous knowledge and relationships.

not really [directly] interacting with that." As a result, there were gaps in the learning experience; for example, in the same course, Vivian and Jennifer struggled with the absence of relationships to land and place, which are critical for participatory agroecological work. Thus, workshop discussions underscored the need for opportunities to learn and practice participatory approaches within an agroecological context.

Beyond coursework, participants also emphasized the need for structured learning environments to practice participatory approaches. Graduate students highlighted that a significant challenge they faced was simultaneously learning participatory strategies and building relationships with partners. Students expressed concern that because both require time, practice, and mentorship that are often not present in graduate training, their mistakes and failures—which are expected when learning new practices—were more likely to harm and alienate partners. Participants proposed short, defined projects would be an opportunity to learn and practice participatory approaches before applying them in longer-term thesis or dissertation projects.

Student and faculty participants reaffirmed the importance of Program and Practitioner Cohorts to collectively hold community-university relationships (see previous section) and provide important access to mentorship from other students, faculty, and community practitioners. A graduate student who was engaging in community food projects shared that:

> *I was originally in arts for art's sake, and through mentorship realized that it's art for social justice. I wasn't necessarily taught that, but it was a process as I was practicing art with my mentor in an environment that was real.*

In this experience, mentorship helped the student deconstruct the separation between art and community, a separation which is common in Western institutions. Their real-world practice, furthermore, led to critical inquiry that facilitated understanding their work within broader social, political, and economic systems and developing interventions to support social justice through their work. Ultimately, this example demonstrates that participatory practice is one way in which individual transformation connects to broader food system transformation.

5.5. Situated knowledge

> *Situated knowledge is the unique and incomplete knowledge held by an individual—stemming from formal and informal training, experiences, and ancestral wisdom—which guides their interpretation of the world.*

Situated knowledge is represented as a column supporting the cohort to recognize the depths of knowledge within each person and its essential contribution to the collective (Figure 1). However, the original model did not include explicit representation of knowledge. Instead, we assumed implementation of the model would be layered on existing academic programs (such as a certificate or interdisciplinary minor). Therefore, people within the program would likely have different sets of knowledge depending on their home discipline and/or personal experiences.

In planning the workshops, however, we anticipated that some colleagues might be distressed that their disciplinary expertise was not recognized within the model. When we introduced the draft model in the first workshop, Vivian explained:

> *Now, some of you may be thinking "wait, what about my expertise as an agronomist, or visual artist, or historian, or as a 4th generation farmer?" What we're talking about in our model is a type of breadth knowledge. I imagine the model coming out horizontally, providing a lens through which I engage with the world. Complementary to that… is my 'deep knowledge.' Think of deep knowledge as a pillar extending from your feet deep into the ground. It's that disciplinary and/or cultural wealth of knowledge that you personally have access to, that will be particular to you.*

In the conversation and activity that followed, many participants did, in fact, struggle with the lack of a specific, disciplinary knowledge system for agroecology and advocated adding a "disciplinary knowledge" component. Yet, as facilitators, we wrestled with how to move beyond the confines of academic disciplines. In our own agroecology learning (see Institutional Context), we had come to value transdisciplinarity. Furthermore, we had received feedback during our presentation at the 2018 Sustainable Agriculture Association Conference, a space which centered Indigenous ways of knowing, that the model should *explicitly* include other ways of knowing to avoid *implicitly* perpetuating Western academic norms. Therefore, in subsequent workshops, we included a preliminary pillar for "disciplinary and experiential knowledge."

Upon reflection during the paper-writing process, we sought a term that would represent the importance of attending to power and multiple ways of knowing within the cohorts and relational centering to self, more-than-human beings, and to place. We found this in feminist scholar Haraway (1988)'s conception of "situated knowledge," which recognizes the partial perspectives that each person brings to spaces of collective learning and action. Situated knowledge is not simply pluralistic, but rather is sensitive to power; the knowledge of those who have been marginalized by dominant systems—the traditional objects of research (including both peoples and places) are explicitly valued for the unique ways it can imagine sustained transformations in the world. Partial perspectives sustain the possibility for webs of connections and solidarities because "situated knowledges are about communities, not about isolated individuals" (p. 590) and, therefore, calls us to be accountable to each other. Accountability requires that we, as scholars, recognize and reckon with our disciplinary and institutional positionalities as they are (or are not) embedded in dominant Western paradigms. We were also inspired by recent work emphasizing knowledge is situated in places (McCune and Sánchez, 2019). As a result, we expanded our understanding of situated knowledge to include partial perspectives of people and place, an interpretation that is similar to how "situated knowledge" is used by the undergraduate program at the Bolivarian University in Venezuela (Domené-Painenao and Herrera, 2019).

6. Discussion

Critical inquiry, relational centering, participatory practice, cohort learning, and situated knowledge are the epistemological structures for agroecology learning in graduate education that emerged from our specific histories, contexts, and relationships at UMN-TC. The pedagogy for graduate agroecology learning proposed in this paper is an interactive and reflective learning framework to think, be, and act—using our head, heart, and hands (Lieblein and Francis, 2007; Jordan et al., 2008; Valley et al., 2018; Ebel et al., 2020)—toward catalyzing transformational change. The explicit engagement with equity and justice in the program purpose articulated by workshop participants is rare in the context of graduate sustainable food systems programs; Valley et al. (2020) found that only one third of graduate programs addressed equity, none of which included doctoral programs. While the workshops made significant progress in articulating a focus on justice, much work remains. The workshop participants (including us, as authors) were predominantly white women, and our shared habits of mind and being impact and limit our ability to envision just food and agriculture systems; though these demographics are representative of broader agroecology programs at UMN-TC, it represents a significant limitation in our pedagogy development process. Future efforts will need to be especially intentional to create spaces that are centered on the experiences of those most oppressed by dominant systems.

Creating academic programs and structures that center anti-oppression is necessary for university agroecology education to participate in transformative movements (Montenegro de Wit et al., 2021). Our findings particularly highlighted the importance of critical and collective processes/structures, and we focused on epistemological interventions because, as prior scholarship has shown, they help teachers and learners develop new vocabularies, deepen analysis, navigate discomfort and uncertainty, and overcome cognitive or emotional blocks to dialogue (Andreotti et al., 2018). In this section, we discuss the key contributions to agroecology pedagogy scholarship that emerged from our workshops, identify important opportunities for future development, and share ongoing efforts to implement the pedagogy as a graduate agroecology program at UMN-TC.

6.1. Transform self to transform the world: Engaging in critical inquiry through collective processes

Our results affirm that critical pedagogies are important to build students' capacity for collective action within and beyond university agroecology courses and programs (Meek and Tarlau, 2016; Classens et al., 2021; Horner et al., 2021). Critical inquiry is important in relationships to self, in that it helps individuals navigate their own positionality. In Freire (2000)'s description of critical consciousness, for example, the first step is to "deal with the problem of the oppressed consciousness and the oppressor consciousness.… [and] take into account their behavior, their view of the world, and their ethics." In other words, to reveal oppression, build trust with others, and commit to action, Freire argues that people "must re-examine themselves constantly." Many theories of change engage with this connection between internal, small-scale changes and external, multi-scalar systemic transformations; it is described as tensions between self and world transformation in agroecology (Lieblein et al., 2007; Francis et al., 2015; McCune and Sánchez, 2019; Nicklay et al., 2020; Casado et al., 2022), fractals in Black organizing strategies (Brown, 2017), inward and outward transformation in Christian liberation theologies (Tarlau, 2015; McCune and Sánchez, 2019; Sit, 2020), and adaptive cycling in ecology (Holling, 2005). To navigate these dialectic relationships, our results highlight the importance of pedagogical structures—specifically, cohorts—that reproduce opportunities for critical inquiry.

Workshop participants highlighted that learning/unlearning in critical inquiry can generate strong emotions and envisioned cohorts as a space to collectively metabolize discomfort. This echoes the concept of affective justice in the EarthCARE Global Justice Framework, which positions "re-configuring neuro-biological connections, digesting and composting traumas, fears, denials, and addictions" as a necessary part of environmental and economic justice (Gesturing Toward Decolonial Futures Collective, 2018; Stein et al., 2020). When engaging with discomfort alone, people may become stuck in cycles of inaction. Shanahan (2022), for example, observed that honeybee researchers, students, educators, and others often avoided discomfort by choosing not to ask the "dangerous questions" about industrial agriculture that challenged their beliefs and assumptions; doing so avoided a threat to their work and identity but ultimately enacted a broader harm by protecting toxic systems. Recognizing this challenge, agroecology education scholarship has called for pedagogies that support students through the feelings of despair and discomfort that emerge when learning about social injustices (Galt et al., 2013; Horner et al., 2021).

Cohorts provide a collective structure to process intellectual and emotional discomfort. Kearns (2021) described this as "standing in the gap" for people as they question deeply held beliefs, core assumptions, and ways of knowing/being and as they face the emotions that emerge, such as embarrassment, shame, and fear. In this context, cohorts are also important to process experiences doing participatory work. Workshop participants noted Peer and Program cohorts could provide an important opportunity for students, faculty, and staff to process discomfort, fear, etc. away from their community partners, which is one way to avoid perpetuating harm. This points to an opportunity for cohorts to enact pedagogies of *alternancia,* similar to the Baserritik Mundura program in Spain (Casado et al., 2022) and movement-led agroecology learning programs more broadly (Rivera-Ferre et al., 2021). By creating a space to "stand in the gap" for fellow agroecologists, cohorts create opportunities to experience these emotions and let them change us, our relationships, and our actions (Andreotti et al., 2018; Rigolot, 2020).

Critical inquiry through cohorts, however, is not only imagined as a space for discomfort; workshop participants repeatedly described collective processes and relationships with words like heart, love, and joy. These emotions, too, create transformative learning experiences for students (Jelinski et al., 2020). It is especially important to cultivate joy, gratitude, and abundance as a way to build resilience when facing challenges, trauma, and grief (Kimmerer, 2013; Stein et al., 2020; Kimmerer and Wilson, 2022). Few university agroecology programs, however, explicitly incorporate love, joy, and abundance in their pedagogies, perhaps because cultural/lived experiences and emotions are often designated as unofficial, non-productive, and non-visible in Western academic institutions (Rivera-Ferre et al., 2021). Many pedagogies based in agroecology movements cultivate solidarity, belief for change, and love for the cause through *mística* practices, which are exchanges of culture, theater, ceremony, poetry, art, and stories (Tarlau, 2015; Black Dirt Farm Collective, 2020; Rivera-Ferre et al., 2021; Casado et al., 2022). In the former Baserritik Mundura program in Spain, for example, students, educators, and partners described *mística* practices as one of the most valuable aspects of the program, with benefits such as construction of identity, cohort cohesion, connecting political/emotional and physical/symbolic, encouragement, commitment, creativity, and joy (Casado et al., 2022). Explicit inclusion of abundance, care, and love in critical and collective processes, therefore, represents an important area for future growth—both at UMN-TC and in the broader field of agroecology education.

Finally, engaging with critical inquiry through cohorts also continues building collective structures that minimize risk. Rivera-Ferre et al. (2021) warns us to not underestimate the difficulties of critical and political agroecology learning in our current historical moment, and our results speak directly to the risks faced by university students, faculty, and staff, particularly for work grounded in critical approaches. Within this context, workshop participants named minimizing risk as a key component of movement building. In developing this pedagogy, one way we (as authors) sought to minimize risk for our cohort was by being very intentional in the names used for each pedagogical component, a strategy that has been used at many other institutions (Jacobsen et al., 2012; Valley et al., 2020; Horner et al., 2021). While writing the initial draft of this paper, for example, we observed the broader social and political pushback against critical race theory (Sawchuk, 2021), which contributed to our decision to rename "critical theory" to "critical inquiry." While this example focuses on minimizing the risks faced by university students, faculty, and staff, the Agroecology Research-Action Collective emphasizes that it is important for those with less precarious positions to leverage their privilege for both colleagues and community partners in agroecological work (Montenegro de Wit et al., 2021).

6.2. Collective, iterative, and long-term participation

Practicing critical inquiry through cohorts builds capacity for participants to learn agroecological values/knowledge and engage with broader social, political, cultural, and ecological systems. According to McCune et al. (2017), such "processes of internalization" must be connected to "processes of socialization"—spaces where participants can integrate what they have learned to support collectively determined needs and goals. Within our model, the link between cohorts and participatory practice supports processes of socialization, connecting individual (self) transformation with collective (world) transformation. Participatory practice builds on the long history of participatory action research (PAR) in agroecology (e.g., Fals-Borda, 2001; Montenegro de Wit, 2014; Méndez et al., 2017; Nicklay et al., 2020; Montenegro de Wit et al., 2021; Utter et al., 2021). Our results affirmed the centrality of participatory work to agroecology but highlighted emerging opportunities for a broader understanding of participatory practice, supported by interconnected cohorts, to reorient agroecological work toward collective needs.

Workshop participants shared experiences that demonstrated their work was motivated by collectively identified needs/opportunities, which is a departure from the focus on individual curiosity or skill development in Western academic institutions. The shift toward the collective echoes recent calls for pedagogies to expand learning beyond the individual (McCune and Sánchez, 2019) and "place the territory at the center of the education process" (Domené-Painenao and Herrera, 2019). A territory is a place defined by specific relationships between people, histories, land and ecologies, and McCune et al. (2017) have previously described

territorial transformation as a process in which "diverse subjects assume specific tasks in specific moments, creating social feedbacks and emergent principles." Using this lens, we open the possibility for university faculty, students, and programs to fulfill a broad range of roles in territorial (collective) transformation. The Agroecology Research-Action Collective similarly argues that researchers and students can provide a wide range of "valuable work," whether that is through research, grant-writing, or digging post holes. When roles align with needs, participatory efforts "build capacity in all areas of expertise—in both research and partner communities—such that interdependence cultivates equity" (Montenegro de Wit et al., 2021). This was reflected in our workshops, where participants encouraged us to expand our model from a focus on participatory research to a broader understanding of "participatory practice." Furthermore, it became evident that cohorts could provide important structures to hold the relationships that create a "territory" for agroecological transformation and through which participatory practice emerges.

Interconnected peer, program, and practitioner cohorts (Table 3) create a structure to build, maintain, and hold long-term community-university relationships. Rather than relying on individuals to build and nurture relationships, this model would instead create webs of relationships between community partners and university students, faculty, and staff. Cohorts create an institutional structure for connections, which Méndez et al. (2017) argues is important to "facilitate the succession of active participants without losing forward momentum." Thus, cohorts address two key challenges identified by both workshop participants and broader literature: the limited timeframe of graduate programs (Bruges and Smith, 2007; Delate et al., 2017) and academic reward structures that don't recognize or support the resources required to build and maintain relationships, including the emotional labor, time, and financial resources (Robinson, 2008; Hilimire et al., 2014; Montenegro de Wit et al., 2021). Furthermore, the research needs identified by partners often require knowledge, expertise, or skills beyond those of an individual faculty/educator (Montenegro de Wit et al., 2021); whereas an individual student or researcher may try to stretch beyond their capacity to fulfill that role in the current university structure, holding relationships collectively could open the opportunity to connect partners and other university cohort members who already have the relevant skills, knowledge, and capacity. This structure would also complement movement-based spaces for collective learning, which are vital to broader agroecological movements (e.g., Martínez-Torres and Rosset, 2014; Fernandez et al., 2015; Meek et al., 2019). For example, within the European Agroecology Knowledge Exchange Network, Anderson et al. (2019) described the importance of dialogue across three dimensions: among food producers, between food producers and other actors, and between food producers and formal education/research institutions. Incorporating cohorts in university programs, therefore, represents an opportunity to engage in multi-scalar, movement-led networks.

Workshop participants particularly highlighted the potential of the Practitioner Cohort to facilitate dialogue across multiple ways of knowing and divergent views, values, and visions. Dialogue, therefore, is critical to create the emergence of participatory projects that serve collectively identified needs and opportunities. This conception differs from the ways dialogue is commonly employed in existing university agroecology programs, where it is often framed as a way to expose students to other ways of knowing or instrumentalized to learn communication skills (Galt et al., 2012; Francis et al., 2018). Instead, our understanding of dialogue in Practitioner Cohorts is similar to the undergraduate agroecology program in at the Bolivarian University of Venezuela, where students conduct participatory research projects that emerge from ongoing *diálogos de saberes* with communities; projects span academic years to ensure the continuity of collaborations and ongoing project development/growth (Domené-Painenao and Herrera, 2019). The language of "emergence" is key here. Martínez-Torres and Rosset (2014) argue that *diálogos de saberes* facilitate the emergence of "new collective understandings, meanings and knowledges [that] may form the basis for collective actions of resistance and construction of new processes." Emergence occurs as the result of participants both exchanging knowledge and engaging in collective critical reflection. During the workshops, we observed a small example of emergence in the activity to develop a program goal. Participants started with divergent views on whether the goal was to develop a toolbox, change farming practices, or transform systems. Through dialogue, a new articulation of the program goal emerged, created from the multiple viewpoints of the participants in the room so that all were excited about it. This example highlights that in our model, the combination of critical inquiry, cohorts, and participatory practice create a unique opportunity to engage in dialogue that leads to emergent collective action.

We recognize, however, that there are many challenges to implementing dialogue processes in the Practitioner cohort that facilitate emergence. First, one of the most commonly cited challenges in existing university agroecology programs (including UMN-TC—see Institutional Context) is that faculty are often uncomfortable facilitating courses that require critical, dialogue-based approaches because their own education did not provide opportunities to practice dialogue (Lieblein and Francis, 2013; Hilimire et al., 2014; David and Bell, 2018; Rivera-Ferre et al., 2021). Even when university educators do have experience with dialogue, they are often still immersed in Western ontologies that are oriented to understand consensus as a midpoint between two different views (Lieblein et al., 2004; Martínez-Torres and Rosset, 2014; Andreotti et al., 2018). Mid-point consensus ultimately functions to narrow possibilities, as described by activist and organizer Brown (2017):

> I have been in countless meetings where there was a moment of creative abundance and energy, and then someone said we needed to pick one thing to get behind, or a three- or five- or ten-point plan… [the] tragedy of this narrowing is that people get left out, not just in a slightly hurtful way, but left out of how we construct every aspect of society, infrastructure, and culture (p. 156).

In other words, the way in which we conduct dialogue determines whether the visions of those most marginalized by dominant food systems are excluded or centered in our programs and broader visions for food system transformations. In implementing cohorts, therefore, it will be important to create processes and structures that expand possibilities, rather than narrow them.

Thus, it will be important to build capacity for dialogue as the cohorts and broader pedagogy is implemented. Practicing collective critical inquiry, described in the previous section, is an important foundation. Additionally, workshop participants emphasized the need for structured opportunities to engage in existing participatory

projects that were co-developed within broader and ongoing community-university networks, allowing them to focus on building skills to engage in critical and collective participatory practices. Participants provided examples of courses or programs at the UMN-TC where instructors maintain long-term community-university relationships and connect students to these networks through coursework and research experiences, which are also common in agroecology programs more broadly (Salomonsson et al., 2009; Hilimire et al., 2014; Runck et al., 2015; Francis et al., 2018; Jelinski et al., 2020; Montenegro de Wit et al., 2021). While supported participatory experiences require significant preparatory work to design projects and mentor students (Salomonsson et al., 2009; Francis et al., 2011; Montenegro de Wit et al., 2021), the interconnected cohorts would hopefully reduce this labor burden on individuals (as discussed in the previous section). This supported practice in short-term participatory projects through coursework would prepare students to engage in longer-term participatory work for their thesis/dissertation projects, with access to ongoing mentorship through the Peer, Program, and Practitioner Cohorts. Through the proposed pedagogy, therefore, workshop participants imagined potential strategies to facilitate collective, iterative, and long-term relationships that lead to the emergence of new ideas and roles for university programs in participatory projects.

6.3. Expanding relationality is necessary but requires networks of accountability

At its core, relational centering understands that knowledge is inseparable from the relational context in which it is held or from which it emerges—an idea that is grounded in feminist and Indigenous epistemologies (Wilson, 2009; Arora and Van Dyck, 2021). In previous sections, we discussed the importance of relationships to self in critical inquiry and relationships with others in participatory practice, both of which are supported through cohorts that provide space for collective dialogue and hold long-term relationships. Our results, therefore, affirm the importance of relationship building to facilitate horizontal learning, community co-production of knowledge and, ultimately, transformative learning (Nicklay et al., 2020; Horner et al., 2021). Relational centering provides a framework for agroecology education to focus on ways to live together (instead of solely on professionalization), which echoes the focus on *formación* in movement-based pedagogies (McCune et al., 2014; Rosset, 2015; McCune and Sánchez, 2019; Black Dirt Farm Collective, 2020).

By connecting self, others, and the more-than-human world, relational centering aligns with scholars and organizers who argue that *formación* does not only transform relationships between people, but also relationships between people, land, and more-than-human beings (Martínez-Torres and Rosset, 2014; McCune and Sánchez, 2019; Black Dirt Farm Collective, 2020). While this expanded understanding of relationships is nascent in agroecology pedagogies, it is important in broader movements for justice. The EarthCARE Global Justice Framework, for example, includes relational justice, which emphasizes ways of relating that enact collective entanglement (Gesturing Toward Decolonial Futures Collective, 2018). In Indigenous struggles for decolonization, radical relationality focuses on interdependence, reciprocity, equality, and responsibility in kinship relations, land body connections, and multidimensional connectivity (Yazzie and Baldy, 2018). Building agroecology spaces that center, recognize, and honor Indigenous and Black agricultural knowledge is especially important because many agroecological practices and principles are based on knowledge appropriated from Indigenous and Black farmers and land stewards, both of which are consistently underrepresented in discussions of agroecology (Cadieux et al., 2019; Montenegro de Wit, 2021).

Expanding relationality and reciprocity are clearly central educational tasks, and we believe it is important to include our articulation of relational centering, even if it is not perfect, so we avoid perpetuating human-centered ontologies/ways of being (Kimmerer, 2013), and instead use pedagogies to create space for alternatives to emerge (Classens et al., 2021). Dring et al. (2022) caution, however, that this is a complicated task for non-Indigenous students, educators, and scholars. Haraway (1988) broadly addresses the dangers of romanticizing or appropriating the visions of "subjugated knowledges," the knowledge of those marginalized by dominant systems; Dring et al. (2022) specifically explores the ways in which this happens within sustainable food systems and agroecology education when multiple ways of knowing are incorporated without awareness of the epistemological and ontological roots of relationality. Within this context, we acknowledge that part of the reason it is important for us to share this evolving understanding of relational centering is to remain accountable to our communities both within and beyond academia.

We attribute the frequent inclusion of relationships with more-than-human beings among our workshop participants (and ourselves) to mentorship in local and international Indigenous-led efforts. Many participants worked with the UMN-TC Native American Medicine Garden under the guidance of the (now former) garden steward, Oglala Lakota, Oceti Sakowin Cânté Sütá Francis Bettelyoun.[5] Additionally, many participated in decolonization cohorts facilitated by a former UMN-TC doctoral student and in movements to stop the Dakota Access Pipeline in North Dakota and the Line 3 Pipeline in Northern Minnesota (Estes and Dhillon, 2019; Andrade, 2021; Science for the People - Twin Cities, 2021). These efforts have demanded that non-Indigenous (particularly white) researchers and students acknowledge that UMN-TC stands on Mní Sóta Makhóčhe, the unceded traditional, ancestral, and contemporary land of the Dakhóta Oyáte,[6] and take anti-colonial actions toward reconciliation and repair. Doing so relies on the connection between critical inquiry, relationships to self, and cohort support described previously to engage with discomfort that surfaces as non-Indigenous people build new habits of mind to expand relationality.

5 Nearly a year after the workshop series, the University of Minnesota chose to not renew their employment contract with Cânté Sütá Francis Bettelyoun, the Native American Medicine Garden steward. For more information on the ways this process perpetuated colonial violence, see Demmings (2020) and Snow (2020).

6 The land was ceded in the Treaties of 1837 and 1851. When the U.S. later abrogated those treaties, the land was not returned to the Dakhóta, as is legally required when treaties are revoked (Case, 2018), and was instead "granted" to the UMN in the 1862 Morrill Act (Lee and Ahtone, 2020).

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6.4. Process as practice: Ongoing efforts and next steps

While the content of our proposed pedagogy for graduate agroecology education is important, the process of creating it has also been an opportunity for transformative learning. Casado et al. (2022) reflected that collective pedagogy design has "the enormous potential to leave a permanent impression on the participants and to give meaning to and reinforce collective political work," and developing the proposed pedagogy model has impacted each of us—and our broader UMN-TC community—in deep and lasting ways. Through critical inquiry, we have learned new ways of thinking—new habits of mind—to learn and unlearn the ways in which current social, economic, political, and ecological systems shape food systems. In relational centering, we developed ways to be in relationship with ourselves and others (human and more-than-human) that connect individual transformation with broader social transformation. Together, critical inquiry and relational centering shape the challenges we address through participatory practice, and our experiences working with others, in turn, change how we understand the world, which drives further critical inquiry. Our work is supported by collective learning through cohorts, composed of people and places with deep situated knowledge, that create space for dialogue across multiple ways of knowing, provide intellectual and emotional support, and build our capacity for collective action.

Our ultimate goal remains to enact the pedagogy for graduate agroecology learning through a dedicated degree program. To build capacity in critical inquiry, an elective, one-credit course entitled "Critical Approaches to Agroecology" was co-developed by Vivian, Sharon, and two faculty members and has been offered twice. Building on energy and connections from the workshop and courses, the FEASt student group was re-started in 2020 and serves as an informal peer cohort. Graduate students continue to pursue participatory training through various departments and institutions. These efforts are slow and vary as student capacity fluctuates, but it remains valuable work; agroecology topics and approaches explored by student groups may become part of required coursework, such as at the National University of General Sarmiento in Argentina (Sarandon and Marasas, 2017), or inform the development of degree programs, such as the Sustainable Agriculture and Food Systems undergraduate major at UC Davis (Parr and Van Horn, 2006; Galt et al., 2012). As a result, many educators have highlighted that such student-led efforts play an important role in creating transformative agroecology education pedagogies (Parr and Van Horn, 2006; Code, 2017; Intriago et al., 2017; Sarandon and Marasas, 2017). However, to create an agroecology program, prior scholarship has found that three components are necessary for success: key players (e.g., students, faculty, staff, partners), support networks and assets, and a programmatic opportunity (Jacobsen et al., 2012). While the ongoing efforts described above continue to build the first two, further work is needed to address institutional challenges and further develop the pedagogy in order to take advantage of programmatic opportunities in the future.

Broadly, there is important work to do at an institutional level. Agroecology programs will need to create grading, qualifying exams, thesis/dissertation expectations, and promotion/tenure processes that support critical, collective, relational, and transdisciplinary agroecology work (Montenegro de Wit et al., 2021), rather than dominant university systems that reward individual productivity and specialized expertise within legible disciplinary boundaries (Boyer, 1997; Diamond, 2002; Bateman and Hess, 2015; Klein and Falk-Krzesinski, 2017). Identifying an institutional home that can support inter- and transdisciplinary work is also important. Prior scholarship has described programmatic challenges when faculty and courses are fragmented across multiple departments (Valley et al., 2018; Ebel et al., 2020), as well as bureaucratic challenges to share resources and coordinate incentives across departments (Russell, 2005; Carroll et al., 2014; Lawrence, 2015; Fiala et al., 2018). Finally, there will need to be significant work to develop strategies to coordinate and maintain the interconnected cohorts, including overcoming distrust from past histories of extractive university research (Cadieux et al., 2019), funding structures to compensate participants (especially community partners), and learning ways of being and knowing that can manage divergence (Casado et al., 2022).

The proposed pedagogy focuses on program epistemologies, but it is also necessary to articulate the desired student outcomes and identify the values from which epistemologies and outcomes emerge (Galt et al., 2012; Valley et al., 2018; Ingram et al., 2020). During the summer 2019 workshop series, we attempted to explore these aspects of pedagogical development through activities to identify "value-driven skill sets" (see Workshop 2 activity descriptions in Supplementary material). However, participants often struggled to

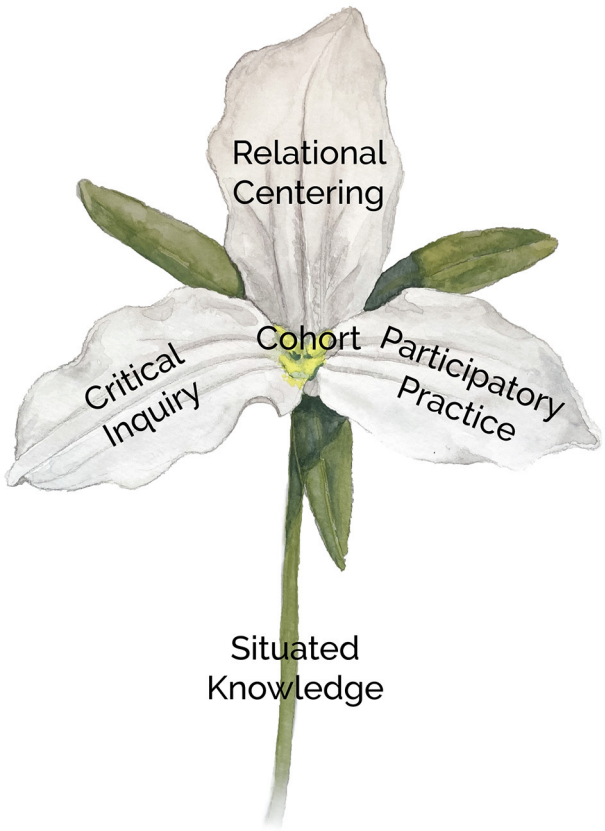

FIGURE 3
Conceptualizing the agroecology pedagogy model as *Trillium grandiflorum* is an opportunity to expand the imaginative possibilities of ongoing, iterative agroecology program development. Referencing both art and nature to visualize frameworks and possible futures can stimulate creative thought and result in new emergent properties.

distinguish between skills and values (e.g., participants categorized listening as both a skill and value) or provided very general examples (e.g., "writing" as a skill for participatory practice rather than "writing partnership agreements"). These challenges indicated that our activities did not provide sufficient scaffolding for participants to engage in these conversations. Future efforts focused on articulating values and outcomes (and refining epistemologies) should also include partners from beyond the university. To develop structures for partners to inform program development, one example to consider is the pedagogical political coordination (PPC) groups for the IALAs in Central/South America and the Baserritik Mundura in Spain (McCune and Sánchez, 2019; Casado et al., 2022). Composed of people and organizations who partner with the agroecology programs, the PPCs "focus and work pedagogically on the worries, concerns or unforeseen events that arise in the group during the training process, trying to politicize the learning process as the course develops, as well as incorporating the questions and proposals for improvement that the participants suggest" (Casado et al., 2022). Including community partners in the program development process is an important step to ultimately create a program that can facilitate dialogue across multiple ways of knowing and reorient agroecology efforts in university agroecology education toward collective (territorial) needs.

We hope that the iterative and reflective process described above, as well as the proposed pedagogy itself, both serve as inspiration for other agroecologists to develop their own models for agroecology learning that are unique to their communities, their context, and their place. Through the process of writing this paper, our ongoing efforts to implement the pedagogy, and envisioning the next steps, our understanding of agroecological learning has continued to grow and deepen. We sought to visualize the proposed pedagogy (Figure 1) in a way that could incorporate future areas of development and reflected the joy we experienced while co-writing this paper, particularly as each of us transitioned to new roles, jobs, and places. Thus, we began conceptualizing the pedagogy as *Trillium grandiflorum* (Figure 3). Because *T. grandiflorum* is a perennial wildflower native to Minnesota, it is an image that reflects our place and collective identity. The three petals represent the main components—critical inquiry, relational centering, and participatory practices—while six stamens at the center of the flower represent the cohort, all supported by the stem, representing situated knowledge. *T. grandiflorum* spreads through underground rhizomes and grows in dense stands, representing both horizontal learning and building networks for collective action (Case and Case, 1997). It is slow to mature in the understory of deciduous forests, representing the need to "move at the speed of trust" (Brown, 2017) in relational centering, even as we face urgent challenges. Other relationships, such as the sun or water that nurture growth, could represent emotional support and hope. The EarthCare Framework for Global Justice, for example, uses a sun and rainbow to indicate healing, rain to encompass lessons from those most marginalized by current systems, and wind to represent hope (Gesturing Toward Decolonial Futures Collective, 2018). Other structures, such as the sepals to the broader deciduous forest ecology, could represent the broader institutional structures and conditions that support transformative learning. By using both art and nature for this conceptualization, we create space to continue imagining future possibilities in our ongoing work. Ultimately, "becoming agroecologists" (Lieblein et al., 2004; McCune et al., 2017) is a life-long pursuit, a commitment to trying, failing, repairing, reflecting, and acting toward collective agroecological transformations within ourselves, academia, food systems, and beyond.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

All authors collaboratively developed, planned, implemented the summer 2019 workshop series, and contributed to writing and editing this publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2023.770862/full#supplementary-material

References

Altieri, M. A., and Francis, C. A. (1992). Incorporating agroecology into the conventional agricultural curriculum. *Am. J. Altern. Agric.* 7, 89–93. doi: 10.1017/S0889189300004525

Anderson, C. R., Maughan, C., and Pimbert, M. P. (2019). Transformative agroecology learning in Europe: building consciousness, skills and collective capacity for food sovereignty. *Agric. Hum. Values* 36, 531–547. doi: 10.1007/s10460-018-9894-0

Andrade, S. (2021). *An Indigenous Leader on Why She Still Needs to Protest Pipelines, Even Under Biden. Slate.* Available online at: https://slate.com/news-and-politics/2021/07/line-3-protest-pipeline-biden.html (accessed January 20, 2023).

Andreotti, V., Stein, S., Sutherland, A., Pashby, K., Suša, K., Amsler, S., et al. (2018). Mobilising different conversations about global justice in education: toward alternative futures in uncertain times. *Policy Pract.* 26, 9–41.

Arora, S., and Van Dyck, B. (2021). Refusal as radical care? Moving beyond modern industrial agriculture. *Development* 64, 252–258. doi: 10.1057/s41301-021-00310-3

ASA (2010). *Case Studies Published in the Journal of Natural Resources and Life Sciences Education, 1992-2005*. Madison, WI: American Society of Agronomy.

Basche, A. D., Roesch-McNally, G. E., Pease, L. A., Eidson, C. D., Lahdou, G. B., Dunbar, M. W., et al. (2014). Challenges and opportunities in transdisciplinary science: The experience of next generation scientists in an agriculture and climate research collaboration. *J. Soil Water Conserv.* 69, 176A−179A. doi: 10.2489/jswc.69.6.176A

Bateman, T. S., and Hess, A. M. (2015). Different personal propensities among scientists relate to deeper vs. broader knowledge contributions. *Proc. Natl. Acad. Sci. U. S. A.* 112, 3653–3658. doi: 10.1073/pnas.1421286112

Bawden, R. (2016). Transforming systems: the Hawkesbury initiatives in systemic development. *South Afr. Rev. Sociol.* 47, 99–116. doi: 10.1080/21528586.2015.1131192

Black Dirt Farm Collective, El Comite de Apoyo a Los Trabajadores Agricolas, Community to Community, Farmworker Association of Florida, Organizacion Boricua de Agricultura Ecologica, Eastern Woodlands Rematriation, et al. (2020). *The People's Agroecology Process: Unlocking Our Power through Agroecology*. Available online at: https://whyhunger.org/category/publications/the-peoples-agroecology-process-unlocking-our-power-through-agroecology/ (accessed January 20, 2023).

Bohman, J. (2021). "Critical theory," in *The Stanford Encyclopedia of Philosophy*, ed E. N. Zalta (Metaphysics Research Lab, Stanford University). Available online at: https://plato.stanford.edu/archives/spr2021/entries/critical-theory/ (accessed January 20, 2023).

Bowness, E., Nicklay, J. A., Liebman, A., Cadieux, K. V., and Blumberg, R. (2021). "Navigating urban agroecological research with the social sciences," in *Urban Agroecology: Interdisciplinary Research and Future Directions*, eds M. H. Egerer and H. Cohen (Boca Raton, FL: CRC Press/Taylor and Francis Group). doi: 10.1201/9780429290992-13

Boyer, E. L. (1997). *Scholarship Reconsidered: Priorities of the Professoriate, 1st Edn., 12th pr.* Lawrenceville, NJ: Carnegie Foundation for the Advancement of Teaching.

Brown, A. M. (2017). *Emergent Strategy: Shaping Change, Changing Worlds*. Chico, CA: AK Press.

Bruges, M., and Smith, W. (2007). Participatory approaches for sustainable agriculture: a contradiction in terms? *Agric. Hum. Values* 25, 13–23. doi: 10.1007/s10460-007-9058-0

Cadieux, K. V., Carpenter, S., Liebman, A., Blumberg, R., and Upadhyay, B. (2019). Reparation ecologies: regimes of repair in populist agroecology. *Ann. Am. Assoc. Geogr.* 109, 644–660. doi: 10.1080/24694452.2018.1527680

Caretta, M. A., and Pérez, M. A. (2019). When participants do not agree: member checking and challenges to epistemic authority in participatory research. *Field Methods* 31, 359–374. doi: 10.1177/1525822X19866578

Carroll, L., Ali, M. K., Cuff, P., Huffman, M. D., Kelly, B. B., Kishore, S. P., et al. (2014). Envisioning a transdisciplinary university. *J. Law Med. Ethics* 42, 17–25. doi: 10.1111/jlme.12183

Casado, B., Urretabizkaia, L., Begiristain-Zubillaga, M., and Martinez, Z. (2022). Strengthening agroecology with the political pedagogy of peasant organisations: a case study of baserritik mundura in the basque country. *Sustainability* 14, 2227. doi: 10.3390/su14042227

Case, F. W., and Case, R. B. (1997). *Trilliums*. Portland, OR: Timber Press.

Case, M. (2018). *The Relentless Business of Treaties: How Indigenous Land Became US Property*. Saint Paul, MN: Minnesota Historical Society Press.

Chang, H., Ngunjiri, F., and Hernandez, K.-A. C. (2016). *Collaborative Autoethnography.* Abingdon, OXON; New York, NY: Routledge. doi: 10.4324/9781315432137

Cheney I, Shattuck S. (Directors). (2020) *Picture a Scientist (Film).* Uprising Productions.

Clancy, K. B. H., Lee, K. M. N., Rodgers, E. M., and Richey, C. (2017). Double jeopardy in astronomy and planetary science: women of color face greater risks of gendered and racial harassment: gender, Race, and Harassment in Astronomy. *J. Geophys. Res. Planets* 122, 1610–1623. doi: 10.1002/2017JE005256

Classens, M., Hardman, E., Henderson, N., Sytsma, E., and Vsetula-Sheffield, A. (2021). Critical food systems education, neoliberalism, and the alternative campus tour. *Agroecol. Sust. Food Syst.* 45, 450–471. doi: 10.1080/21683565.2020.1829776

Code, J. M. (2017). Innovations in agroecology education: from bicycles to blended learning. *J. Educ.* 197, 34–45. doi: 10.1177/0022057418782353

Committee on the Impacts of Sexual Harassment in Academia, Committee on Women in Science, Engineering, and Medicine, Policy and Global Affairs, and National Academies of Sciences, Engineering, and Medicine. (2018). *Sexual Harassment of Women: Climate, Culture, and Consequences in Academic Sciences, Engineering, and Medicine*, eds P. A. Johnson, S. E. Widnall, and F. F. Benya. Washington, DC: National Academies Press, 24994.

Crowley, R. M., and King, L. J. (2018). Making inquiry critical: examining power and inequity in the classroom. *Soc. Educ.* 82, 14–17.

David, C., and Bell, M. M. (2018). New challenges for education in agroecology. *Agroecol. Sust. Food Syst.* 42, 612–619. doi: 10.1080/21683565.2018.1426670

Delate, K., Canali, S., Turnbull, R., Tan, R., and Colombo, L. (2017). Participatory organic research in the USA and Italy: across a continuum of farmer–researcher partnerships. *Renew. Agric. Food Syst.* 32, 331–348. doi: 10.1017/S1742170516000247

Demmings, I. (Director). (2020). *Food Freedom Radio. In Food Freedom Radio*. AM950: The Progressive Voice of America. Available online at: https://www.am950radio.com/food-freedom-radio-june-13-2020/ (accessed January 20, 2023).

Diamond, R. M. (2002). Defining scholarship for the twenty-first century. *New Direct. Teach. Learn.* 2002, 73–80. doi: 10.1002/tl.57

Domené-Painenao, O., and Herrera, F. F. (2019). Situated agroecology: Massification and reclaiming university programs in Venezuela. *Agroecol. Sust. Food Syst.* 43, 936–953. doi: 10.1080/21683565.2019.1617223

Dring, C. C., Cajková, T., Mendes, W., Stein, S., Valley, W., and Clegg, D. J. (2022). Ontological awareness in food systems education. *Front. Sust. Food Syst.* 6, 750776. doi: 10.3389/fsufs.2022.750776

Ebel, R., Ahmed, S., Valley, W., Jordan, N. R., Grossman, J., Byker Shanks, C., et al. (2020). Co-design of adaptable learning outcomes for sustainable food systems undergraduate education. *Front. Sust. Food Syst.* 4, 568743. doi: 10.3389/fsufs.2020.568743

El Colegio de la Frontera Sur. (n.d.). *Maestría en Agroecología. ECOSUR postgrado*. Available online at: https://www.ecosur.mx/posgrado/oferta-de-posgrado/maestria-en-agroecologia/ (accessed January 20, 2023).

Estes, N., and Dhillon, J. (Eds.). (2019). *Standing With Standing Rock: Voices from the #NoDAPL Movement*. Minneapolis, MN: University of Minnesota Press. doi: 10.5749/j.ctvr695pq

Fals-Borda, O. F. (2001). "Participatory (action) research in social theory: origins and challenges," in *Handbook of Action Research*, eds P. Reason and H. Bradbury (Thousand Oaks, CA: SAGE Publications), 27–37.

Fernandez, M., Méndez, V. E., Mares, T., and Schattman, R. (2015). "Chapter 10: agroecology, food sovereignty, and urban agriculture in the United States," in *Chapter 10: Agroecology, Food Sovereignty, and Urban Agriculture in the United States*, eds V. E. Méndez, C. M. Bacon, R. Cohen, and S. R. Gliessman (Boca Raton, FL: CRC Press/Taylor and Francis Group), 161–175.

Fiala, V., Freyer, B., Klimek, M., and Fahringer, A. (2018). How do you teach transdisciplinary competences for food and farming systems research? Insights from the course "System Analysis and Scenario Technique." *Open Agric.* 3, 553–566. doi: 10.1515/opag-2018-0059

Francis, C. A. (2020). Training for specialists vs. education for agroecologists. *Agroecol. Sust. Food Syst.* 44, 3–6. doi: 10.1080/21683565.2019.1648359

Francis, C. A., Breland, T. A., Lieblein, G., and Nicolaysen, A. M. (2018). "Agroecology education to sustain resilient food production," in *Climate Change and Crop Production, 1st Edn.*, ed N. Benkeblia (Boca Raton, FL: CRC Press), 173–185. doi: 10.1201/9781315391861-11

Francis, C. A., Jordan, N. R., Porter, P. M., Breland, T. A., Lieblein, G., Salomonsson, L., et al. (2011). Innovative education in agroecology: experiential learning for a sustainable agriculture. *Crit Rev Plant Sci.* 30, 226–237. doi: 10.1080/07352689.2011.554497

Francis, C. A., Lieblein, G., Gliessman, S., Breland, T. A., Creamer, N., Harwood, R., et al. (2003). Agroecology: the ecology of food systems. *J. Sustain. Agric.* 22, 99–118. doi: 10.1300/J064v22n03_10

Francis, C. A., Nicolaysen, A. M., Morse, S., Lieblein, G., and Breland, T. A. (2015). Educational innovations in agroecology: learning-centered open-ended cases. *Acta Fytotechnica Zootechnica* 18, 86–89. doi: 10.15414/afz.2015.18.si.86-89

Freire, P. (2000). *Pedagogy of the Oppressed (30th Anniversary ed)*. New York, NY; London: Continuum.

Galt, R. E., Clark, S., and Parr, D. (2012). Engaging values in sustainable agriculture and food systems education: toward an explicitly values-based pedagogical approach. *J. Agric. Food Syst. Commun. Develop.* 2, 43–54. doi: 10.5304/jafscd.2012.023.006

Galt, R. E., Parr, D., Van Soelen Kim, J., Beckett, J., Lickter, M., and Ballard, H. (2013). Transformative food systems education in a land-grant college of agriculture: the importance of learner-centered inquiries. *Agric. Hum. Values* 30, 129–142. doi: 10.1007/s10460-012-9384-8

Gesturing Toward Decolonial Futures Collective (2018). *The House Modernity Built and EarthCARE Global Justice Framework v. 3.1*. Available online at: https://decolonialfuturesnet.files.wordpress.com/2018/04/housemycelium.pdf (accessed January 20, 2023).

Gliessman, S. (2018). Defining agroecology. *Agroecol. Sust. Food Syst.* 42, 599–600. doi: 10.1080/21683565.2018.1432329

Gonzalez de Molina, M. (2013). Agroecology and politics. how to get sustainability? About the necessity for a political agroecology. *Agroecol. Sust. Food Syst.* 37, 45–59. doi: 10.1080/10440046.2012.705810

Haraway, D. (1988). Situated knowledges: the science question in feminism and the privilege of partial perspective. *Feminist Stud.* 14, 575. doi: 10.2307/3178066

Hartle, J., Cole, S., Trepman, P., Chrisinger, B., and Gardner, C. (2017). Interdisciplinary food-related academic programs: a 2015 snapshot of the United States landscape. *J. Agric. Food Syst. Community Dev.* 7, 1–15. doi: 10.5304/jafscd.2017.074.006

Hilimire, K., Gillon, S., McLaughlin, B. C., Dowd-Uribe, B., and Monsen, K. L. (2014). Food for thought: developing curricula for sustainable food systems education programs. *Agroecol. Sust. Food Syst.* 38, 722–743. doi: 10.1080/21683565.2014.881456

Holling, C. S. (2005). From complex regions to complex worlds. *Minnesota J. Law Sci. Technol.* 7, 1–20. doi: 10.5751/ES-00612-090111

Horner, C. E., Morse, C., Carpenter, N., Nordstrom, K. L., Faulkner, J. W., Mares, T., et al. (2021). Cultivating pedagogy for transformative learning: a decade of undergraduate agroecology education. *Front. Sust. Food Syst.* 5, 751115. doi: 10.3389/fsufs.2021.751115

Ingram, J., Ajates, R., Arnall, A., Blake, L., Borrelli, R., Collier, R., et al. (2020). A future workforce of food-system analysts. *Nat. Food* 1, 9–10. doi: 10.1038/s43016-019-0003-3

Intriago, R., Gortaire Amézcua, R., Bravo, E., and O'Connell, C. (2017). Agroecology in Ecuador: Historical processes, achievements, and challenges. *Agroecol. Sust. Food Syst.* 41, 311–328. doi: 10.1080/21683565.2017.1284174

Jacobsen, K., Niewolny, K., Schroeder-Moreno, M., Van Horn, M., Harmon, A., Chen Fanslow, Y., et al. (2012). Sustainable agriculture undergraduate degree programs: a land-grant university mission. *J. Agric. Food Syst. Commun. Dev.* 2, 13–26. doi: 10.5304/jafscd.2012.023.004

Jelinski, N. A., Perrone, S. V., Blair, H. K., and Fabian, M. L. (2020). Growing hearts and minds: linking landscapes and lifescapes in a soils field course. *Nat. Sci. Educ.* 49, e20018. doi: 10.1002/nse2.20018

Jordan, N. R., Andow, D. A., and Mercer, K. L. (2005). New concepts in agroecology: a service-learning course. *J. Nat. Resour. Life Sci. Educ.* 34, 83–89. doi: 10.2134/jnrlse.2005.0083

Jordan, N. R., Bawden, R. J., and Bergmann, L. (2008). Pedagogy for addressing the worldview challenge in sustainable development of agriculture. *J. Nat. Resour. Life Sci. Educ.* 37, 92–99. doi: 10.2134/jnrlse2008.37192x

Jordan, N. R., Grossman, J., Lawrence, P., Harmon, A., Dyer, W., Maxwell, B., et al. (2014). New curricula for undergraduate food-systems education: a sustainable agriculture education perspective. *NACTA J.* 58, 302–310.

Jordan, N. R., Gutknecht, J., Bybee-Finley, K. A., Hunter, M., Krupnik, T. J., Pittelkow, C. M., et al. (2021). To meet grand challenges, agricultural scientists must engage in the politics of constructive collective action. *Crop Sci.* 61, 24–31. doi: 10.1002/csc2.20318

Kearns, F. (2021). *Getting to the Heart of Science Communication: A Guide to Effective Engagement*. Washington, DC; Covelo, CA: Island Press.

Kimmerer, R. W. (2013). *Braiding Sweetgrass: Indigenous Wisdom, Scientific Knowledge and the Teachings of Plants, 1st Edn.* Minneapolis, MN: Milkweed Editions.

Kimmerer, R. W., and Wilson, D. (2022). *Milkweed presents Robin Wall Kimmerer*. Available online at: https://www.northrop.umn.edu/events/robin-wall-kimmerer (accessed January 20, 2023).

Klein, J. T., and Falk-Krzesinski, H. J. (2017). Interdisciplinary and collaborative work: framing promotion and tenure practices and policies. *Res. Policy* 46, 1055–1061. doi: 10.1016/j.respol.2017.03.001

Lake, E. J. (2021). A *Case Study of Black Students' Perception of Experiential Learning at PWIs*. National Association of Colleges and Employers Journal. Available online at: https://www.naceweb.org/diversity-equity-and-inclusion/trends-and-predictions/a-case-study-of-black-students-perception-of-experiential-learning-at-pwis/ (accessed January 20, 2023).

Lawrence, R. J. (2015). Advances in transdisciplinarity: epistemologies, methodologies and processes. *Futures* 65, 1–9. doi: 10.1016/j.futures.2014.11.007

Lee, R., and Ahtone, T. (2020). *Land-Grab Universities: Expropriated Indigenous Land is the Foundation of the Land-Grant University System*. High Country News. Available online at: https://www.hcn.org/issues/52.4/indigenous-affairs-education-land-grab-universities (accessed January 20, 2023).

Levine, P. (2016). Saving relational politics. *Perspect. Polit.* 14, 468–473. doi: 10.1017/S1537592716000165

Lieblein, G., Breland, T. A., Østergaard, E., Salomonsson, L., and Francis, C. A. (2007). Educational perspectives in agroecology: steps on a dual learning ladder toward responsible action. *NACTA J.* 51, 37–44.

Lieblein, G., and Francis, C. A. (2007). Towards Responsible action through agroecological education. *Italian J. Agron.* 2, 83. doi: 10.4081/ija.2007.83

Lieblein, G., and Francis, C. A. (2013). Faculty prerequisites for dialogue-based education. *NACTA J.* 57, 72–74.

Lieblein, G., Østergaard, E., and Francis, C. A. (2004). Becoming an agroecologist through action education. *Int. J. Agric. Sust.* 2, 147–153. doi: 10.1080/14735903.2004.9684574

Lofland, J., Snow, D. A., Anderson, L., and Lofland, L. H. (Eds.). (2006). *Analyzing Social Settings: A Guide to Qualitative Observation and Analysis, 4th Edn*. Long Grove, IL: Waveland Press.

Martínez-Torres, M. E., and Rosset, P. M. (2014). Diálogo de saberes in La Vía Campesina: food sovereignty and agroecology. *J. Peasant Stud.* 41, 979–997. doi: 10.1080/03066150.2013.872632

McCune, N., Reardon, J., and Rosset, P. M. (2014). Agroecological formación in rural social movements. *Rad. Teacher* 98, 31–37. doi: 10.5195/rt.2014.71

McCune, N., Rosset, P. M., Salazar, T. C., Saldívar Moreno, A., and Morales, H. (2017). Mediated territoriality: rural workers and the efforts to scale out agroecology in Nicaragua. *J. Peasant Stud.* 44, 354–376. doi: 10.1080/03066150.2016.1233868

McCune, N., and Sánchez, M. (2019). Teaching the territory: agroecological pedagogy and popular movements. *Agric. Hum. Values* 36, 595–610. doi: 10.1007/s10460-018-9853-9

Meadows, D. H. (2008). *Thinking in Systems: A Primer*, ed D. Wright. White River Junction, VT: Chelsea Green Publishing.

Meek, D., Bradley, K., Ferguson, B., Hoey, L., Morales, H., Rosset, P. M., et al. (2019). Food sovereignty education across the Americas: multiple origins, converging movements. *Agric. Hum. Values* 36, 611–626. doi: 10.1007/s10460-017-9780-1

Meek, D., and Tarlau, R. (2016). Critical food systems education (CFSE): educating for food sovereignty. *Agroecol. Sust. Food Syst.* 40, 237–260. doi: 10.1080/21683565.2015.1130764

Menakem, R. (2017). *My Grandmother's Hands: Racialized Trauma and the Pathway to Mending our Hearts and Bodies*. Las Vegas, NV: Central Recovery Press.

Méndez, V. E., Bacon, C. M., and Cohen, R. (2015). "Introduction: agroecology as a transdisciplinary, participatory, and action-oriented approach," in *Agroecology: A Transdisciplinary, Participatory, and Action-Oriented Approach*, eds V. E. Méndez, C. M. Bacon, R. Cohen, and S. R. Gliessman (Boca Raton, FL: CRC Press/Taylor and Francis Group), 1–21. doi: 10.1201/b19500-2

Méndez, V. E., Caswell, M., Gliessman, S., and Cohen, R. (2017). Integrating agroecology and participatory action research (PAR): lessons from Central America. *Sustainability* 9, 705. doi: 10.3390/su9050705

Migliorini, P., Gkisakis, V., Gonzalvez, V., Raigón, M., and Bàrberi, P. (2018). Agroecology in Mediterranean Europe: genesis, state and perspectives. *Sustainability* 10, 2724. doi: 10.3390/su10082724

Migliorini, P., and Lieblein, G. (2016). Facilitating transformation and competence development in sustainable agriculture university education: an experiential and action oriented approach. *Sustainability* 8, 1243. doi: 10.3390/su8121243

Montenegro de Wit, M. (2014). A Lighthouse for urban agriculture: university, community, and redefining expertise in the food system. *Gastronomica* 14, 9–22. doi: 10.1525/gfc.2014.14.1.9

Montenegro de Wit, M. (2021). What grows from a pandemic? Toward an abolitionist agroecology. *J. Peasant Stud.* 48, 99–136. doi: 10.1080/03066150.2020.1854741

Montenegro de Wit, M., and Iles, A. (2016). Toward thick legitimacy: creating a web of legitimacy for agroecology. *Elementa Sci. Anthrop*. 4, 000115. doi: 10.12952/journal.elementa.000115

Montenegro de Wit, M., Shattuck, A., Iles, A., Graddy-Lovelace, G., Roman-Alcalá, A., and Chappell, M. (2021). Operating principles for collective scholar-activism: early insights from the agroecology research-action collective. *Jo. Agric. Food Syst. Community Dev.* 10, 1–19. doi: 10.5304/jafscd.2021.102.022

Newbery, L. (2003). Will any/body carry that canoe? A geography of the body, ability, and gender. *Can. J. Environ. Educ.* 8, 204–216.

Nicklay, J. A., Cadieux, K. V., Rogers, M. A., Jelinski, N. A., LaBine, K., and Small, G. E. (2020). Facilitating spaces of urban agroecology: a learning framework for community-university partnerships. *Front. Sust. Food Syst.* 4, 143. doi: 10.3389/fsufs.2020.00143

Nicklay, J. A., Perrone, S., Wauters, V., Badger, S., Grossman, J., Hecht, N. D., et al. (2018). *Moving Agronomic Pedagogy Beyond Disciplinary Boundaries [Oral Session]*.

Østergaard, E., Lieblein, G., Breland, T. A., and Francis, C.A. (2010). Students learning agroecology: phenomenon-based education for responsible action. *J. Agric. Educ. Extens.* 16, 23–37. doi: 10.1080/13892240903533053

Parr, D. M., Trexler, C. J., Khanna, N. R., and Battisti, B. T. (2007). Designing sustainable agriculture education: academics' suggestions for an undergraduate curriculum at a land grant university. *Agric. Hum. Values* 24, 523–533. doi: 10.1007/s10460-007-9084-y

Parr, D. M., and Van Horn, M. (2006). Development of organic and sustainable agricultural education at the University of California, Davis: a closer look at practice and theory. *Horttechnology* 16, 426–431. doi: 10.21273/HORTTECH.16.3.0426

Perfecto, I., Vandermeer, J. H., and Wright, A. L. (2019). *Nature's Matrix: Linking Agriculture, Biodiversity Conservation and Food Sovereignty, 2nd Edn*. Abingdon, OXON; New York, NY: Routledge, Taylor and Francis Group. doi: 10.4324/9780429028557

Porter, P. M., Runck, B. C., Brakke, M. P., and Wagner, M. (2015). Agroecology education by bicycle on two continents: student perceptions and instructor reflections. *Nat. Sci. Educ.* 44, 69–78. doi: 10.4195/nse2014.05.0011

Rigolot, C. (2020). Transdisciplinarity as a discipline and a way of being: complementarities and creative tensions. *Hum. Soc. Sci. Commun.* 7, 100. doi: 10.1057/s41599-020-00598-5

Rivera-Ferre, M. G., Gallar, D., Calle-Collado, Á., and Pimentel, V. (2021). Agroecological education for food sovereignty: insights from formal and non-formal spheres in Brazil and Spain. *J. Rural Stud.* 88, 138–148. doi: 10.1016/j.jrurstud.2021.10.003

Robinson, C. J. (2020). *Black Marxism: The Making of the Black Radical Tradition, 3rd Edn., revised and updated*. Chapel Hill, NC: The University of North Carolina Press.

Robinson, J. (2008). Being undisciplined: transgressions and intersections in academia and beyond. *Futures* 40, 70–86. doi: 10.1016/j.futures.2007.06.007

Rosset, P. M. (2015). Epistemes rurales y la formación agroecológica en La Vía campesina. *Rev. Ciencia Tecnol. Soc.* 2, 4–13.

Rosset, P. M., and Martínez-Torres, M. E. (2012). Rural social movements and agroecology: context, theory, and process. *Ecol. Soc.* 17, art17. doi: 10.5751/ES-05000-170317

Runck, B. C., Brakke, M. P., and Porter, P. M. (2015). The extended classroom framework for teaching systems analysis of food systems. *Nat. Sci. Educ.* 44, 101–111. doi: 10.4195/nse2015.04.0004

Russell, A. (2005). No academic borders?: transdisciplinarity in university teaching and research. *Austral. Univ. Rev.* 48, 35–41.

Salomonsson, L., Nilsson, A., Palmer, S., Roigart, A., and Francis, C. A. (2009). Farming systems education: case study of Swedish test pilots. *Renew. Agric. Food Syst.* 24, 48–59. doi: 10.1017/S1742170508002408

Sarandon, S., and Marasas, M. E. (2017). Brief history of agroecology in Argentina: Origins, evolution, and future prospects. *Agroecol. Sust. Food Syst.* 41, 238–255. doi: 10.1080/21683565.2017.1287808

Sawchuk, S. (2021). *What is Critical Race Theory, and Why is it Under Attack?* Education Week. Available online at: https://www.edweek.org/leadership/what-is-critical-race-theory-and-why-is-it-under-attack/2021/05

Science for the People - Twin Cities (2021). *Line 3 Myth vs. Fact.* Twin Cities SFTP. Available online at: https://twincities.scienceforthepeople.org/index.php/2021/04/03/line3-myth-fact/ (accessed January 20, 2023).

Shanahan, M. (2022). Honey bees and industrial agriculture: what researchers are missing, and why it's a problem. *J. Insect Sci.* 22, 14. doi: 10.1093/jisesa/ieab090

Simmons. (2021). *Our needs will not diminish: Perspectives of ontario non-profit organizations on experiential learning partnerships with post-secondary institutions [Order No. 28769949]*. University of Toronto.

Sit, T. (2020). Centering marginalized voices. *Relig. Educ.* 115, 100–115. doi: 10.1080/00344087.2020.1708169

Snow, J. (2020). *University under fire for treatment of sacred Indigenous garden, caretaker*. Minnesota Daily. Available online at: https://mndaily.com/191865/news/ctmedicinegarden/ (accessed January 20, 2023).

Stein, S., Andreotti, V., Suša, R., Amsler, S., Hunt, D., Ahenakew, C., et al. (2020). Gesturing towards decolonial futures: reflections on our learnings thus far. *Nordic J. Compar. Int. Educ.* 4, 43–65. doi: 10.7577/njcie.3518

Sustainable Agriculture Education Association (2018). *Equity Statement*. Available online at: https://sustainableaged.org/equity-statement/ (accessed January 20, 2023).

Tarlau, R. (2014). From a language to a theory of resistance: critical pedagogy, the limits of "framing," and social change: from a language to a theory of resistance. *Educ. Theory* 64, 369–392. doi: 10.1111/edth.12067

Tarlau, R. (2015). How do new critical pedagogies develop? Educational innovation, social change, and landless workers in Brazil. *Teach. Coll. Rec.* 117, 1–36. doi: 10.1177/016146811511701103

Utter, A., White, A., Méndez, V. E., and Morris, K. (2021). Co-creation of knowledge in agroecology. *Elementa Sci. Anthrop.* 9, 00026. doi: 10.1525/elementa.2021.00026

Valley, W., Anderson, M., Blackstone, N. T., Sterling, E., Betley, E., Akabas, S., et al. (2020). Towards an equity competency model for sustainable food systems education programs. *Elementa Sci. Anthrop.* 8, 33. doi: 10.1525/elementa.428

Valley, W., Wittman, H., Jordan, N. R., Ahmed, S., and Galt, R. E. (2018). An emerging signature pedagogy for sustainable food systems education. *Renew. Agric. Food Syst.* 33, 467–480. doi: 10.1017/S1742170517000199

Walter, M., and Andersen, C. (2013). *Indigenous Statistics: A Quantitative Research Methodology*. Oakland, CA: Left Coast Press.

Wauters, V., Badger, S., Grossman, J., Hecht, N. D., Jordan, N. R., Liebman, A., et al. (2018*). Moving agronomic pedagogy beyond disciplinary and institutional borders [Oral Presentation]*.

Wauters, V., Liebman, A., Badger, S., Grossman, J., Hecht, N. D., Jordan, N. R., et al. (2017). *Moving agronomic pedagogy beyond disciplinary and institutional borders [Oral Presentation]*.

Wezel, A., Bellon, S., Doré, T., Francis, C. A., Vallod, D., and David, C. (2009). Agroecology as a science, a movement and a practice. A review. *Agron. Sust. Dev.* 29, 503–515. doi: 10.1051/agro/2009004

Wezel, A., Goette, J., Lagneaux, E., Passuello, G., Reisman, E., Rodier, C., et al. (2018). Agroecology in Europe: research, education, collective action networks, and alternative food systems. *Sustainability* 10, 1214. doi: 10.3390/su10041214

Wezel, A., Herren, B. G., Kerr, R. B., Barrios, E., Gonçalves, A. L. R., and Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agron. Sust. Dev.* 40, 40. doi: 10.1007/s13593-020-00646-z

Wiedenhoeft, M., Simmons, S., Salvador, R., McAndrews, G., Francis, C. A., King, J., et al. (2003). Agroecosystems analysis from the grass roots: a multidimensional experiential learning course. *J. Nat. Resour. Life Sci. Educ.* 32, 73–79. doi: 10.2134/jnrlse.2003.0073

Wilson, S. (2009). *Research is Ceremony: Indigenous Research Methods*. Black Point, NS; Winnipeg, MB: Fernwood Publishing Company.

Yazzie, M. K., and Baldy, C. R. (2018). Introduction: indigenous peoples and the politics of water. *Decoloniz. Indig. Educ. Soc.* 7, 1–18. doi: 10.7591/9781501714290-004