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Leaving the classroom: a didactic framework for education in environmental sciences

Eduardo Dopico · Eva Garcia-Vazquez

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Abstract In Continuous Education curricula in Spain, the programs on sciences of the environment are aimed toward understandings of sustainability. Teaching practice rarely leaves the classroom for outdoor field studies. At the same time, teaching practice is generally focused on examples of how human activities are harmful for ecosystems. From a pedagogic point of view, it is less effective to teach environmental science with negative examples such as catastrophe, tragedy, and crisis. Rather, teaching environmental sciences and sustainable development might be focused on positive human-environment relationships, which is both important for the further development of students and educators. Within rural settings, there are many such examples of positive relationships that can be emphasized and integrated into the curriculum. In this article, we propose teaching environmental sciences through immersion in rural cultural life. We discuss how fieldwork serves as a learning methodology. When students are engaged through research with traditional cultural practices of environmental management, which is a part of the real and traditional culture of a region, they better understand how positive pedagogy instead of pedagogy structured around how not-to-do examples, can be used to stimulate the interactions between humans and the environment with their students. In this way, cultural goods serve as teaching resources in science and environmental education. What we present is authentic cases where adults involved in a course of Continuous Education explore 'environmentally-friendly' practices of traditional agriculture in Asturias (north of Spain), employing methodologies of cultural studies.

Keywords Science literacy · Environmental education · Teaching–learning process · Traditional knowledge · Rural culture

E. Dopico (✉)
Department of Education Sciences, University of Oviedo, C/Aniceto Sela s/n, 33005 Oviedo, Spain
e-mail: dopicoeduardo@uniovi.es

E. Garcia-Vazquez
Department of Functional Biology, University of Oviedo, C/Julian Claveria s/n, 33006 Oviedo, Spain

As in other European countries (Giolitto 1997), the Spanish education system envisions that environmental education should play a large role in how students learn to become more sustainable. In schools, science and environmental education aims to develop environmental awareness and promote good relations between students and nature (Mueller and Bentley 2009). Correspondingly, science contents are structured around the basic components of scientific knowledge: conceptual ideologies, methodological principles, and cultural aspects (Koliopoulos and Constantinou 2005).

The ethical issues in teaching environmental education are generally presented in a Manicheanistic form. Didactic tools for learning at all educational levels usually emphasize cognitive aspects (Maarschalk 2006) and focus students' attention on examples of human activities that are aggressive or harmful for the environment, for example anthropogenic factors involved in loss of biodiversity, and linkages between population, land use and land cover (Ghimire and Hoelter 2007). Outdoor activities are generally integrated with visits to protected natural areas, or spaces near the classroom, for identifying autochthonous species. Humans need natural resources extracted from the wild, but the cost is high, and human activities are not always sustainable. Social studies of science are deemphasized or ignored, and students get the final impression is that humans are not able to maintain a friendly relationship with the ecosystems of the earth, which is certainly true in many cases, but not a positive message for encouraging students to interact with Nature, balancing conservation, and human development. As students begin reaching adulthood, they may be introduced to science and environmental education in a positive way that becomes more difficult because of their life-long exposure to many negative messages about how harmful humans are for the ecological environment. Cultural assumptions and the language used, from an ecojustice perspective, may influence attitudes toward nature (Mueller 2009a). A prime example of this idea in the popular media is the ways in which environmentalism is connected with corporate deception, or *greenwashing*, when companies manipulate environmental messages to gain greater marketing shares.

Negative messages and culpability behind, theoretical, methodological, conceptual and practical changes in science education can be made through perspectives within cultural studies (Treagust and Duit 2008). A collaboration between teachers and students is necessary. While discursive teaching methods communicate theoretical aspects of science, which are necessary, we can go further by considering science education as a cultural good for developing teaching methodologies based on the scientific activity of students.

Learning is to learn with others (Vygotsky 1989) and also to learn from others. To teach environmental sciences, we include local and traditional knowledge within instructional materials to explore the ways in which traditional societies establish relationships with natural resources (Riggs 2005). Active learning while developing these relationships places students in outdoors learning environments (Dierking et al. 2003), leaving the confined space of the classroom where the students are taught to manage scientific vocabulary and memorize (Sanmartí 2001). We all know that science education is much more than memorizations (Bybee 1997). Including field research as part of classroom practice is a way of also advancing the concept of *science for all* (Fensham 1985), linking science and everyday practice, which also involves connecting educational contents with sustainable ecology and culture (Glasson et al. 2006). This pedagogical approach can be applied in processes of science and environmental education (Simmons 1998), integrating environmental problems in the places where they are crucial for life (Darnés 2002).

Rural areas have a variety of contexts that offer great opportunities for learning about the environmental sciences. One of these contexts is the sector devoted to the production of traditional crops and livestock breeding, which are life spaces where rural traditions are still very much preserved and employed in quotidian life (Dopico et al. 2008). This science education context is composed of peasants, smallholder and farmers, who obtain resources for subsistence from their natural environments. Science knowledge comes from intergenerationally learned and endorsed experiences gained and transmitted to practice agriculture. Investigating environmental sciences outdoors in direct contact with environment and peasants, educators can appreciate and interpret their possible contributions to preserving agroecosystem health (Alkorta et al. 2004). Such practical ecological knowledge may change students' conceptions (Bogner 1998) and help them to develop greater awareness of local environmental issues (Kadis and Avraamidou 2008), while learning expected competencies in environmental education, such as healthy values and habits.

To address these challenges in the framework of science and environmental education, we propose exploring the possibilities of meaningful scientific research within a socio-educative environmental context also called, ecosociocultural environments, aimed at developing ecological understandings in addition to engaging students in stimulating learning experiences (Kyburz-Graber et al. 2006) such as interviewing Asturian peasant farmers. Here, science and environmental education is considered a form of culture, and around the development of a larger educational environment, we schedule interesting and attractive tasks whose applicability can be seen by students. Now, we discuss our work within the context of an educational program aimed at adults, transforming scientific knowledge as it is generally conceived and derived from empirical research, into learning contents tailored with and by students' academic reach (Hofstein and Lunetta 2004).

Methodology

The students-researchers in the case study

The students involved in the course of Continuous Education were 13 women aged 29–47, who inhabit in the River Trubia valley (Asturias, north of Spain, between 42°52′–43°43′N and 0°50′–3°28′W). Their formal education reached the standard level of Secondary. The objective of our course is to develop an employment workshop (Suárez Ortega 2004) for increasing students' academic and professional skills and improve their employability options. Their professional profiles include agriculture and agricultural services. Environmental services, rural tourism and community development were assumed to be future employment routes. Student-researchers participated in a cultural study with the aim of learning by observing and analyzing science within the community, the environmental context that belongs to cultural heritages (Leslie 2005) where human activity can be (or has been) compatible with environment conservation. The learning experience was developed in daily 4-h morning sessions from January to April 2009.

The sample investigated

The rural population considered as a case for researching ecosustainability followed an ethnographic approach (Dopico et al. 2008). A total number of 43 household interviews to the same number of families were carried out in eleven different rural settlements in Asturias. These families were native to the region and had been living there for many generations. One person was designed by each family as representative, family head, for the purposes of interview, and additional information was provided by other family members under request of the representative and/or the interviewers. The age range of the interviewees was 67–86. Most of them had not followed what might be considered a "formal education track" and/or training in professional agriculture. Interviewees were informed in advance about the objective of the interviews and the aim of the study and agreed to participate in the research. The interviews were recorded and then transcribed in writing. The interviewees agreed to the publication of their statements. The interviewers respected a confidentiality agreement, and permitted the interviewees to review the written papers. Student-researchers were invited to share within most quotidian activities with peasants, so some practices described by them were confirmed in situ during the visits. Thus, students participated in the tasks of tilling soil and compost before planting crops, collaborated in fields delimited by stonewalls shrub, and white ash, to protect the area from predators and pests. Finally, students participated in the work of transporting cattle to pastures and feeding them in their pens.

The research tool: questionnaire

Science and environmental education encourages science literacy of students. When individuals do not possess the scientific knowledge that is part of cultural literacy, mastering scientific concepts is best achieved through invested participation (Wells 2008). A field study involving peoples' relationships with surrounding environments is one method of teaching and learning with an extra incentive. The explicit motivation to learn has the potential to foster science literacy and a comprehensive vision of social and cultural perspectives in the study of culture. To obtain meaningful information, a questionnaire was prepared by the student-researchers for compiling data of ecological significance (Cohen et al. 2003). The questionnaire was designed to guide the interviews with farmers. The method of collecting information through personal and group interviews was adopted with a transparent format: getting open answers to short and concise questions.

The interview was organized into three blocks (Table 1). In the first block, farmers were asked to describe the main aspects of their agriculture practices. In the second block the husbandry practices were explored. Finally, a third block was dedicated to social and cultural aspects of their activity. These elements together may provide valuable information about their way of interacting with the environment which is their source of resources in the current critical situation for socioecological sustainability (Källström and Ljung 2005).

Table 1 Questionnaire provided to the informers

Key concepts	Questions
Agriculture	Species cultivated and origin of seeds Techniques of cultivation Pest control
Husbandry	Species raised Livestock feeding (pasturages, complementary food) Livestock management
Social aspects	Awareness of environmental problems Communal works Formation in agriculture (formal, familiar) Perception of agriculture activities Perception about the future of agriculture in the region

The interpretation of results: a priori analysis

As mentioned earlier, the situation was opportune for posing a method of teaching focused on student learning based on a research project. Through a context of research embedded within science education learning, students not only experienced authentic examples of how to improve their relationship with the environment, they also analyzed these experiences and information gathered for intuitive approaches that the peasants used to interact within environmental resources. The interpretation of the information compiled (real natural resources used and managed by peasants) from a perspective of scientific knowledge was very important to evaluating the learning process. The dynamics of team work (Scott 1994) was agreed by the class group as the best procedure to follow. Together with the course instructor, they developed the field study, learning experiences, and discussed their results for reaching conclusions on the three blocks of questions. The student-researchers searched ecologically interpretive elements in the activity of farmers by also employing the Internet as an exploration tool. They searched principally the public database, PubMed (http://www.ncbi.nlm.nih.gov/PubMed/), with the help of the instructor for language details (the native language of the students is Spanish). The students also visited libraries to do their analysis. Elements within the study were identified as "ecologically friendly," that is, when the skillfulness to utilize environmental resources while maintaining environmental sustainability of the health of an ecosystem was noted.

Findings: results of the dialogic experience

By analyzing the results of the interviews, our student-researchers identified some agricultural practices, environmentally friendly and not, those practices where the exploitation of natural resources is compatible with its conservation goals (i.e., sustainable, or longer-term, use of natural resources). Organizing these contents adequately, students were able to explain environmental sciences within all educational levels, from primary school to graduates. By analyzing ethnographic, ecological and educational aspects, student-researchers were able to better integrate various disciplines both within and outside the scholarly context, emphasising what were deemed 'friendly interactions' with the environment and sustainability of natural resources.

Now, we summarize below, by blocks, the information provided by Asturian traditional peasants about their agriculture practices in the XXI Century.

Block 1. Agriculture activities (Fig. 1)

Species cultivated and origin of seeds

Twenty-one plant species were reported to be cultivated in the region by all the families. The species planted provide fresh vegetables all year round, with some variation between seasons. Eating food is a seasonal activity. The farmers obtained the seeds from a previous yield, thereby seed-saving, keeping a portion for planting the next season or year. Most farms (86%) exchange seeds and plants with neighbors. In fewer cases, the additional use of commercial seeds was reported (27.9% farms).

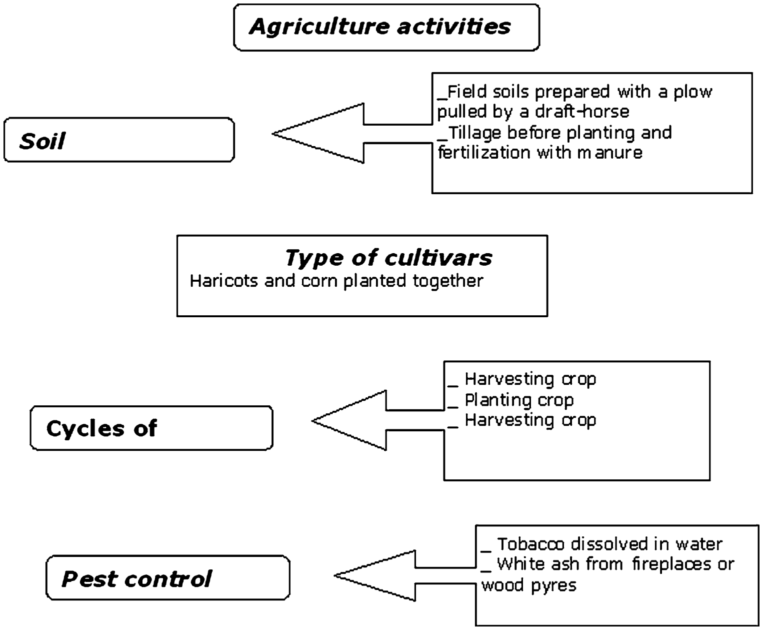

Fig. 1 Cultivation practices

Techniques of cultivation

Soil preparation. Before planting, field soils were prepared manually with the help of a plow pulled by a draft-horse. Shrubbery was cut-off and burned, this technique being the only agricultural use of fire reported in the area.

Tillage is employed before planting in all cases, followed by *traditional fertilization* with manure or *cuchu* (mostly cow, in 100% farms, and occasionally poultry litter in some crops), complemented in some cases with crop residues or natural compost (*traditional*), additional sewage sludge (7%, considered *modern*), or commercial phosphorus-containing fertilizers (34.9%, *modern*, all of them in eastern counties). Nitrogen-derived fertilizers were not reported.

Type of cultivars. At least 50% of cultured land supported mixed-species systems, especially haricots and corn, were always planted together. The reason provided by farmers for this practice is that corn plants serve as support for climber haricots. The *spatial system* consists of more or less linear frameworks, alternating species in contiguous lines. Family orchards are generally small, no larger than 500 m^2 surface in any case. Their borders are natural plant hedges (generally bramble and/or hawthorn), occasionally reinforced with short stonewalls, aimed to protect crops from wild animals like hogs or deer. With respect to the *temporal organization*, in a daily basis many tasks depend on climatology. For example, rainy days are dedicated to clean agriculture tools and other indoor activities. A year-long term crop rotation is the most common agriculture strategy (100% farms). Alternating cereals (ancestral wheat or *escanda*, wheat) and non-cereal crops (rape, potatoes) in the same field is the usual system. The alternating crops and their order were varied among farms. Cycles of planting crop 1-harvesting crop 1- planting crop 2- harvesting crop 2 are consecutive from March to October. Tilling occurs only once a year, around January–February. The fields are fertilized after tilling, just before planting the first crop—the moment depends on the crop species.

Plant watering. was reported as very uncommon, only occasionally employed in family orchards during dry summers. Plant watering practices were usually not necessary in this rainy region of Spain, where periodic floods of rivers and tributaries of pluvial regime also contributed to prevent soil dryness.

Pest control

Besides physical barriers to big mammals (stonewalls for protecting crops from hogs and deer), natural methods of pest control identified as *traditional* by the informers were reported in 100% farms. Occasional use of artificial pesticides (identified by the farmers as *modern* techniques) against slugs (in the orchard and garden) and mice (indoors) has been reported in most households (88.4%). Rat and mice control was generally left to house cats (100% farms). Craft (hand-made) scarecrows (*espantayu* in vernacular Asturian language) for chasing the increasingly abundant magpies (*pegues*) in the region were widely employed in all cultivars in the region.

Insects and other parasites were controlled with tobacco in 27.9% farms. For tomato cultivars, tobacco fermented in water was directly sprayed on plant leaves. Beans, haricots (*fabes asturianes*) and other plants were left in water with tobacco for some days before planting. The homemade recipe for both uses is, tobacco contained in five packs of cigarettes dissolved in ten liters of tap water, which is then directly employed as insecticide. A traditional method of pest control was employed in 81.4% farms against snails and slugs, based on white ash obtained from home fireplaces or wood pyres. White ash was dispersed all around the cultivar perimeter. All informers reported successful prevention of snail and slug pests.

Block 2. Husbandry practices (Fig. 2)

Species bred

Dogs and cats existed in all farms studied, with purposes of property guard and hunting (dogs) and mice control (cats), or simply as pets. Ten animal species were reared by all families studied including avian and mammals generally cultured in European farms.

Livestock management

The systems reported by the interviewees for livestock management were identical in all farms. Cattle, horses, donkeys and ovine herds were protected in stables near houses during the night. Two management systems were alternated during the year for cattle and sheep. One system, employed during the winter, spring and late autumn, was half-indoor because the animals were driven to neighboring pasturages some hours per day (daylight) and back to the stable at dawn. It can be called "short transhumance". The distance walked daily by the herds was no longer than 1 km. The other system, of longer transhumance consisted of walking with the herds to mountain pasturages located generally around 10–20 km from the village. One full journey was employed for the travel up to the mountains and vice versa. The herds were left in the mountains with surveillance by shepherds during the summer. Family members were displaced to the mountain pasturages (grasslands)

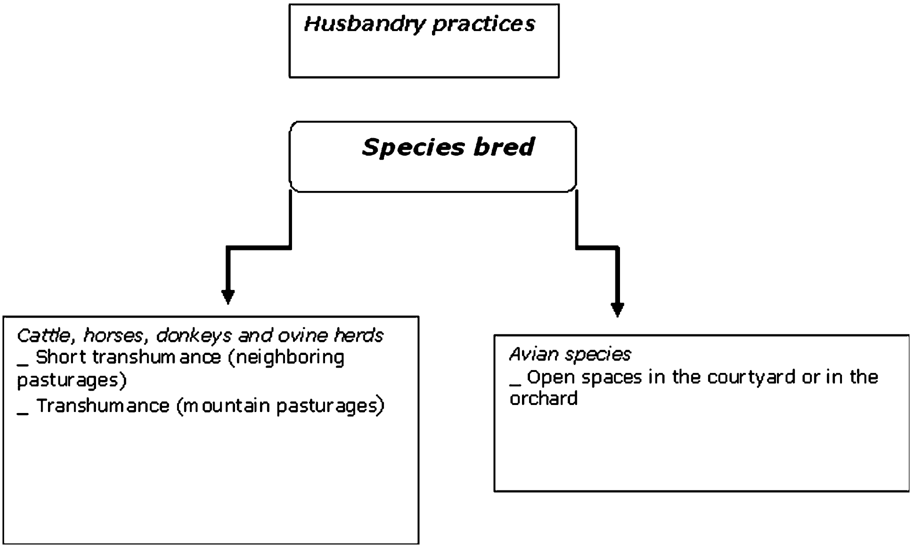

Fig. 2 Husbandry practices

everyday for routine tasks like milking, surveying pregnant females and assisting delivery together with the veterinary if necessary. This is called in Asturias *dir a la braña.*

Avian species (poultry or *pites*, ducks) and pigs were raised in open spaces, created for them by the main house, in the courtyard or in the orchard, with small sheds for free usage by the animals. Intensive indoors rearing of poultry and pig farming were not reported in any of the 43 farms considered in this study.

Vaccination and veterinary care, as well as assisted reproduction and genetic selection, is routinely carried out and controlled by rural agents employed by the regional government employees. These practices were considered *modern* by farmers.

Livestock feeding (pasturages, complementary food)

Poultry and ducks were fed with cereal grains (corn), with additional commercial fodder for chicks. Cattle and sheep grazed directly on grasslands near the farms or in mountain pasturages. During the winter, particularly in the few weeks when fields are covered with snow, they were fed indoors with alfalfa and packed pasture.

Block 3. Social aspects (Fig. 3)

Awareness of environmental problems

Farmers were able to cite a minimum of three different problems affecting the surrounding environment. The most commonly reported were: abundance of predators (wolves) and harmful species like hogs (91%); invasive plants and shrubbery following abandonment of arable lands (72%) and river pollution (65%). Some cautions were traditionally taken for preventing environmental damage, always from the farmers' perspective. For example, pigs, ducks and geese were never reared in areas located in river borders because 58.1% farmers believe that they are harmful for wild trout and salmon.

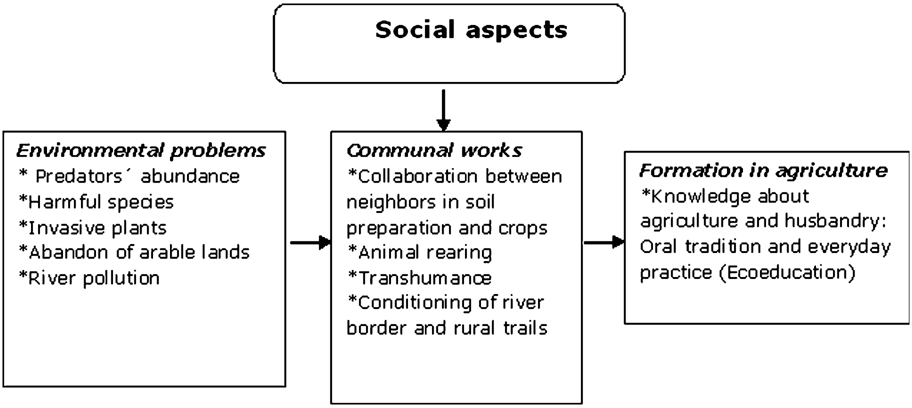

Fig. 3 Social aspects

Communal works

With respect to the character familiar or communal of agriculture in this area, most activities associated to crops were individually developed by each family, and help from the community was generally concentrated on collaboration between neighbors. Some tasks associated to animal rearing were developed in community: collective transport of animals to mountain pasturages (transhumance); assistance to cattle, donkeys and horses deliveries; and collective use of communal pasturage areas. Other collective tasks were accomplished only sporadically, no more than one or two times per year, like river border conditioning. All the farmers reported intense communal and collaborative activity in the past generation (30–40 years ago). Collective tasks included corn yielding and selection; operating the mills; grass recollection (mowing down); pig finishing and related tasks like elaboration of pig-derived products; conditioning of rural trails and many others. Some of these tasks no longer exist—such as mill activity. The others have been mechanized and can be accomplished individually, or are under responsibility of the Regional Administration.

Formation in agriculture

With respect to the origin of their knowledge about agriculture and husbandry practices, all the farmers declared that they have learned how to execute their daily activities from their relatives in the family context, generally from their parents or grand-parents. It should be noted that all the farms investigated were family farms. In all cases the property had been inherited within the family from the previous generation. None of the respondents had received specific formation (either non-formal or formal) on farming practices. All their knowledge about agriculture came from observing and participating in oral tradition and everyday practice.

Perception of agriculture activities

The activity of farmers was self-perceived as under-valorized and not well recognized by society in general (100% farmers). Some negative aspects pointed out by the interviewees

(Fig. 4) were the following: lack of clarity about the usage of agriculture taxes, which are paid in the head town (Oviedo city), which are not thought to be redistributed for improving rural life (53%); lack of initiatives for promoting social activity in the rural areas (44%); abandon of farms and rural activities by local people, without population replacement (70%); progressive impoverishment of families dedicated to agriculture and husbandry in exclusive (79%); and lack of expectations for the future (65%).

Perception about the future of agriculture in the region

Directly related with the answers reported above, the farmers' perception about the future of agriculture in Asturias was negative in 100% of cases. Despite intergenerationally endorsed tradition of rural settlements with intense integration of rich cultural habits related with agriculture and natural resources, the interviewees envisioned agriculture such an activity in extinction for the region.

Summary of elements identified as environmentally sustainable by students-researchers

The student-researchers involved in this experience found several interesting elements of sustainable use of natural resources. Traditional agriculture practices like crop rotation, use of manure and crop residues as fertilizers, and mixed cultivars have been identified by student-researchers as 'environmental-friendly.' They are substantial part of modern organic agriculture, which is considered one of the most effective farming systems (Mäder et al. 2002) and also considered much more respectful for the environment than conventional agriculture (Kramer et al. 2006). Our students explored the scientific basis of this reasoning of sustainability for environmentally-friendly practices identified. Amongst the information collected in the research experience, student-researchers identified the following elements of friendly relationship with the ecological environment which could be a part of the educational content of environmental science, science and environmental education in the future:

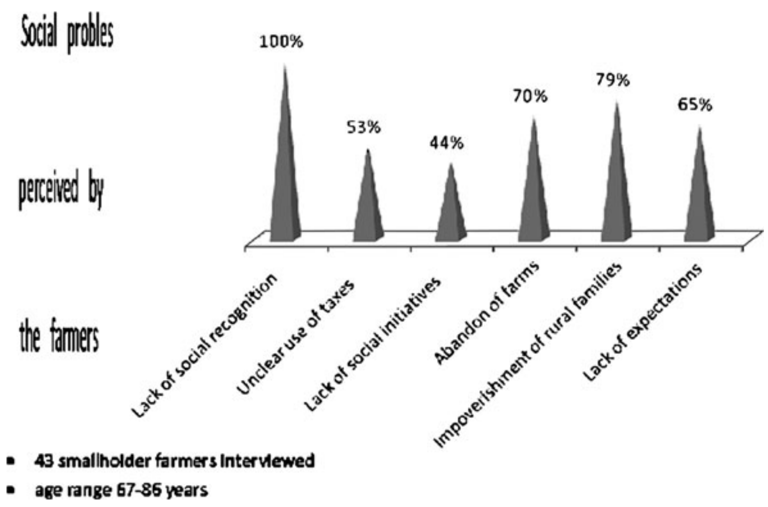

Fig. 4 Social problems of agriculture perceived by the farmers interviewed (in percent)

Mixing up crops. Mixed cultivars of one cereal (corn in this case) and one leguminous (haricot) is particularly good for soils because symbiotic organisms attached to leguminous roots contribute to nitrogen fixation (Fujita et al. 1992). Indigenous rhizobia diversity is remarkably lower in soils under maize monoculture (Depret et al. 2004), but monoculture does not occur in traditional Asturian agriculture. As artificial fertilization with commercial nitrogen-based products is not necessary, nitrogen leaches that are one of the main sources of agriculture-derived pollution (e.g., Larsson et al. 2005) are better prevented.

Controlling pests. One of the most serious threats of modern agriculture is the presence of pesticides in soil, water and farm products (e.g., Joannon et al. 2001). The use of pesticides, herbicides and chemical fertilizers do not take into account the consequences of all of these chemicals when they enter the food chain. The most dangerous products (Reach 2008) may have a carcinogenic effect, cause mutagenesis (inheritable genetic alterations) or endocrine disruption (altering the hormonal system). But in this part of the Asturian region farmers employ natural methods of pest control, such as ash against gastropods (i.e., snails, slugs). The use of ash for controlling snail and slug pests has been modernly recommended for reducing pesticides in modern small farms and gardens, based on the aversion of those invertebrates for high pH substrates like ash (Flint 1999).

Rotation of pasturages. In animal husbandry, it was also observed by students that there is a deep relationship involving mutual cooperation between farmers and their living environment. We observed farmers moving herds of livestock to neighboring pasturages that we call, “short transhumance,” or which creates a landscape where crops are alternated with grass fields. These short movements, destined to provide food for livestock also facilitate the conservation of pasture grass and concomitantly prevent the invasion of shrubs on this land. These effects of traditional husbandry contribute to conserving non-crop habitats in a diverse landscape, avoiding one of the impacts of European agriculture, which is the significant loss of non-crop ecosystems (Stoate et al. 2001).

Preventing contamination. River pollution, also reported as a problem by our farmers, is actually one of the main problems derived from agriculture and husbandry (e.g., Schilderman et al. 1999). In the Asturias landscape, constituted by valleys and river basins, the care of rivers is vital for farmers because streams provide water and fishing grounds. The ways in which some peasants who breed livestock are contributing to preventing environmental damage were identified as scientifically sound practices. For example, pigs can heavily contaminate river water (Beck and Fellow 1989). However, ducks and geese really impact on salmonids mostly through predation on juveniles (Kålås et al. 1993).

Improving the genetic diversity of crops. Collaboration between farmers for seed exchange contributes to preserving and creating genetic diversity for crops, as expected with farms managed in a traditional way (Louette 1999). The different forms of collaboration and community participation in rural settlements are rooted in oral culture: peasants exchanged labour force, farm tools, and animals for breeding and seeds. Partnership arrangements between farmers might be a way to secure the economic viability of their farms as well as to increase profitability. As educational researchers, we surmised that it may be interesting to analyze the perceptions of students about whether these traditions can be transferred to modern agriculture and livestock (e.g., Andersson et al. 2005).

Rising environmental awareness. Although conventional farming systems are not always respectful in their relations with the environment (Bignal and McCracken 2000), we found that in the rural contexts considered during our learning experience, area considered here as case study, ecosystem conservation is a concern. Environmental awareness has been identified as a key element of sustainability by student-researchers in this research because when the farmers pay attention to these relationships, they are manifest in their agricultural practices. Although the families interviewed never attended formally designed institution courses on environmental sciences and their science knowledge was substantially based on oral tradition, some of their environmental concerns are well supported by science. For example, biological invasions and uncontrolled population growth of some species were the environmental problems most frequently cited by Asturian farmers in this research. Precisely, abandonment of arable management has led in other European areas to the replacement of wildlife with more common and widespread species (Stoate et al. 2001), creating new spaces that are occupied by invasive plants and animals. In summary, the traditional agriculture practices employed by Asturian farmers in their quotidian farm life are less aggressive for the environment than many other modern management systems. Thus they contribute to environment preservation also in an involuntary way.

Discussion

All the compiled data were analyzed in a participative manner by student-researchers. In the described learning experience, an issue that caused controversy among student-researchers was the pessimistic vision of Asturian peasants concerning their future, as well as their negative perception of other rural activities. This problem is not exclusive to north Spanish peasants. Many small farmers in Europe today perceive an impoverished social situation (Källström and Ljung 2005); they put the problem in the lack of control in decision-making processes that affect them directly, which hinders their ability to continue farming. Public images and politic decisions too often show a lack of respect for peasants' skills and knowledge (Bowers 2003). In Asturias, farmers reported (see Fig. 4) some issues that they believed were under-valuated by society. In aspects related to decision making, they wish for a greater effort by politicians and trade unions to understand their cultural ways of life that could contribute to improving relations of interdependence. On the socio-educational aspects, dissemination of practices friendly to the environment, basic criteria of sustainability and the reported concern of peasants for the natural surroundings could enhance the social role of rural inhabitants.

At the same time, we do not want to romanticize rural agriculture. Some elements of traditional agriculture practice are not considered environmental-friendly. Although they are truly traditional, this does not necessarily imply that they are of ecological value (Cajete 1994). This idea is where we might differ from Bowers (2003) with respect to intergenerational knowledge, because he does not adequately describe the kinds of traditional knowledge that should be endorsed nor fully describe the role of the environmental sciences in relation to this knowledge (Mueller 2009a, b). This idea can be integrated in classroom discussions for emphasising the importance of new research on environmental issues and in developing new systems for environment preservation. Students may learn that the process and content of science is always changing (Falk 2001), and that although tradition is a source of knowledge, science continues to evolve as knowledge in action. For example, in the experience described in this study student-researchers identified harmful elements such as the use of tobacco for pest control. The effectiveness of tobacco-derived compounds (nicotine) as an insecticide is widely known (Read 1952), but nicotine is highly toxic and nicotine-derived pesticides are considered dangerous (see the official page of the US Environmental Protection Agency [http://www.epa.gov/pesticides/] and many references therein). Nevertheless, our student-researchers also recognized that the use of pesticides is not easy to discard in practice (Devine and Furlong 2007), even necessary for human food production. The use of commercial tobacco diluted in water, students concluded after discussing the issue in a participative and lively way (Clover 2003), is probably less harmful for the environment and human health than nicotine.

An important matter of pedagogical discussion that arises from this study is how peasants have learned their knowledge on agriculture and husbandry, which may contribute to understanding and validate the binomial teaching–learning in non-scholar spaces (Colardyn and Bjornav 2004). From a socio-educational approach we know that the generation of human practices is limited by social conditions that support them (Bourdieu and Boltanski 1975). From a socio-ecological point of view, Moos (1979) reminds us that evolution and human ecology within the environment could be a constraint on people's actions. People learn different things and habits depending on the interactions experienced within a specific community or context (Guffey 2008). But the scope of knowledge and experience of an individual, whatever the context in which learning takes place, transcends environmental context. This is what we call from Thorndike, "transfer of learning" (Perkins and Salomon 1992). There is no doubt that most human learning occurs outside of what are deemed formal learning spaces (Eraut 2000) but still, the skills and competencies acquired outside formal and non-formal education, remain invisible, and even taken for granted when they go unnoticed and unchecked. The results obtained from experiences described in this study emphasize the fact that even today many human communities continue to use oral transmission as a source of basic teaching.

In Asturias, like in other European regions, traditional agriculture practices orally transmitted for generations are of ecological value (Berkes et al. 2000). This way of learning, where the practice of quotidian tasks immersed in the setting of environmental resources conforms within a synthesis perspective of ecological knowledge and educational knowledge, and can be a relevant science education topic which could be called *Ecoeducation*. Ecoeducation represents action within participatory environments, expressed within the activities developed in nonstatic working contexts, and affect, caused by teaching by which we integrate oral traditional methods with an assemblage of practical knowledge learned intergenerationally. Intergenerational learning contents (what is taught and learned over longer periods of time) are directly related to what is necessarily needed for living. Ecoeducational learning is natural and environmentally contextual learning. It is produced in the context where persons develop their activity through didactic practical examples directly observed in spaces of real experience within the natural environment.

Conclusions

The learning experience that is presented here is intended to raise new prospects for science and environmental education in educational contexts, both inside and outside of school. New spaces where teachers and students can get involved with the ecological environment and reflect together about the different ways in which individuals, communities and environment work together (Mueller 2009a). In this study, students participating in Continuous Education initiatives, assuming the role of student-researchers, and developing their conceptualizations of ecojustice, have also learned some elements for which agriculture practices are sustainable with the conservation of ecosystems and natural resources. Equally, if not more importantly, it is possible to maintain a *friendly* virtuous relationship with the natural environment, experiencing cultural lifestyles that are beneficial for both people and ecosystems. This science knowledge and literacy positively influences environmental attitudes.

This field research experience as part of a course in the environmental sciences demonstrates the potential of a positive vision when relationships between humans and their environments are recognized, and we have shown to be much more motivational for teaching and learning science and environmental education. The lessons learned from peasants thereby improve school curricula and Continuous Education in Spain and abroad.

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Author Biographies

Eduardo Dopico Rodríguez Doctor of Pedagogy from the University of Oviedo (Asturias, Spain) is Professor in the Area of Didactics and School Organization, Department of Educational Sciences at the University of Oviedo. He teaches pedagogy at this university and his research activities are focused on teaching content and teaching and learning processes in educational spaces.

Eva García-Vázquez Doctor of Biology from the University of Oviedo (Asturias, Spain), is Professor of Genetics. She teaches Biology at the Faculty of Medicine and in the Faculty of Biology of the University of Oviedo. Her research activities are focused on population genetics, species-specific genetic markers and biology of ecosystems.