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Experiential, Social, Connectivist, or Transformative Learning? Farm Advisors and the Construction of Agroecological Knowledge

Chrysanthi Charatsari [1,2,*], Evagelos D. Lioutas [3,4], Afroditi Papadaki-Klavdianou [1], Alex Koutsouris [5] and Anastasios Michailidis [1,*]

[1] Department of Agricultural Economics, School of Agriculture, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece; papklavd@agro.auth.gr
[2] School of Humanities, Hellenic Open University, 26335 Patras, Greece
[3] Department of Supply Chain Management, International Hellenic University, 60100 Katerini, Greece; evagelos@agro.auth.gr
[4] School of Social Sciences, Hellenic Open University, 26335 Patras, Greece
[5] Department of Agricultural Economics and Rural Development, Agricultural University of Athens, 11855 Athens, Greece; koutsouris@aua.gr
* Correspondence: chcharat@agro.auth.gr (C.C.); tassosm@auth.gr (A.M.)

Abstract: How do agronomists offering advisory support to farmers who practice agroecology construct agroecology-related knowledge, and how does experiential, social, and connectivist learning lead to knowledge creation and facilitate their personal and professional transformation? In this study, following a mixed research design, which combined thematic analysis and simultaneous regressions, and drawing on data from a sample of Greek farm advisors, we sought to answer these questions. Our analysis revealed that the engagement with the praxis of agroecology lays the basis for the development of advisors' agroecological knowledge. This knowledge is then negotiated and socially reconstructed within the social fabric of agroecological communities. Connectivist knowledge, derived from multiple sources, is also validated within these communities. In its turn, agroecology-related knowledge leads advisors to alter their worldviews, thus transforming their professional and personal selves. These findings confirm that agroecological knowledge has both an experiential and a social dimension. Our results also disclose that advisors facilitate the osmosis of knowledge toward agroecological communities. From a theoretical point of view, our study highlights that by merging different learning theories, we can better depict how agroecological knowledge emerges and evolves.

Keywords: experiential learning; social learning; connectivism; transformative learning; advisors; agroecology; agroecological communities; agricultural extension

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1. Introduction

Agroecology is based on a holistic view of the agroecosystem which emphasizes the various and often unpredictable interrelations between biotic and abiotic factors [1]. Today, there is consensus among scholars that agroecology is associated with positive environmental [2,3], economic [4,5], and social impacts [6]. However, the complexity, uniqueness, and continuous evolution of agroecosystems [7,8], along with the need to understand the interplay between the social and the environmental dimensions of agroecological systems [9], make agroecology one of the most knowledge-intensive forms of practicing agriculture [10,11].

Knowledge is a complex and ill-defined concept. Framed experiences, values, contextual information, and expert insights represent different aspects of knowledge [12] which allow individuals and social groups to effectively respond to different situations [13]. Although a few decades ago a common perception was that farmers are empty vessels

expecting to be filled with knowledge by "experts" such as advisors or agronomists [14], today there is a general agreement that advisors play many roles [15–17], facilitating not the delivery of knowledge but the pursuit, generation, refinement, and exploitation of knowledge by farmers. Thus, the role of farm advisors is much broader and more demanding than that of the "knowledge deliverer" in the linear knowledge transfer models, encompassing different functions.

Especially in the case of agroecology, linear, top-down models of knowledge diffusion, whose limited success even for conventional farming is hardly a secret [18,19], cannot capture the complexity of systems and processes [20]. To be useful, new agroecological knowledge should be place- [21], context- [22], and culture-specific [23]. It should be consistent with local conditions, specificities, and problems; particular social contexts; and the local culture. In agroecology, the emphasis turns from "knowledge transmission" to "knowledge co-production". In the most successful examples, the actors involved in agroecological production combine their knowledge to develop a mutual understanding of the agroecosystem [24]. Individuals' experiential knowledge lays the foundation for the collective knowledge construction process [8], which is situated within the social nexus of agroecological communities [25]. Thus, agroecological knowledge has both an experiential and a social dimension.

Notably, that social dimension does not refer exclusively to the knowledge co-produced within the borders of communities of practice. Several indications confirm that agroecological farmers develop knowledge through interacting with external sources, even though this knowledge needs to be validated through experience [26,27]. Externally facilitated knowledge co-production can take place in both physical and digital environments. Some recently introduced web applications and Wiki-based tools serve as spaces for collaboratively constructing and sharing agroecological knowledge. These platforms offer farmers the opportunity to easily access agroecology-related knowledge, either by reading Wiki-type articles or by communicating through chat rooms [28]. Other information and communication technology developments serve as spaces for connecting different actors, from farmers to citizens, thus facilitating the development and diffusion of new knowledge [29].

Through a learning theories lens, it can be argued that the construction of agroecological knowledge involves three types of learning: experiential learning, which emerges from the grasping and transformation of experience [30]; social learning, i.e., the learning that occurs within social groups through observing and reflecting upon other people's actions and consequences [31]; and connectivist learning, which is produced by connecting the knowledge offered through different (often unrelated) sources, including technological appliances [32]. Through the amalgamation of these three types of learning, members of agroecological communities can arrive at new knowledge, transforming in this way some of their perspectives. As Mezirow [33] explains, perspective transformation is the process of critically reconsidering habits of perception and thoughts that affect the ways individuals view, understand, and approach different problems. This process finally leads to both personal and professional transformation.

In this work, drawing upon different learning theories (experiential learning theory, social learning theory, connectivism, transformative learning theory), we examine how agronomists who serve as advisors to agroecological farmers build agroecological knowledge, and we assess the degree to which different types of knowledge facilitate their personal and professional transformation. Although a large edifice of research deals with the issue of agroecological knowledge, the emphasis of the relevant work is upon farmers' local [34], traditional [35], or indigenous knowledge [36]. Thus, scientists who serve as advisors remain an underrepresented group in this research area.

The limited number of relevant studies indicates that scientists can contribute their knowledge to agroecological systems by designing experiments, evaluating the state of agroecological systems against scientific standards, offering explanations to observed phenomena, and so on [37–39]. However, contrary to their roles in conventional agriculture, scientists working in agroecology have to put their knowledge into action, to combine it with the knowledge that resides in farmers' minds as well as in the culture of communities of practice [40], and to

reject the label of "expert" that they sometimes attribute to themselves [41]. Thus, for scientists, the engagement with agroecology is a process of continuous knowledge (re)construction and transformation. In this study, by focusing on agronomists who offer advisory support to farmers practicing agroecology, we attempt to shed some light on this process.

2. Learning and the Agroecological Praxis

Learning is a concept marked by many definitions and vague interpretations. Knowles [42], in his famous "Andragogy", describes adult learning as an internal, volitional, and self-directed process in which individuals mobilize intellectual, emotional, and psychological resources in an attempt to fill learning gaps. In this view, learning is the outcome of a person's interaction with her/his environment. Kolb [43], drawing on earlier theories of human learning, was one of the first authors who explicitly described the mechanism of knowledge creation through experience. In the Experiential Learning Theory, learning is conceived as the procedure through which different experiences are translated into meaningful sets of sense-making knowledge. This process of knowledge construction is continuous, in the sense that knowledge is created and re-created through varying learning experiences [44].

Several studies point out the pivotal role of practical experience in constructing new agroecological knowledge. For instance, Francis et al. [45] discovered that students' engagement with experience-based learning situations leads them to reflect on a plethora of issues associated with agroecology, while Laforge and Levkoe's [46] work indicated that practice-oriented training of farmers facilitates the development of context-specific agroecological knowledge. In other words, knowledge is approached through a systems lens, shifting emphasis from the specific environmental, biological, or social components of agriculture to the broader context within which the practice of agroecology takes place [47]. Nevertheless, in agroecology, the term "practice" has a wider meaning, denoting learners' engagement not only with the agroecosystem but also with their peer social environment.

The observation that social surroundings catalyze the ways knowledge is co-created is not new, dating back to earlier writings on social imitation [48] and social learning systems [49]. According to Social Learning Theory [31], both direct experience and observation of others' behavior can activate learning processes. In other words, not only personal experience but also the reflection upon the consequences of other people's actions leads to the construction of new knowledge. Individuals observe their social surroundings and code information, which is used on later occasions as a compass, guiding their behavior. This view acknowledges the networked nature of knowledge, emphasizing that the interactions within a social system open up spaces for knowledge acquisition.

In agroecology, networks of social learning [50] or communities of practice [51] bring together actors with heterogeneous backgrounds and foci [52], thus accommodating knowledge from different sources and enhancing the exchange of practices, ideas, and assets (both material and intangible). This way, networks or communities serve as knowledge co-creation terrains, helping actors understand the principles of agroecology and translate them into meaningful practices [53].

However, a network or community is not an island that operates in isolation from its social, technological, and economic environment. As a social system, it consists of interconnected actors who exchange knowledge and other social resources, but, as systems theories suggest [54], it also interacts with higher-order systems, thus receiving external resources. To deal with the complexity that emerges from this "openness" of agroecological communities, we need to integrate current learning theories that pay attention not only to the interactions among individuals (farmers, advisors, farm workers, etc.) or between individuals and the learning object (the agroecosystem) but also emphasize the changing nature of knowledge and the importance of technology for knowledge construction. In this vein, connectivism [55] might offer fertile ground for understanding how knowledge evolves within agroecological communities.

The connectivistic view conceives of knowledge as a resource resting in the diversity of opinions and learning as the capacity to puzzle out different pieces of information

derived from both human and technological entities. Indeed, technology and media can considerably boost the mechanisms of agroecological knowledge production [56] and exchange [57]. On the other hand, as Lampkin et al. [58] (p. 47) argue, agroecological communities or networks are connected through two types of knowledge: "science-based and technological knowledge" and "farmers' tacit knowledge". Although the latter is located within the community, the former is usually externally mediated. Nevertheless, this external knowledge can take diverse forms when introduced within agroecological communities, depending on their members' perspectives, principles, and values [59]. So, it is the hybridization of external and internal knowledge which eventually catalyzes the ways agroecological knowledge is produced and evolves.

This evolution of knowledge leads individuals to redefine expectations, perceptions, patterns of cognition, and feelings, finally transforming their "habits of mind" and "points of view", as Mezirow [60] (p. 5) stated in his Transformative Learning Theory. Through transformative learning, problematic frames of reference, which operate within or outside the level of awareness, became more open and reflective [61]. Notably, transformative learning has both an experiential and a relational nature: it is fostered by active, direct, and reflection-stimulating experiences, and it takes place within social contexts, catalyzed by trustful relationships among individuals [62].

The transformative power of agroecology for social groups and food systems is well documented in the literature. A growing body of high-quality research focuses on the transformative nature of agroecology, affording insights into different systemic levels. For instance, recent work indicates that agroecology paves the way for the transformation of rural communities [63], urban farming systems [64], and national agri-food systems [65]. However, such a systemic transformation requires the transformation of the different units that form the system. Gliessman [66] terms that metamorphosis "the fifth level of food system change", i.e., a paradigm shift that acknowledges the interdependence between humans and the environment and challenges belief models, (re)sets ethical priorities, and reorganizes value systems. Farmers and scientists practicing agroecology transform their identities by engaging with the praxis of agroecology [5] and by developing knowledge through that praxis [67]. Nevertheless, research has not yet addressed how these actors construct agroecological knowledge and whether this knowledge has a transformative character.

In this study, shifting our attention to farm advisors who work in the field of agroecology, we sought to answer three questions. First, to what extent do they rely on experiential, social, and connectivist learning as well as on scientific sources to build agroecological knowledge? Second, which of these four different learning sources create the conditions for advisors' transformation? Third, how does advisors' personal and professional transformation evolve as the outcome of the construction of agroecological knowledge? Figure 1 summarizes our research questions, showing the research approaches used to address them.

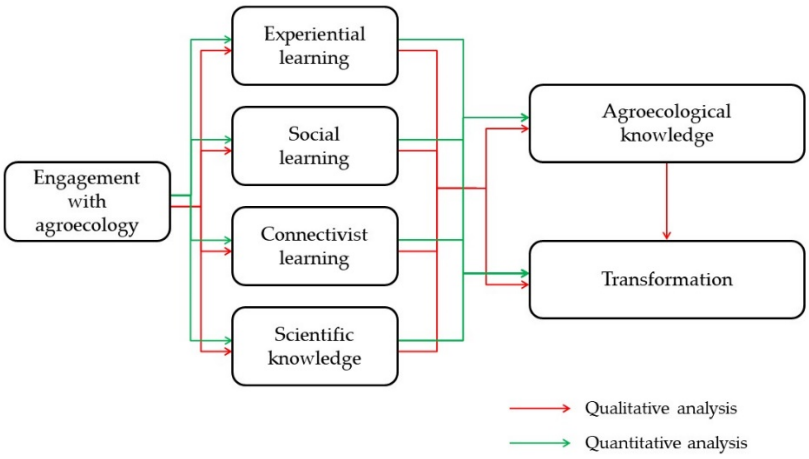

Figure 1. Conceptual framework.

3. Methods

3.1. Participants and Procedure

To answer our research questions, we employed a mixed research design. Qualitative data were used to investigate the potential connection between agroecological knowledge and transformation and to support and explain quantitative findings. Data for this study were drawn from a sample of 59 agronomists offering advisory support to farmers practicing agroecology in Greece. A snowball sampling technique was adopted to recruit participants from across the country. Two agronomists working in the field of agroecology were used as seeds, suggesting other potential participants. The proposed persons were contacted and informed about the purpose of the study. They were also requested to recommend other potential participants. The inclusion criterion was at least one year of experience as advisors of agroecological farmers.

This way, we identified 70 agronomists working with farmers who practice agroecology. Then, we sent them a quantitative questionnaire. The response rate was quite high (84.28%). All of the 59 advisors (72.9% men; mean age = 43.5 years, S.D. = 7.45; average work experience = 15.7 years, S.D. = 7.51; average experience in agroecology = 7.12 years, S.D. = 3.93) who returned the completed instrument were asked to participate in electronic focus groups conducted by the first two authors. In sum, 44 respondents (77.8% men; mean age = 43.4 years, S.D. = 7.98; average work experience = 15.5 years, S.D. = 7.96; average experience in agroecology = 6.7 years, S.D. = 3.51) participated in eight focus groups.

3.2. Quantitative Strand

3.2.1. Measures

To assess the degree to which participants engage in experiential, social, and connectivist learning, we developed three scales. In all cases, response options ranged from 1 (not at all true for me) to 5 (very true for me).

For experiential learning, we used three items referring to the interaction between advisors and the natural environment ("for me, interacting with the agroecosystem is an important way to learn"), the process of active experimentation ("setting up my own experiments in the field helps me acquire new knowledge"), and the reflection upon experience ("I reflect upon my agronomic decisions to understand why things went wrong or why things went well"). A principal axis factor analysis revealed that the three items form a single factor accounting for 76.4% of the explained variance (eigenvalue = 2.29). Cronbach's alpha was satisfactory ($\alpha = 0.84$). A new variable (labeled "experiential learning") was calculated by averaging the items.

For social learning, we used items reflecting the process of peer-learning ("interaction with other agronomists working in agroecology helps me learn new things"), the behavior of copying successful practices used by colleagues ("I'm trying to build knowledge by observing and applying practices successfully used by other agronomists"), the learning occurred within the agroecological communities ("participating in communities of practice, I have learned many lessons about agroecology" and "I'm always trying to find and exploit learning opportunities when discussing with other members of the agroecological community"). Items were found to load on a single factor (eigenvalue = 2.95) which explains 73.7% of the total variance. Cronbach's alpha had a value of 0.88. A composite score for the variable "social learning" was computed as the average of the four items.

Finally, for connectivist learning, we developed four items that reflect the basic principles of connectivism [55,68]. First, that learning emerges through the connection of different networked nodes ("I learn through my interactions with different networks, including but not limited to the agroecological community"); second, that learning emerges through discovering connections among fields, ideas, and concepts ("to develop new knowledge, I combine what I learn from my own experience with the knowledge of other people—from or outside the agroecological community"); third, that individuals' learning activities aim at the acquisition of current, up-to-date knowledge ("I'm always trying to update my agroecological knowledge by getting involved in different activities"); fourth, that today,

technology is a factor that enables and facilitates learning ("to learn new things about agroecology, I use the technological advances that are available today"). As in the previous scales, items were subjected to principal factor analysis. The process yielded a single-factor solution (eigenvalue = 2.85, explained variance = 71.1%). The scale was found to have a high internal reliability coefficient (α = 0.86). A new variable (labeled "connectivist learning") was computed as the mean of the four items.

Three items measured on a five-point scale were used to assess the degree to which farm advisors rely on scientific sources (scientific textbooks, seminars organized by scientific communities/associations, higher education institutes) to enhance their agroecological knowledge. The principal factor analysis revealed a one-factor solution (eigenvalue = 2.48) accounting for 82.7% of the total variance. Cronbach's alpha value (α = 0.89) confirmed high internal reliability. After averaging the three items, we created a variable labeled "scientific knowledge".

Agroecological knowledge was measured by a single item. Five possible responses were offered to participants (low, rather low, medium, rather high, high) to rate their levels of agroecology-related knowledge.

Finally, to evaluate the levels of advisors' personal and professional transformation, we developed four items referring to the altering of their mindsets ("I gave up some old habits of mind"), meaning perspectives ("I have changed the way I make sense of agriculture"), professional viewpoints ("I have developed a more holistic view of agronomy"), and the process of reconsidering assumptions about farming ("I learned to critically reflect on my assumptions about farming"), after engaging with agroecology. All items endorsed the statement "through my engagement with agroecology . . . ", whereas a five-point scale from "not at all true for me" to "very true for me" was employed. The four items were found to load on a factor explaining 74.5% of the total variance (eigenvalue = 2.98). Cronbach's alpha was 0.88. To arrive at a score for the variable "transformation", we averaged items.

3.2.2. Data Analysis Procedures

To provide a first overview of the quantitative data, we used descriptive statistics (mean scores and standard deviations). Independent samples *t*-tests were used to examine differences between women and men participants in the scores of the measures presented in the previous section. Pearson's r was computed to assess the correlation between age and the same variables. Two simultaneous regression models were built to test the hypothesis that experiential learning, social learning, connectivist learning, and knowledge derived from scientific sources affect advisors' agroecological knowledge and influence their transformation. In all cases, *p*-values less than 0.05 were considered statistically significant.

3.3. Qualitative Strand

A focus group guide was designed to offer answers to our research questions and to explain the findings of the quantitative research strand. The guide included a series of probing questions to encourage participants' involvement in group discussions on the ways different types of learning facilitate the construction of agroecological knowledge and the transformative character of that knowledge. After collecting data, we generated codes based on their manifest or latent content. Then, following the principles of thematic analysis [69], we sorted these codes into sub-themes, which were finally merged to create two overarching themes.

4. Results

4.1. Quantitative Analysis

The descriptive statistics for the variables used in the quantitative part of the analysis are presented in Table 1. To examine the potential effects of gender, age, and years of experience in the field of agroecology on these variables, we conducted bivariate analyses. Independent samples *t*-tests revealed that gender did not affect advisors' engagement with experiential, social, and connectivist learning, their reliance on scientific sources, their levels

of agroecological knowledge, and the levels of the transformation they experience through practicing agroecology. In all cases, *p*-values were not significant, with *t*-values ranging from 0.02 to 1.36. Age was also found to not correlate with the above-mentioned variables ($0.05 < r < 0.16$, $p > 0.05$, in all cases). The only significant correlation was between years of experience in agroecology and levels of advisors' personal/professional transformation ($r = 0.31$, $p = 0.016$).

Table 1. Summary statistics of the study variables.

Scale	Mean Score	Standard Deviation
Experiential learning	2.16	0.66
Social learning	3.53	1.17
Connectivist learning	3.24	0.99
Scientific knowledge	3.68	0.68
Agroecological knowledge	2.46	0.99
Transformation	2.14	0.76

To assess the contribution of experiential, social, connectivist learning and scientific knowledge to the levels of participants' agroecological knowledge, we used a simultaneous regression. The beta coefficients indicated that connectivist, social, and experiential learning were positively associated with agroecological knowledge (Table 2), with the two first constructs to receive the highest beta values ($\beta = 0.35$ in both cases). On the contrary, the knowledge derived from scientific sources made no significant contribution to the model.

Then, we developed a second regression model to examine the contribution of the same independent variables to the levels of advisors' personal/professional transformation. Following the same procedure, the four scales were entered simultaneously in the model. As Table 2 illustrates, the variables referring to experiential, social, and connectivist learning obtained, again, positive and significant beta values (ranging from 0.23 to 0.42).

Table 2. Standardized coefficients of the regression analyses.

Independent Variable	Agroecological Knowledge			Transformation		
	R^2	β	*p*	R^2	β	*p*
	0.29		0.002	**0.32**		0.001
Experiential learning		**0.25**	0.035		**0.42**	0.001
Social learning		**0.35**	0.004		**0.35**	0.003
Connectivist learning		**0.35**	0.004		**0.23**	0.046
Scientific knowledge		−0.01	0.932		−0.01	0.965

Note: Significant coefficients are in boldface; positive/negative beta values indicate positive/negative associations with the dependent variable.

These findings show that all these three types of learning facilitate participants' personal and professional transformation. Experiential learning was found to have the most important contribution in predicting advisors' transformation in the second model, followed by social learning. As in the previous regression, the levels of knowledge emanating from scientific sources did not contribute to the model.

4.2. Qualitative Analysis

4.2.1. The Agroecosystem as a Field for Learning and Transformation

Our analysis revealed that advisors, especially in their early career stages, face considerable difficulties in dealing with agroecology. The complexity of the interactions between agroecological subsystems, along with the need to envisage the consequences of human decisions in the agroecosystem, make agroecology a terrain less standardized than that of conventional agriculture. In this vein, advisors are often challenged to reconsider some of their beliefs about farming. Although in conventional agriculture they often rely on standard recipes or how-to guides, in agroecology the knowledge emerges as the outcome of experimenting and observing the aftermaths of their experimentation. As some participants noted, every human decision leads to a large amount of data. The procedure of

linking these data to a specific ecological context in a way that helps advisors to make sense of it generates new forms of knowledge.

Nevertheless, the shift from the datum to the context is not an easy task. As focus group participants noted, the uniqueness of every farm complicates any attempt to draw a link connecting causes and effects. Furthermore, the unpredictable and often turbulent nature of the physical environment further increases complexity. Differences in the microclimate, local biodiversity, and soil properties generate a rich tapestry of factors affecting the ways agroecology is practiced. Traditional knowledge delivery methods cannot provide solutions to real farm problems, whereas courses offered at universities just lay a theoretical basis for building agroecological knowledge. A farm advisor who, during his studies, had the opportunity to attend agroecology courses commented:

> "Studying agroecology is interesting, but doing agroecology is a quite different story. In real life, one should consolidate all the available data; it's the only way to understand what happens on the farm. Then, you have to go back, reconsider your options, and try figuring out why things went this way. The farm talks; you should be ready to listen to it."

Importantly, what hampers knowledge creation is a conventional way of conceiving agriculture that dominates in the early stages of advisors' engagement with agroecology. Thus, developing an alternative mindset that emphasizes ecological variation instead of uniformity across settings is a lengthy process. Actual involvement with the agroecosystem provides opportunities for firsthand observation, but the quality of the reflection process varies among individuals. As a participant who became involved in agroecology after an eight-year experience in conventional farms noted:

> "When I started working with agroecological farmers, I felt like a blind person. I believed that memorizing solutions was enough to help farmers solve their problems. Well, that never works well. After some eleven years [of experience in agroecology], I can say that agroecology is not about memorizing procedures and outcomes or about choosing among already tested solutions; it's all about learning to understand the environment."

The analysis indicated that agroecology is in itself a transformative process that leads advisors to question some of their earlier understandings of farming and adopt a holistic approach in which the farm is put into specific ecological contexts. In this vein, the farm offers space for instrumental learning, which immerses advisors into a different knowledge construction culture. However, it is the process of critically judging their assumptions, hypotheses, options, and actions which leads them to arrive at new knowledge. Our data revealed that this new knowledge transforms their perception of the agroecosystem, also changing their attitudes towards the environment and the role of humans in it, beliefs about work ethics, patterns of sense-making, and understandings of their roles as scientists. Thus, it can be argued that the engagement with agroecology transforms not only the professional but also the personal self.

4.2.2. The Group Factor and Osmotic Mechanisms of Knowledge Production

Participation in agroecological communities also emerged as a crucial way to build agroecological knowledge. Participants explained that, within these communities, farmers and agronomists/advisors exchange experiences and knowledge, discuss problems and tested practices, and co-extract meaning from the everyday praxis of agroecology. In this vein, agroecological communities offer a place for the negotiation of meaning. Advisors noted during the focus group sessions that these communities host a wide range of experiences, thus providing a fertile space for integrating different opinions and points of view about farming. That is exemplified in the following comment:

> "The community is the best place to learn. It consists of people with different experiences, ideas, and points of view. It houses different knowledges. You

> bring your knowledge to the table, and you are trying to combine it with your teammates' knowledge."

Interestingly, advisors hold a dual role within agroecological communities, given that they are simultaneously scientists and co-learners. Thus, they contribute their scientific expertise while simultaneously synthesize new knowledge through analyzing farmers' experiences. The participants confirmed that, in agroecological communities, the traditional expert–farmer relationship, where agronomists offer advisory support to farmers, is replaced by a cooperative knowledge construction culture, which faces farmers and advisors as peers who collectively "reconstruct the puzzle of knowledge", as one participant put it. Notably, knowledge and social capital are two crucial resources exchanged within agroecological communities. Knowledge is, in itself, social capital-dependent, in the sense that social capital-rich communities offer more opportunities for collaboratively reflecting upon dilemmas, actions, mistakes, and consequences.

Our data revealed that e-communities also connect farmers and agronomists/advisors from different parts of the world. Some participants stated that they are members of virtual international agroecological communities (Facebook and blog communities) within which they exchange experiences, advice on good practices, and information with their counterparts from Europe, the USA, or Australia. Such communities do not offer opportunities for face-to-face discussion and for developing common ventures. Nevertheless, they are characterized by a high level of social capital and by a knowledge-sharing culture. Of course, as some advisors stated, the context-specific nature of the problems faced by farmers reduces the applicability of different solutions proposed by e-community members, whereas the loose intra-community relationships and the different linguistic backgrounds are likely to create communication difficulties. However, members of these communities develop a sense of "working together while living apart" that permits the exchange of agroecological experiences. By analyzing successful and failed approaches, members of e-communities can develop a better understanding of the ecological processes and the causal mechanisms of different problems. As one participant commented:

> "Facebook really works. Not as a solution-generating device but as a forum for exchanging opinions, practices, experiences, and approaches. I participate in several Facebook groups from France, Austria, the USA, Australia. In such fora, you can discuss with people sharing the same problems with your fellow community members. You cannot apply their solutions—most of the time that doesn't work—but they can help you understand the causes of the problems."

Nevertheless, the knowledge built within physical and virtual agroecological communities mainly refers to the practice of agroecological production. While participants emphasize the importance of this type of knowledge, most of them agree that knowledge associated with the use of different distribution channels, the changing market dynamics, or potential future market opportunities is also necessary. Notably, the agroecological communities cannot help advisors construct knowledge on the ways markets operate or the business models that farmers can apply. As some participants noted, this knowledge emerges through osmotic mechanisms: market actors, business consultants, public bodies, specialized publications, and websites are often used by advisors to collect information and develop market-related knowledge, which then can be transmitted to farmers. In this vein, advisors operate as cut-sets, connecting agroecological communities with the markets. A focus group participant outlined the reliance on these "outside" sources in the following quote.

> "Many people mistakenly believe that agroecology is about applying old-fashioned and sometimes eccentric or even paganistic practices to produce food. In fact, agroecology is an alternative way of viewing and practicing farming, but it is still an entrepreneurial activity. The need to reduce costs, find niches, sell at good prices, and correctly administer funds should somehow be addressed. Farmers who practice agroecology usually have a good understanding of the ecosystem,

but they face difficulties in dealing with the market's complexity. So, when it comes to entrepreneurial issues, the only way to learn is from the outside world."

In addition, some advisors stated that their interaction with research institutes helps them enhance their understanding of the crop responses to different practices used or interpret the ways that soil properties affect production. However, the limited number of institutes with expertise in agroecology and the loose connection between them and field advisors reduce the knowledge flow from research to agroecological communities.

5. Discussion and Conclusions

In the present study, we examined how different types of learning help advisors construct agroecological knowledge. We also aimed to identify the contribution of these types of learning to advisors' transformation and depict how agroecological knowledge transforms their professional and personal selves. Our quantitative analysis supports the hypothesis that all the examined types of learning influence agroecological knowledge construction and transformation. The regression models revealed that social, connectivist, and experiential learning lead to the development of agroecological knowledge and enable advisors to transform their perspectives. Interestingly, the knowledge derived through scientific sources was not found to contribute to either knowledge construction or transformation.

The regressions also uncovered that experiential learning was the most important predictor of participants' transformation. That is not surprising, since advisors' experiences facilitate their reflection [70,71], which is pivotal for initiating the process of transformation [61]. The crucial role of experience in constructing an agroecological identity is a consistent finding in the relevant literature. Although most studies focus on the need to offer experiential learning opportunities to agronomists/advisors during their higher education years [72,73], Coquil et al. [74] emphasize the significance of experiential learning for the reconsideration of norms and values on the part of advisors when they start their career paths. Our qualitative analysis lends support to this argument by pointing out that active engagement with the agroecosystem provides the conditions for the interrogation of old beliefs and perceptions and the reorientation of advisors' roles.

Agronomists who advise agroecological farmers build agroecological knowledge by experimenting, linking causes and effects, and reflecting upon their actions. That knowledge is inherently transformative, given that it helps them adopt a different knowledge construction culture, learn how to learn, and acknowledge and appreciate the complexity of the contexts (both physical and social) within which they work. Such a transformation alters both their professional and personal selves. As Illeris [75] posits, beyond frames of reference and habits of mind, the term "transformation" refers to the process of personal identity reformation. The results of the present study indicated that this reformation is lengthy and difficult, presupposing the development of a new mindset through the exposure to the praxis of agroecology. The attachment to a conventional way of thinking is a knowledge-blocking mechanism. However, throughout their engagement in agroecology, advisors embrace the need to change worldviews, redefine their relationship with the agroecosystem, and reconceptualize their roles as scientists.

In this vein, transformative learning enables advisors to overcome the role of experts and become co-learners and co-evolvers of knowledge. In agroecological communities, scientific agronomic expertise meets farmers' experiential knowledge [76], plotting a course for knowledge contextualization. Through that process, codified knowledge is put into action [40] and is tested against authentic knowledge. Such a transition from the role of expert to that of knowledge co-evolver does not mean that advisors' work is less scientific. It is a paradigm shift from what DeLind and Howard [77] term "hegemony of scientism" to a collective knowledge- and sense-making process.

Agroecological communities serve as rooms for these collective processes. In such networks, individual knowledge becomes communal through both participation in social events (discussions, reflections, etc.) and the production of conceptual artifacts (words, methods, and stories) [78]. As the theory of social learning postulates [31], within social

contexts, individuals (advisors) and groups (communities) do not independently produce knowledge but act as an organism, where multidirectional interactions lay the foundation for reciprocal knowledge production.

The thematic analysis also revealed that experiential learning is socially refined and interactionally adjusted within agroecological communities. The meaning of different experiences is negotiated among participants, allowing new understandings to emerge. This finding is in line with current theories that conceptualize knowledge construction as an emergent social process. Simply put, the knowledge constructed within agroecological communities is not the sum of the different "knowledges" carried by their members but a novel product that expands previous knowledge, thus encompassing new forms of value [79]. Farmers and advisors contribute different pieces of knowledge, which are then blended into new forms, whereas advisors also serve as sense-makers, giving meaning to farmers'—and their own—implicit knowledge.

Interestingly, as the results illustrated, not only physical but also virtual communities serve as knowledge construction spaces, creating opportunities for reflection and peer-to-peer learning and connecting geographically remote agroecological communities. The different perspectives and the context-dependent nature of the experiences that virtual community members have are not an obstacle to the development of new knowledge by advisors. Contrariwise, such a pluralism enhances advisors' reflection processes by exposing them to different problem-solving cultures. Thus, although information and communication technologies often detach agroecological knowledge from its contexts [80], e-communities can bring different contexts together, therefore permitting the exchange of knowledge across them.

The vital role of experiential and social (intra-community) learning in the agroecological knowledge construction process is well-supported by the literature [52,81,82]. Nevertheless, our findings showed that advisors also connect their knowledge with that emerging from their interactions with external sources, such as market actors, business consultants, publications, etc. As the connectivism theory points out, different "small worlds" are connected to produce new knowledge [55]. Advisors' experiences are connected with those of their fellow community members, thus socially reconstructing knowledge within the small world of the agroecological community. In parallel, ties with external sources bridge agroecological and market knowledge, thus creating networks of different worlds that interact and shape dynamic learning ecosystems.

Remarkably, scientific bodies are largely absent from these ecosystems. That constitutes a typical problem for alternative production approaches in Greece [83]. Both the quantitative and qualitative analysis affirmed that scientific institutes are unable to supply Greek advisors with agroecological knowledge. University courses offer knowledge mainly focused on the theoretical underpinnings of agroecological systems. This dominance of theory over practice [84] and the limited emphasis on the creation of agroecological experiences [85] restrict advisors' preparedness in dealing with agroecology. On the other hand, agronomic research institutes in Greece are poorly connected with agroecological communities—a common problem in many European countries [86]—thus limiting the flow of knowledge from science to the arena of praxis.

In sum, our study, building upon three different learning theories, confirms that agroecological knowledge is not a set of true beliefs but a non-static and dynamically evolving output of the interaction between advisors and the agroecosystem which deepens over time as it is blended through the involvement of different actors in agroecological communities. In that sense, agroecological communities represent meeting points of varying "knowledges" that are integrated, negotiated, and socially reconstructed. Contrary to the common misconception of agroecological communities as closed systems, our work uncovered that they are permeable to osmotic knowledge flows. Advisors connect different pieces of information derived from multiple sources, building new knowledge which is then filtered and validated within agroecological communities. Individual and peer reflections are processes

that give meaning to experiential, social, and connectivist knowledge, transforming, in parallel, advisors' professional and personal selves.

To conclude, the present work suggests that agroecology-related knowledge, emerging through experience, social validation, and interaction with multiple sources outside the agroecological communities, enables advisors to alter their belief systems, value frames, and ways of working and being. Since knowledge is a necessary precondition for pursuing the agroecological transition, researchers have the challenging task of uncovering what enables or impedes its construction. We hope that the insights gained from our study will spur additional research in this area.

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