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Linking Farm and School: a Theoretical Review

Conectar la granja y la escuela: una revisión teórica

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Resumen. Esta revisión teórica surge de la necesidad de investigar el supuesto de que las granjas son entornos de aprendizaje cuyo valor se ve reforzado cuando las actividades de enseñanza-aprendizaje son diseñadas conjuntamente por los profesores y los agricultores. El propósito de la revisión es apoyar teóricamente la justificación del proyecto DEMETER, cuyo objetivo es desarrollar una metodología de enseñanza interdisciplinaria e identificar estrategias y herramientas para evaluar los resultados del aprendizaje en las granjas (en términos de competencias disciplinarias y transversales). Revisamos las investigaciones existentes que probaron instrumentos y recogieron evidencias en relación con los focos del proyecto: asociaciones granja-escuela, resultados del aprendizaje al aire libre y estrategias de enseñanza para contextos de aprendizaje al aire libre. Los estudios revisados se seleccionaron en función de la fiabilidad de sus contenidos y del rigor con el que los autores formularon las preguntas de investigación y analizaron los datos empíricos. En general, a pesar de la popularidad de muchas formas de aprendizaje al aire libre, los estudiosos convergen en la necesidad de un mayor exámen de la eficacia y la fiabilidad de las metodologías de enseñanza implementadas.

Abstract. This literature review stems from the need to investigate the assumption that farms are learning environments whose value is further enhanced when teaching-learning activities are co-designed by teachers and farmers. The literature was intended to theoretically support the rationale for the DEMETER project, which aims to develop an interdisciplinary teaching methodology and identify strategies and tools to assess farm-based learning outcomes (in terms of both disciplinary and cross-curricular competencies). We reviewed existing research that tested tools and gathered evidence regarding the project's focuses: farm-school partnerships, outdoor learning outcomes, and teaching strategies for outdoor learning contexts. The reviewed studies were selected based on the reliability of their contents and the rigor with which the authors formulated the research questions and analysed the empirical data. Overall, despite the popularity of many forms of outdoor learning, scholars converge on the need for greater scrutiny of the effectiveness and reliability of the teaching methodologies deployed.

Palabras clave · Keywords

Aprendizaje al aire libre, escuela primaria, formación del profesorado, granja, metodologías de enseñanza, resultados del aprendizaje.

Farm, learning outcomes, outdoor learning, primary school, teacher education, teaching methodologies.

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1. Background: the pedagogical role of the farm

Understanding the educative possibilities afforded by the farm as a learning environment is rooted in the field of outdoor education and opens up various connections with education for sustainable development, for nutrition, good health, and wellbeing. As noted in the goals outlined in the *Global Sustainable Development Report 2019* (United Nations Department of Economic and Social Affairs, 2019), education for sustainable development (henceforth ESD) and outdoor education can be enhanced by strengthening the co-operation among schools, local area partners, and civil society in order to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" as stated in Sustainable Development Goal number 4 (ibidem). Such school-farm co-operation can be based on several guiding principles like locality, continuity and active participation (Risku-Norja and Korpela, 2010).

As educational agencies embedded in natural and anthropized settings (Torquati and Ernst, 2013), schools play an active part in their broader environment; hence, when a working alliance is formed among the actors in a local area, especially via ad hoc networks such as Environment and School Initiatives and the Global Environmental Education Partnership, teachers' professional development can be enhanced, fostering innovative teaching practices in the field of ESD (Smith, 2018, p. 282).

Numerous studies show that outdoor education settings and the opportunity to interact with the environment can facilitate more complex learning in children: such approaches create a continuum with the external environment, of which young learners may have little prior experience, especially in heavily urbanised contexts (Scott et al., 2012; Fägerstam and Blom, 2013; Selmer et al., 2014). Many examples of such studies are presented in the volume *Research in Early Childhood Education for Sustainability: International Perspectives and Provocations* which, according to the editors, focused on research that engaged with "children working authentically to explore sustainability topics/issues of interest to them, while working alongside teachers, families and communities" (Davis and Elliott, 2014, p. 173). The authenticity of these situations can be seen via children's involvement "in solving problems, seeking solutions and taking actions that 'make a difference,' mostly within their local context, but occasionally on a bigger stage" (p. 173).

Educational experiences in outdoor settings and engagement with outdoor environments have been shown to have a positive impact on psychological and physical wellbeing where the focus is on the person (Grey et al. 2015; Roberts et al., 2019), and to yield enhanced learning outcomes in students in both highly structured and loosely structured settings (Dhanapal et al., 2013; O'Brien and Murray, 2007). However, as observed by Skamp and Bergmann (2001), teachers may, in these circumstances, forgo learning experiences that include or are based on the natural environment, suggesting that the opportunity to design educational offerings with other local actors is missed.

To address this issue, several European programs, such as Erasmus+ (the EU's programme to support education, training, youth, and sport), Horizon 2020 (EU Research and Innovation programme), LIFE (the EU's funding instrument for the environment and climate action) and European Agricultural Fund for Rural Development (EAFRD), support research in the field of environmental education, to help identify successful educational strategies and build guidelines for teacher training. In this paper we specifically focus on the DEMETER - DEveloping interdisciplinary Methodologies in Education Through Enhanced Relationships between schools and farms - Erasmus Plus Project. The DEMETER project (Sept. 2018-Aug. 2021) was co-funded by the Erasmus+ programme of the European Union (Strategic Partnerships Key Action2), under Grant number 2018-1-SE01-KA201-039146. The lead partner is the Municipality of Vänersborg (SE). Other partners are The Soil Association (UK), Hushållningssällskapet Väst (SE), Washingborough Academy (UK) Colégio do Sardão (PT), Municipality of Bertinoro (IT), IC Da Vinci School (IT), University of Milano Bicocca (IT), Emilia Romagna Network (IT). The project aims to develop an interdisciplinary teaching methodology for implementation with primary school students based on a close collaboration between farms and schools and driven by the assumption that the value of farms as learning contexts is underpinned by involving farmers in co-designing the educational activities with teachers.

The DEMETER project consists of two main parts. The first part is the current literature review, conducted between September 2018 and March 2019 by Milano Bicocca University research unit, in collaboration with two teacher-researchers: Doris Valente and Chiara Gianotti. The literature review investigates how previous research has addressed the relationship between primary schools and farms from different perspectives, i.e., educational partnerships, teaching strategies adopted and learning outcomes promoted. The second part of the project engages teachers and farmers in a collaborative research (Desgagné, 1997), starting from the documentation and analysis of particular teaching practices (Vinatier and Altet, 2008) to "make visible" the learning outcomes they promoted (Giudici et al., 2001) and identify which elements of school-farm partnership were central to support effective co-design of the teaching strategies adopted in the different countries.

The teaching-learning methodologies targeted for implementation in DEMETER project are pedagogically grounded in the Reggio Emilia approach (Ceppi and Zini, 2011; Gandini, 1998), which assumes the environment as a "third educator" with the power to convey and catalyse the educational messages underlying school planning, expecting learning to be enhanced by student observation and inquiry.

2. Structuring the Literature Review

The purpose of the literature review was to provide a theoretical basis to the rationale for the DEMETER project by identifying effective teaching and learning methodologies for developing key competencies in primary school children through farm-based education as a specific approach to outdoor education. In a systematic approach to the literature (Qais, 2018), we follow a three-phase process for the identification, selection (elimination or inclusion), and analysis of studies (Williams and Dixon, 2013, p. 214).

Phase 1: Previous literature reviews

We drew first on previous literature reviews within the broader fields of food, health, sustainability, and environmental education that guided us in constructing a sharper definition of the topic and organising our own review around main categories more strictly related to the farm as a learning environment. These previous reviews revealed a great versatility of outdoor and environmental education and the need for diverse approaches in research design (Ardoin et al., 2018). They also highlighted the need for emphasising research validity and reliability (Williams and Dixon, 2013) in order to improve practices and evaluation methods, thereby better assisting programs to meet their goals (Joshi et al., 2008). Several researchers focused on the learning outcomes promoted in the various approaches to outdoor education, highlighting two types: academic outcomes and outcomes related to transversal and transferable skills, which are skills "not specifically related to a particular job, task, academic discipline or area of knowledge that can be used in a wide variety of situations and work settings" (UNESCO International Bureau of Education, 2013, p. 58). Most of this research showed a positive impact on both academic and transversal and transferable skill outcomes (Williams and Dixon, 2013). This focus on learning outcomes also revealed a need for improved means for measuring and understanding the effects, i.e., how direct interaction with nature may impact wellbeing (Roberts et al., 2019), outcomes related to diet and food consumption (Berezowitz et al., 2015; Robinson-O'Brien et al., 2009; Savoie-Roskos et al., 2017), or physical activity (Gray et al., 2015). Another important research consideration has revolved around teaching strategies and teacher education. These topics were barely addressed in the studies related to environmental and outdoor education (Jeronen et al., 2017), also due to the lack of teachers' confidence with outdoor and natural settings, an issue that may be reduced by promoting teacher training in this field (Blair, 2009; Dillon et al., 2003).

Phase 2: Database-driven approach

In the second phase, we follow a database-driven approach by entering combinations of keywords (Table 1) into three online search engines and databases - Google Scholar, SpringerLink and Elsevier – to "alleviate the effects of differing coverage between individual databases" (Hiebl, 2021, p. 6).

The choice of keywords relied on three main themes – school-farm partnership, learning outcomes, teaching strategies teacher education - identified through previous literature review and the analysis of relevant weaknesses (Williams and Dixon, 2013). The selection of keywords across the literature was based on the need to identify positive connections between children's learning strategies and unstructured learning environments, i.e., farms. Moreover, the identification process considered the positive statistical links between the keywords and their effective correspondence to the contents of titles and abstracts. These two linkages were considered for selection purposes (Lu et al., 2020; Tripathi et al. 2018). In line with Jesson and Lacey (2006) and Qais (2018), the first keywords selection process was deliberately generic to collect most existing studies across several fields. Subsequently, the references obtained through the search engines used were further shortlisted.

Table 1
Outcomes of scoping

Keywords combinations	Google Scholar	Springer Link*	Elsevier
"Farm + School"	8300	481	270
"Farm + Learning Outcomes"	4	204	520
"Farm + Teaching"	346	237	18
"Farm + school + children"	96	390	3

Discipline: Education; subdiscipline: Learning and Instruction

As previously noted by Dillon et al. (2003), the topic of farm-school continuity as a learning tool for children is related to several research areas and elements that can be used as indicators to identify more accurate selection parameters. The analysis carried out on the selected references showed interconnections with different disciplinary areas (nutrition education; agricultural education; environmental education; outdoor education; geographical/science/technology education; food education; health education; experiential education; development education; museum education), learning environments (classrooms, school grounds, school farms, city farms, botanical gardens, museums, field centres, farms, summer camps) and teaching strategies (hands-on activities, experiments, guided visits, inquiries).

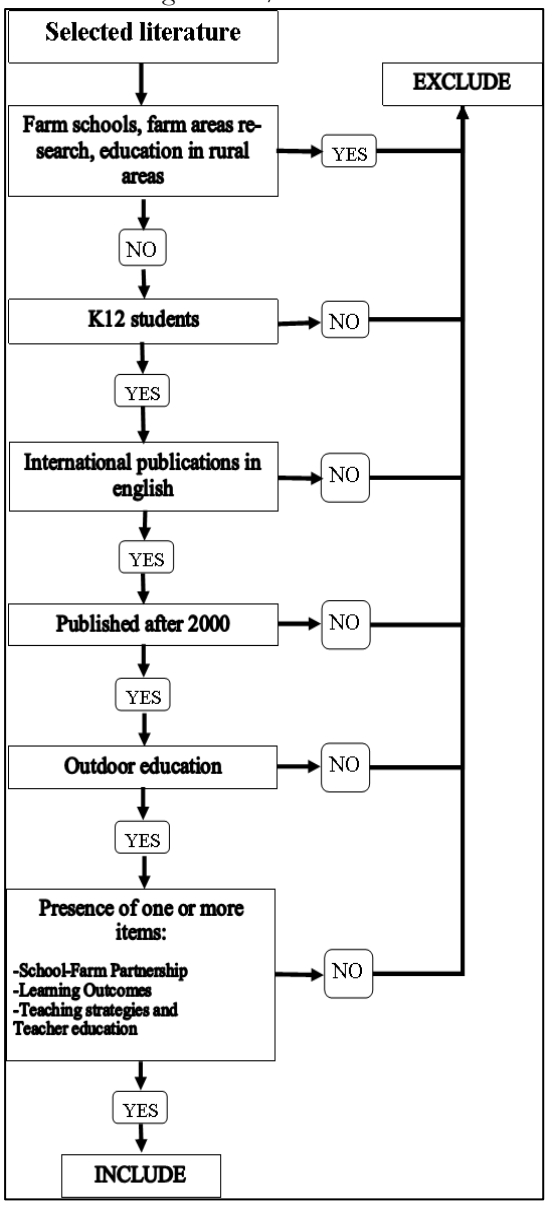
Phase 3: Preliminary analysis and fine-tuning

Following in the footsteps of Dillon et al. (2003, p. 8), as reported in Figure 1, the third phase of the study involved using limited parameters to identify more suitable references for the research.

Using these parameters allowed excluding all publications dealing with agricultural schools and institutes, preschool, higher education and universities; the papers related to children's education in rural contexts and poorly or non-urbanised areas were also excluded. The reference material was also selected based on the language used and the year of publication. Priority was given to English, being the primary language used in the Demeter project. In terms of year of publication, the research focused on the most recent studies issued after 2000. As far as the educational setting is concerned, the research only included educational studies focusing on the following topics: the outdoor space intended as an educational setting able to improve the children's competencies and knowledge; teaching educational and planning strategies promoting hands-on experiences and, more specifically, one or more features related to the settings and methodologies described and which may be used within the farm setting.

Figure 1

Tree summarising inclusion/exclusion criteria



During this phase, we selected 118 papers and 3 theses based on title and abstract (Avalos, 2011).

Thanks to the Mendeley library - a web tool that allows creating shared archives accessible to the entire research team -, we streamlined the document selection process and divided the selected works into the three main themes mentioned above, even with multiple overlapping areas (Figure 2): school-farm partnerships (18 papers), learning outcomes (55 papers), teaching strategies and teacher education (48 papers).

Table 2

Papers and Theses selected to read in full addressing the three themes

Papers and Theses selected to read in full	SCHOOL-FARM PARTNERSHIP	LEARNING OUTCOMES	TEACHING STRATEGIES
Anderson et al., 2006			x
Ballantyne and Packer, 2009	x	x	x
Bontrager Yoder, et al., 2014		x	
Botkins and Roeb, 2018	x		

Bowker, 2010			x
Dhanapal and Lim, 2013		x	
Fägerstam, 2014		x	x
Fägerstam and Blom, 2013		x	
Hazard et al., 2018	x		
Kangas et al., 2016		x	x
Klemmer et al., 2005a		x	x
Klemmer et al., 2005b		x	x
Knobloch et al., 2007			x
Krog and Jolly, 2011	x		
Kropp et al., 2018		x	
Mayer-Smith et al. 2009	x	x	x
Murray and O'Brien, 2005		x	
Norðdahl and Jóhannesson 2016			x
O'Brien and Murray, 2007		x	
Peterat and Mayersmith, 2008	x	x	
Pigg et al., 2006		x	
Risku-Norja and Korpela, 2010	x	x	x
Scott et al., 2012		x	
Scott et al., 2015			x
Selmer et al., 2014	x		x
Smeds et al., 2015a	x		
Smeds et al., 2015b		x	x
Tal and Morag, 2009			x
Torquati and Ernst, 2013			x
Trexler et al., 2000			x
Theses			
Marcombe, 2013	x	x	
McIver Mattu, 2016	x	x	x
Smeds, 2017	x	x	x

A first analysis of the selected articles identified other significant works which were subsequently included in our review following a "snowballing" process (Hiebl, 2021, p.6).

A cross-subjective discussion within the research group - aimed at "developing a refined common understanding about the specific review focus and inclusion/exclusion criteria" (p.20) - resulted in the selection of 31 papers and three theses. We focused on empirical studies, choosing them based on the reliability and validity of their contents and the rigor applied by the authors in defining and reporting research questions, instruments, phases, and data analysis. These features were identified following the criteria underlined by Williams and Dixon: "(a) is the study empirically based, are there pertinent research questions, (c) is the methodology described, (d) is research evidence provided, (e) are links made between garden and school/curriculum/subjects, and (f) are outcomes measured?" (2013, p.216).

Figure 2
Categorisation of selected studies and overlapping areas

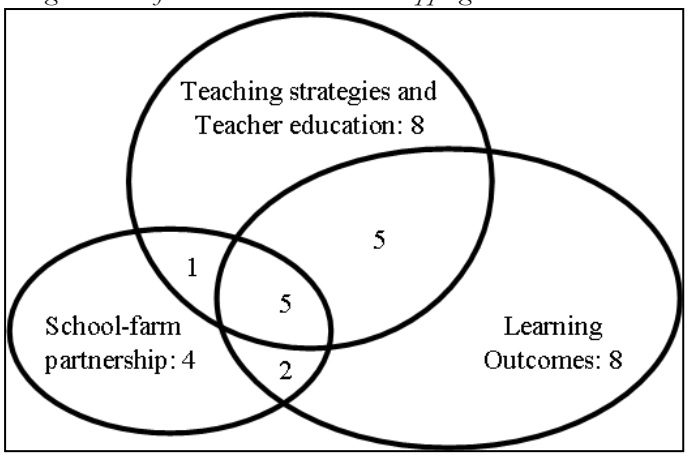


Figure 3
Breakdown of the reviewed papers by country where the research was conducted

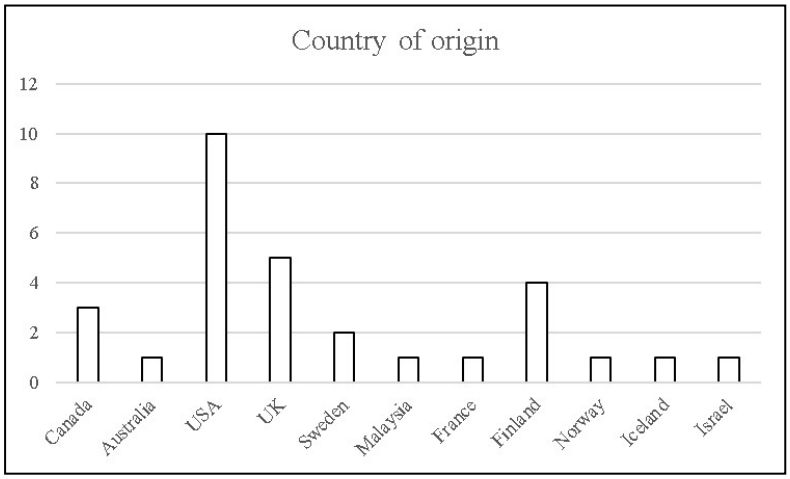
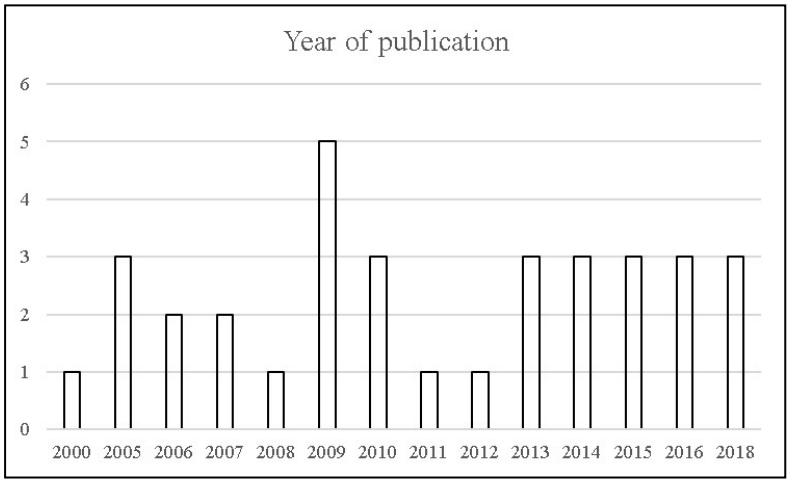


Figure 4
Breakdown of the reviewed papers by year of publication



Following the selection, the researchers analysed the studies divided into three categories. The following section reports their overall findings and research design (Williams and Dixon, 2013, p.218) by underlining the strengths and weaknesses that may be used to define other research paths on the topics addressed.

3. Building a Farm-School Partnership

Substantial research on this theme has been conducted within the framework of the Norwegian movement *The Farm as a Pedagogical Resource*, founded in 2002 (Jolly and Krogh, 2010; Krogh and Jolly, 2011). In their work, Jolly and her research group describe the core principles informing the design of courses that initially saw farms and schools working together to implement the pioneering "Living School" project jointly. Specifically, these literature sources suggest the importance of: offering joint training to teachers and farmers, ensuring that any program of educational activities is co-designed by farmers and teachers, developing a shared vision, and mediating between farmers' and teachers' needs. During the follow-up interviews with the teachers involved in the project, they defined it as "a turning point, both personally for themselves and for the students" and "a 'renewal' as a teacher" (Krogh and Jolly, 2011, p.318). Also, in addition to the fact that they feel "happy" while performing outdoor activities, the questionnaire administered to students shows that they learned to "eat healthy food" and became aware "of being part of a community which did something useful." (p.319).

Offering joint training to teachers and farmers

To put these principles into practice, Jolly and colleagues developed a one-year course, during which the researcher asked participating farmers and teachers to work in pairs to design a specific project, implement the initial stages of it, and evaluate their experience from an experiential learning perspective (Jolly and Krogh, 2010). The need to establish a two-way dialogue, as part of the project, between outdoor learning setting (farmer) and school setting(teacher) forced many teachers out of their comfort zone and fostered mutual learning by farmers (and researchers), helping them to acquire a more in-depth understanding of the broader situation involving the two settings which the students experience (Hazard et al., 2018).

The importance of professional development programs designed to support the capacity of teachers to facilitate learning in natural environments is underlined in an Australian farm-school program (Ballantyne and Packer, 2009). The researchers interviewed both teachers and children to assess their representations, learning outcomes, and self-assessments. Teachers reported their growing awareness of how experience-based learning entails cooperation and inclusion and many suggested that this way of learning should be adopted as best practice. The Australian farm-school program also highlighted the key role of having access to dedicated centres, such as Queensland's Outdoor and Environmental Education Centres (Queensland Government Department of Education, 2018), in building the partnerships by providing institutional support.

The significance of institutional support is similarly emphasised via the "Farm-to-School" program in the USA (National Farm to School Network, 2021), which has focused more narrowly on food education, aligned with federal and state legislation such as *No Child Left Behind*. This project analysis has revealed positive outcomes in enhancing children's agri-food knowledge, nutritional awareness and behaviours (Joshi et al., 2008). The effective school-farm collaboration implemented by the Farm-to-School program also generated several benefits such as supplying local products to school canteens, hosting community events across the farms (Botkins and Roe, 2018), and creating a regular market for local producers (Allen and Guthman, 2006; Selmer et al., 2014).

Ensuring that any program of educational activities is co-designed by farmers and teachers

A second characteristic of the program, shaping effective partnerships, is farm-school co-design of the activities. This element presumes a mutual recognition of skills and knowledge, encouraging "close contact" between farmers and teachers so that the activities on the farm can become a feature of the regular curriculum (Jolly et al., 2004, p. 3). One complexity experienced with such close relationships between farmers and teachers was the challenge presented when a teacher left the school (for whatever reason), which often resulted in the partnership collapsing (Jolly and Krogh, 2010).

If there are also logistic difficulties to consider, as co-design takes a long time, however, Risku-Norja and Korpela (2010) research highlighted that teachers reported that it was worth it for the opportunity to offer children experiences in continuity with the curriculum in a new authentic learning environment, and farmers for the development of an effective way of dealing with the public resulting from cooperation with the schools.

Farmers' and teachers' mutual representations and relationship

Another critical issue implicated in the farm-school co-design is the pedagogical role of the farmer that also has to deal with the – often stereotypical – children's and teacher's representations of farmers and farm

life. One child involved in the Canadian study "Intergenerational Environmental Education on the Farm" states that "she changed her beliefs about farmers through contact with her farm friend" (Mayer-Smith et al., 2009, p.111). Similarly, recurrent prejudices had been also noticed in several educational programs conducted in Italian farms (Nigris et al., 2014), such as the idea that all farmers are male, wear straw hats and do not avail of modern technologies. Revealing prejudices always unfolds new spaces for open-minded exploration, and this is even more the case in inspiring and inclusive learning settings such as natural environments (Mayer-Smith and Peterat, 2019; Smeds et al. 2015a).

The Norwegian studies also showed that the greater effectiveness of projects is guaranteed by continuity in the relationship; the results of the three cases analysed show that a project in which contact with farmers is direct and well-integrated into the curriculum is more effective for students. More specifically, children's answers to the questionnaires show a better attitude towards the topics addressed in the farm visit if the relationship with the farm was concrete and the interaction with the farmer was not casual but prepared beforehand at school (Jolly and Krogh, 2010).

Encouraging regular farm visits to provide children with the opportunity to enjoy and participate in everyday farm tasks directly could also "breaks down social barriers to age segregation and provides opportunities for children and adults to meet and talk about real life issues and life experiences" (Mayer-Smith et al., 2009, p.119). The research also underlined how, in the intergenerational exchange observed between elderly volunteers called "farm friends" and elementary school students, the natural outdoor setting of farm itself acted as a teacher for the participants (Peterat and Mayer-Smith, 2006).

Figure 5

Summary table of the main issues involved in building the school-farm partnership

INSTITUTIONAL UMBRELLA	TRAINING	CO-DESIGN	SOCIAL AND ECONOMIC SPILLOVER	OBSTACLES
Queensland's Outdoor and Environmental Education Centres (Ballantyne & Packer, 2009)	"The Farm as a Pedagogical Resource" course led by Norwegian University of Life Sciences. One year course for teachers and farmers (Krogh et al., 2011)	Activities carried out both at school and on the farm (Ballantyne & Packer, 2009; Krogh & Jolly, 2011; Mayer-Smith et al., 2009; Risku-Norja & Korpela, 2010; Selmer et al. 2014; Smeds et al. 2015)	Local products in school meals, farms hosting community events (Botkins & Roe, 2008)	Stereotypical representations of farm life (Mayer-Smith et al. 2009, Nigris et al., 2014, Risku-Norja & Korpela, 2010)
National pioneer project "Living School" (Krogh & Jolly, 2011)	A training day at the farm recommended (Harris, 2009)	Interaction with the farmer prepared beforehand at school (Jolly & Krogh, 2010)	Steady market for local producers (Allen & Guthman, 2006)	Farmers refers difficulty in finding schools cooperation (Harris, 2009)
National FTS Network (Botkins & Roe, 200)	Need of design professional development programmes (Ballantyne & Packer, 2009)	Two-way dialogue (Hazard et al., 2018)	Opportunity for farmers to develop public relationship (Risku-Norja & Korpela, 2010)	Move out from teaching comfort zone (Hazard et al., 2018)
	Pedagogical enforcement of the farmer's role (Risku-Norja & Korpela, 2010)	Link with the curriculum (Jolly, 2004; Risku-Norja & Korpela, 2010; Selmer et al. 2014)	Parents involvement (Selmer et al. 2014)	Co-design takes a long time (Risku-Norja & Korpela, 2010)
	Fostered mutual learning (Hazard et al., 2018)	Specific codesigned and evaluated project required (Krogh & Jolly, 2011)	Intergenerational dialogue (Mayer-Smith et al. 2009)	Fund & seasonality (Botkins & Roe, 2008)

4. Learning Outcomes

Learning outcomes can be divided into two types: more purely academic outcomes, in terms of subject-specific learning, and broader outcomes, such as transversal skills, attitudes, and behaviours. Two previous literature reviews have addressed this theme, among others, offering a valuable initial guide to the key issues surrounding the impact on student learning outcomes of outdoor and non-formal learning settings such as farms.

The latest of these two reviews - conducted by Williams and Dixon (2013) at Portland State University - examined the *Impact of Garden-Based Learning on Academic Outcomes in Schools: Synthesis of Research Between 1990 and 2010*. The work pointed out key gaps in the existing research, considering that the studies conducted so far have rarely succeeded in identifying what aspects of a particular program had helped to yield positive impacts. The authors concluded that a "parallel focus on rigorous research to understand the academic learning outcomes in a systematic manner" (p.226) had not accompanied the investment in outdoor education. Nevertheless, they also pointed out "a preponderance of positive academic outcomes especially in Science, Math, and Language arts, giving credence to gardens serving as instructional and curricular means

for covering academic content" (ibidem). Another key finding of their review was that "several studies referred to validity and reliability of the scores for the standardised tests utilised as an academic outcome, but none of the studies mentioned threats to construct validity, content validity, criterion validity, or reliability" (p.225).

Detailed analysis and assessment of the learning outcomes has been carried out by Finnish researchers (Smeds et al., 2015b), examining the role of the farm as a learning environment in light of the drastic decrease in the number of active farms in Finland. They investigated whether the type of learning environment made a difference when Year 5 (11-year-old) pupils were learning about the milk chain, comparing the long-term persistence of concept and process when educational activities were conducted in the classroom, in a farm as an authentic learning environment, or in a combination of both. They, therefore, designed three different interventions: a) classroom only, b) classroom and farm, and c) farm only. They assessed the targeted learning (mainly science-related) immediately before, immediately after, and five months after the interventions, by administering a test designed according to the general principles of school tests in Finland. The test results indicated that, at the five-month follow-up stage, low academic performers exposed to authentic farm learning environments obtained higher mean test results than high academic achievers who had received their intervention in classroom setting only. This finding bears out not only the effectiveness of on-farm activity but also its significant potential to boost inclusivity.

Within the previously mentioned strand of research into food education, several studies (Nigris and Balconi, 2015; Robinson-O'Brien et al., 2009; Savoie-Roskos et al., 2017) revealed that garden-based food education positively influenced children's and adolescents' consumption of fruit and vegetables with a long-term effect (Kropp et al., 2018), also underlining the importance of the impact especially on children with previous low intakes (Berezowitz et al., 2015). Another study of the vegetable garden and farm settings by Kangas and colleagues suggested that the more the teacher "trusts" pupils, the more the latter "take responsibility in resolving problems and asking for help from other pupils" (Kangas et al., 2017, p. 88).

While farms were not directly involved in this group of studies, it is interesting to note that, like the above-cited Finnish study, they found that learning outcomes were enhanced by combining outdoor intervention with classroom-based lessons.

Other positive effects included gains in children's liking for fruit and vegetables, their interest in tasting them, and their general awareness of the food chain (Smeds et al., 2015b).

These outcomes are in keeping with a broader framework that defines educationally effective programs as those that do not lay a strong emphasis on the *products* of learning but rather stimulate *processes* of inquiry, generate open-ended questions, and generally foster active participation and engagement by the students. The wide-ranging cognitive, affective, physical, and behavioural impacts of outdoor educational experience are well illustrated in several studies like the Forest School project by O'Brien and Murray (2007).

The positive impact of outdoor activities on students' soft skills include also attitudinal behavioural changes (Ballantyne and Packer, 2009; Blair, 2009), problem solving and peer cooperation (Fägerstam and Blom, 2013; Fägerstam, 2014; Kangas et al., 2017), motivation, concentration and confidence (O'Brian and Murray, 2007), and self-assessment skills (Nuutinen, 2018).

Within Nuutinen empirical study, *The Encounters Project* in Finland, children used the KLW grid (what they already Knew, what they had Learnt and what they Want to know further) to self-assess their learning.

Other researchers have investigated the outcomes of outdoor education in terms of subject-specific learning. Neither of the following two studies that we reviewed under this heading involved farm visits, but the educational activities evaluated in them could easily be adapted to suit a farm setting. The authors of the first study investigated science learning outcomes among the students of seven schools of the Temple school district in Texas. They identified a significant statistical difference between the scores of an experimental group that received science lessons via a garden-based curriculum developed by the Texas Agriculture Extension Service (TAEX) alongside traditional teaching and a control group that received only conventional classroom-based teaching: specifically, the experimental group students obtained significantly higher scores than their peers in the control group (Klemmer et al., 2005a). The test administered to participants was based on the garden-based curriculum developed by TAEX (Klemmer et al., 2005b), Texas Essential Knowledge and Skills (TEKS) guidelines, and Science Scope and Sequence documents for the school district.

In contrast, another study conducted in Texas (Pigg et al., 2006) showed that fifth-grade students who had followed a traditional learning program achieved higher math scores than students who had taken part in a gardening program. The researchers attributed this finding to the nature of the test administered to participating students, being it more suited to measuring notional learning. When analysing test results, it might also be salient to consider "how different multiple intelligences would affect the choice and perceptions of students to learn indoors or outdoors" (Dhanapal et al., 2013, p. 23). However, in the

Fägerstam and Blom (2013) research, it is shown how students engaged in outdoor activities have long-term better results in math tests.

A further study in the UK (Scott et al., 2012) concerned the literacy outcomes of a Year 5 (9–10 years old) class, following a year-long program based on *the forest school approach*. More specifically, an inquiry-based learning methodology was deployed to engage participating children in producing a field guide, an authentic task that combined learner autonomy and open-ended inquiry with field work, ICT, and classroom-based activities. A pre-post-test design was deployed to evaluate the impact of the integrated field and classroom learning activities on participants' cognitive abilities. Specifically, the researchers compared aspects of children's factual writing ability both before and after the exercise. The improvement in participants' written production at the post-test stage suggests that outdoor scientific activities can also produce benefits in areas of learning other than science.

A study conducted in Malaysia that investigated the impact of students' perceptions of indoor and outdoor learning on their science understanding (Dhanapal et al., 2013), pointed out how indoor and outdoor learning complement each other and underlined the potential of the role of children's attitude in promoting meaningful learning. Fägerstam as well states that "an outdoor educational potential of experience-based learning outdoors was that it could be used as a mutual point of departure for further learning indoors" (2014, p. 78).

Two Ph.D. theses have also offered in-depth investigations of outdoor learning outcomes: Pia Smeds work (2017) and *Farm Visit: Interdisciplinary outdoor learning for Primary School Pupils and Scotland's Curriculum for Excellence* (McIver Mattu, 2016). The latter explored the use of educational farm visits as an example of outdoor learning in the context of the *Scottish Curriculum for Excellence through Outdoor Learning* (Learning and Teaching Scotland, 2010). The author's starting assumption was that the new curriculum is lacking insofar as it offers no evidence of broader connections between outdoor learning formats and curricular contents.

McIver Mattu observed that the teachers involved in her case study were able to link their farm visits to a wide range of curricular areas, such as Art, Music, Drama, Numeracy, and Science. The researcher pointed out that children's experiences at the farm, like touching, feeding, and seeing animals, produce long-lasting and emotionally charged knowledge (McIver Mattu, 2016, p. 150). She provided a detailed account of all the instruments used in her research (questionnaire for teachers, interviews with teachers and farmers, and 'group discussions' with primary school pupils). As mentioned earlier, another theme addressed in McIver Mattu's doctoral research was the respective roles of the teacher and the farmer, and the incentives and barriers that can affect a teacher's decision to take students on a farm visit or a farmer's decision to host visitors.

Figure 6

Summary table of the main Learning Outcomes

SCIENCE	MATH	OTHER SCHOOL SUBJECT	SOFT SKILLS AND ATTITUDE	NUTRITIONAL KNOWLEDGE AND BEHAVIOURS	LONG-TERM IMPACT
Effectiveness of outdoor context in science scores (Fägerstam & Blom, 2013; Smeds et al., 2015; McIver Mattu, 2016)	Higher math scores for students who followed traditional learning programme (Pigg et al., 2006)	Art, music, drama (McIver Mattu, 2016)	Problem solving and peer collaboration (Fägerstam, 2014, Fägerstam & Blom, 2013; Kangas et al., 2017, Murray & O'Brien, 2005)	Fruit and vegetables consumption increased among those with the lowest intakes (Bontrager Yoder et al., 2014)	Long term persistance of concepts and process (Smeds, et al., 2015b)
Effectiveness of garden based curriculum in science scores (Klemmer et al., 2005)	Long-term better results in math tests for students engaged in outdoor activities (Fägerstam & Blom, 2013)	Literacy: outdoor exploration activities enhanced children's writing ability (Scott et al., 2012)	Confidence, social skills, language and communication, motivation and concentration, knowledge and understanding (O'Brien & Murray, 2007)	Fruit and vegetables consumption increased (Kropp, 2018)	Long-lasting and emotionally charged knowledge (McIver Mattu, 2016)
The potential for indoor and outdoor learning to complement each other (Dhanapal & Lim, 2013)	Numeracy (McIver Mattu, 2016)	Language improvement (Murray & O'Brien, 2005)	Attitudinal and behavioural changes related to environment (Ballantyne & Packer, 2009, Blair, 2010; Murray & O'Brien, 2005)	Awareness of the food (milk) chain (Smeds et al., 2015b)	Higher degree of long-term knowledge retention (Fägerstam & Blom, 2013)
			Self-assessment skills (Nuutinen, 2018)	Higher veg intakes with long-term effect (Kropp, 2018)	

5. Teaching strategies and teacher education

Several studies have identified teacher-reported obstacles to conducting farm/outdoor learning activities. Multiple authors raised another critical issue, already addressed in the school-farm partnership paragraph, concerning the fact that effective farm-school educational projects require ad hoc training for teachers. This need emerges as the teachers perceive themselves as poorly informed about farming topics and not confident in their ability to teach them well (Bowker, 2002; Knobloch et al., 2007; Tal and Morag, 2009). A key for training effectiveness is teachers' "openness to find value in training related to field-based teaching and individual's predisposition to being out of doors" (Scott et al., 2015, p. 177).

A recently published report on Erasmus Plus project, *A Rounder Sense of Purpose* (Vare et al., 2019), offered a practical accreditation model for ESD educators, suggesting that they require 12 competencies, each of which breaks down into three learning outcomes with multiple underlying components.

The four rows of the RSP competence table suggest a process that the educator might follow:
(a) integration–using knowledge from different dimensions, looking at interconnections and cause-effect relationships
(b) involvement—building this understanding into their personal sense of commitment
(c) practice—combining the two stages above in their practical work as an educator
(d) reflection—evaluating the process and results of their work, assuming responsibility, and taking decisions before repeating the process in an iterative learning loop. (p.9)

An associated key issue is the relationship between the educator's competence and the competencies to be developed by the student, which in turn relies on the need to support teachers' (and farmers') professional development through ad hoc training activities and documentation of practices, as mentioned earlier in this review. One example is the portfolio evidence that RSP participants in the UK and Italy were asked to provide, which was found to "encourage a wider reflection on personal and professional roles in light of the concepts being discussed on the program" (p.17).

Other significant aspects resulting from the RSP project concern both the pedagogical approach - more specifically, the educational activities conducted during the project were informed by the "principles of collaborative and socio-constructivist theories of learning in which participants are encouraged to take an active role" (p.16) -, and the fact it identified the validation of a range of assessment techniques as a key priority for future research.

Lack of time is another reported obstacle (Harris, 2009) that already emerged in the process of partnership building. Teachers have little time to engage in additional planning, whether at school or on-site at the farm; moreover, they may fail to initiate collaboration with farmers due to a lack of awareness about the presence and activity of local environmental organisations (Marcombe, 2013). Furthermore, the number of months when spending time outdoors is possible depends on seasonal weather patterns (Trexler et al., 2000). Teachers have also emphasised the need for expert support to teach agricultural topics and cooperation with stakeholders from the farm world, facilitating the effective integration of outdoor learning activities in the school curriculum (Trexler et al., 2000; Affolter and Varga, 2018). For example, as stated by Tal and Morag, "field trips as complex learning settings enable the curriculum to be bound to the environment in order to promote science learning" (2009, p. 247).

The already mentioned US research (Klemmer et al, 2005a; 2005b) reported an interesting example of a garden-based curriculum strictly linked with Texas Essential Knowledge and Skills (TEKS) developed to design and evaluate children's learning. Cooperation with an expert may also help teachers to overcome concerns about threats to child safety. According to a study (Torquati and Ernst, 2013) on student teachers' perceptions of outdoor learning settings, the main reason why certain sites were viewed as less suitable for educational activities was safety hazards, which typically require the presence of additional adults in order to guide and supervise children.

Torquati and Ernst found that teachers' awareness of the benefits of nature experiences, the extent to which they perceived natural settings as challenging to use, and their personal levels of nature relatedness, all significantly predicted the degree to which they intended to use natural settings in their future teaching practice. Basic and in-service teacher training can thus play a crucial role (Smeds et al., 2015b) in helping teachers to develop key competencies needed to offer children learning experiences in natural settings: teachers require technical knowledge about how to provide appropriate supervision, but also the capacity to design structured and unstructured learning experiences in natural environments (Tal and Morag, 2009; Torquati and Ernst, 2013). Similarly, teachers' prior knowledge and hands-on experience in outdoor learning are influenced by, and influence, their preconceptions and representations of education in natural settings

benefits (Anderson et al., 2006), potentially setting off a virtuous cycle of educational offerings, combining outdoor and indoor experiences (Norðdahl and Jóhannesson, 2016).

Given that outdoor education is based on the idea that the various elements of natural settings are interconnected within a systemic whole, it is of key importance to examine teachers' ability to support their students in developing a systemic perspective. This was the focus of a study by Angelotti and colleagues on pre-service teachers' conceptualisations of science: authors called for teacher education to foster a more holistic approach to learning, which considers scientific knowledge as a tool for reconnecting with nature (Angelotti et al., 2009).

Other studies confirm that teaching confidence in promoting this holistic perspective and experience-based strategies are increased by training (Anderson et al. 2006, Zhai. 2012).

As observed by Angelotti et al., stimulating future teachers to get involved in and reflect on their knowledge acquisition process has further educational value because it provides them with an educational model replicable in schools. It is of great value for teachers to have a systemic overview of the connection between food products and primary sources and makes them able to guide their students to acquire this concept.

Other research focused on how teachers' preconceptions about outdoor learning can influence their students' likelihood of successful outdoor learning experiences. The teachers could fully understand the learning opportunity offered by gardening and they will be more likely to include this type of activity in their educational programs, especially in cases where they have some agricultural training (Blair, 2009; Fägerstam 2014; Harris, 2009; Knobloch et al., 2007).

Furthermore, when teachers have training background or a personal interest in farming/nature, they are more inclined to invite open and focused questions from their students and help children to develop more complex answers (Bowker, 2002). Nevertheless, research shows that teachers' interest in, and knowledge about, farming and nature is not enough to produce an effective learning environment, just as visits to outdoor settings do not guarantee, by themselves, that learning will take place (Smeds et al., 2015a).

By contrast, as pointed out by Smeds and colleagues and Kangas and colleagues, the teacher's role and the teaching-learning strategies deployed are crucial to achieving best practice and must be tailored to suit the specific farm setting and jointly planned with the farmer (Smeds et al., 2015b; Kangas et al., 2017).

The literature offers teachers some guidelines on how to make their outdoor/school education programs effective: the most successful outdoor learning projects are those in which learning products are not heavily emphasised, inductive teaching methods are used, an inquiring approach is stimulated (Bowker, 2002), open-ended questions are generated, and students actively participate and appear involved (Ballantyne and Packer, 2009, Jeronen et al., 2017; Kangas et al. 2017; Zhai, 2012). Inquiry-based learning is encouraged, first, by considering children's prior knowledge (Zhai, 2012), irrational conceptions (Smeds et al., 2015b) and misconceptions (Bowker, 2002).

This suggests the need, as also pointed out by Torquati and Ernst (2013), to design learning experiences in outdoor environments in which exploration is neither optional nor left to chance.

Figure 7

Summary table of the teaching strategies and teachers' competences

TEACHING METHODOLOGIES	TEACHERS' TRAINING	TEACHERS' COMPETENCES and ATTITUDES	CURRICULAR LINKS	CONCERNS AND BARRIERS
Inquiry based learning (Bowker, 2002)	Agricultural training for teachers is recommended (Knobloch et al. 2007)	Teachers' preconceptions and beliefs influence the success of outdoor learning experiences (Harris, 2009; Knobloch et al., 2007)	TEKS objectives and School gardening curriculum content (Klemmer at al., 2005)	Teachers perceive themselves as poorly informed about farming topics/environmental issues (Bowker, 2002; Knobloch et al., 2007; Marcombe, 2013; Tal & Morag, 2009)
Experience based learning (Ballantyne & Packer, 2009; Zhai, 2012)	Teaching confidence, holistic and experienced strategies increased by training (Anderson et al., 2006; Angelotti et al., 2009; Blair, 2010)	Teachers prior knowledge influences preconception of outdoor learning benefits (Anderson et al., 2006)	Cooperation with agricultural/enviromental experts facilitate the integration of outdoor learning activities with the school curriculum (Affolter & Varga, 2018; Trexler et al., 2000)	Teacher' lack of knowledge about local organizations, lack of equipment (Scott et al., 2015; Marcombe, 2013; Trexler et al., 2000)
Work in groups (Jeronen et al., 2016)	Training courses help teachers designing outdoor/classroom (Norðdahl & Jóhannesson, 2016; Tal & Morag, 2009, Smeds et al. 2015b)	Teachers' personal levels of nature relatedness predicted intention to outdoor teaching (Fägerstam, 2014; Torquati & Ernst, 2013)	Field trips, as complex learning settings, link the enviroment to the science curriculum (Tal & Morag, 2009)	Children health and safety (Scott et al., 2015; Marcombe, 2013; Trexler et al., 2000)
Multi-sensory learning (Smeds et al., 2015a)	Teachers asked for specific training (Trexler et al., 2000)	Educators need to integrate students' botanic garden experience with school subject knowledge (Zhai, 2012)		Cost and travel time (Harris, 2009; Marcombe, 2013; Scott et al., 2015; Trexler et al., 2000)
Pupils actively partecipation and agency (Jeronen et al., 2016; Kangas et al., 2017)	Courses recommended in order to provide appropriate supervision in natural environments (Torquati & Ernst, 2013)	Reflection and assuming responsibility: evaluating the process and results of their work (Vare et al., 2019)		
Interdisciplinarity (Vare et al., 2019)	Individual's predisposition to being outdoor influence openness to find value in training (Scott et al., 2015)			

6. Conclusions

The present literature review supported the definition of the key factors underpinning strong farm/school partnerships and effective outdoor education experiences: these provided the scaffolding for designing the next steps in the DEMETER project and include both broader educational principles that could be applied to outdoor education and ESD, and items that are specific to the farm/school partnership.

The topic of the farm-school relationship has led us to examine several issues that have implications for a broader range of learning environments - including other outdoor settings such as gardens and forests - and cover several learning goals and outcomes that are both subject-specific and transversal to environmental and sustainable education. Another key factor we address is related to teachers' competencies and teacher education in promoting outdoor learning activities.

Some of the weaknesses and gaps that we have identified had been already pointed out by previous literature reviews and advocate the need to focus future research on the following questions:

-How should teachers and farmers be trained to allow a meaningful and effective learning experience?

-How to consistently incorporate farm experience into school curricula?

-How to detect and assess academic and transversal learning outcomes in a systematic manner?

These questions informed the implementation of the set of key actions of the Demeter project:

- promoting training sessions involving both teachers and farmers strengthened farm-school partnership developing a common language and sharing educational goals while addressing logistical issues (like time, funds, seasonality…);

- supporting the pedagogical role of the farmer as a co-designer of the activities and improve teacher's confidence in their ability to manage farm visits and flexibly tailor their teaching practices;

- evaluating academic and transversal skills with coherent assessment tools highlighting the role played by both classroom-based and outdoor experiences.

An effective school-farm co-designed teaching strategy include also well-structured curricular links, consideration for students' and teachers' pre and misconceptions, expectations and fears. It needs time for hands-on experience, explanation, reconstruction, reflection, design and settings to promote inquiry-based learning.

These points of attention can also guide future research in monitoring the different factors that may impede or facilitate the implementation of effective farm-based learning activities and gathering others evidences and documentation to support the role of the farm as a meaningful learning environment.

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