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A CONCEPTUAL FRAMEWORK TO INVESTIGATE THE ROLE OF PEER LEARNING PROCESSES AT ON-FARM DEMONSTRATIONS IN THE LIGHT OF SUSTAINABLE AGRICULTURE

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ABSTRACT

Peer-to-peer approaches seem promising in enhancing sustainable agricultural systems. However, the kind of learning processes that underlie peer learning approaches have not been sufficiently studied in farmer-to-farmer settings. To answer the question how peer learning processes can foster farmer learning for sustainable agriculture, we will develop empirical research tools that can give us more insight into these processes as currently occurring in on-farm demonstration settings. In this explorative paper, we explore the common ground on how to design an integrative framework of effective farmer-to-farmer learning processes at on-farm demonstrations in the light of sustainable agriculture. During the in-depth literature search, we focussed on three main subfields in scientific literature addressing effective learning processes: peer assisted learning (PAL) process model, adult learning theory and education for sustainable development (ESD). We link effective learning processes supported by these three subfields with findings from previous research on farmer-to-farmer practices. The comparison of the three subfields led to a conceptual framework with core interacting effective learning processes defined as engagement, interactive knowledge creation and initiated communication, fostering cognitive conflict and critical reflection.

Keywords: On-farm demonstration, peer learning, learning processes, adult learning, education for sustainable development.

INTRODUCTION

The request for agricultural development to ensure the promotion of an economically, socially and environmentally sustainable future is urgent and worldwide (International Assessment of Agricultural Knowledge Science and Technology for Development (IAASTD), 2009). In 'The Future we want' (United Nations, 2012), agricultural research, extension services, training and education to improve agricultural productivity and sustainability through the voluntary sharing of knowledge and good practices is described as a necessity. Similarly, different international sources

(IAASTD, 2009; United Nations, 2012) call for the empowerment of farmers and enabling them to link their own local knowledge to external expert and scientific knowledge for innovative management. This call arose from the unfortunate finding that best practices regarding innovative agriculture still often remain tacit knowledge within local communities and are not well spread across the EU territory or made known to researchers (European Union, 2017). Efficient, durable strategies for knowledge dissemination and, even more, (co-)creation among farmers and other specialists concerning agricultural innovations is essential to answer that call (EIP-AGRI, 2015).

Regarding the effectiveness of peer learning in the farmer community, research on the adoption and

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diffusion of innovations has consistently confirmed that one of farmers' most commonly cited sources of information and ideas are other farmers (Oreszczyn *et al.*, 2010; Rogers, 1995). Farmers tend to be most influenced by proof of successful farming methods that is showed and explained by other farmers (Hamunen *et al.*, 2015; Kilpatrick & Johns, 2003; Schneider *et al.*, 2009; Warner, 2007). This kind of research also suggests that farmers are open to and value the practice of peer learning. It is not surprising then that already numerous examples of peer-to-peer training movements have developed worldwide in the farmer community. Apart from Farmer Field schools (FFS), started around the 1980's and based on adult learning theories and learning-by-doing (Feder *et al.*, 2004), the "campesino-a-campesino" (farmer-to-farmer) movement has promoted agro-ecological techniques over the past 35 years in Latin- America. Another but smaller European example is ALMO. This is an Austrian bottom-up farmer's initiative, concentrating on sustainable Alpine oxen beef farming (Karner, 2009). The initiative covers multiple practices that include peer learning, and it is important to emphasize here, that peer learning is thus not merely a single practice. It covers a wide range of different activities, each of which can be combined in different ways in order to suit the characteristics of a particular learning setting (Topping, 2005). The question we ask ourselves here is what the characteristics are a peer learning practice requires to enhance effective learning. Which processes make peer learning between farmers at on-farm DA's stand out from the traditional learning methods at DA's?

Furthermore and despite the firm establishment of peer learning in research literature and in agricultural practices (EIP-AGRI, 2015), Emerick *et al.* (2016) states that there is still room for improvement and thus that farmer-to-farmer learning can become more effective. Simply relying on farmers to share information with peers without any further intervention might sound empowering, but will more realistically damper adoption of improved agricultural technology. An increased understanding of peer learning processes could help to develop institutions and programs that can foster innovation dissemination and learning for sustainable practices in agriculture (Lankester, 2013).

The aim of this paper is thus to reflect on relevant theories capturing effective learning processes related to peer learning between farmers at on-farm

demonstrations with the potential to foster learning for sustainable agriculture. The result is a conceptual framework with core interacting learning processes that are supposed to effectively support learning outcomes in the outlined context of on-farm demonstrations. Although the framework points to the specific conditions of a DA, this paper will not focus on the structural and functional characteristics of a DA. This is done in other papers, respectively by Pappa *et al.* (2018) and Ingram *et al.* (2018). We will use this framework for data gathering in multiple case studies via interviews and observations.

We start this paper explaining shortly our methodology. Secondly, we elucidate how the concept of effectiveness is interpreted in this research, building on the concepts of adoption and diffusion (Rogers, 1995) and single (SLL) and double loop learning (DLL) (Argyris & Schön, 1996). Third, we explore learning processes within three different relevant subfields of scientific literature, referred to further in this paper in short as 'subfields'. In conclusion, we present the main corresponding learning processes between the different subfields, suggested to support effective learning by both theory and practice, in a farmer-to-farmer learning environment during an on-farm demonstration.

METHODOLOGY

This paper is preceded and based upon an exploratory narrative conceptual literature review. Scientific databases we used included Web of Science, KU Leuven online library and Google Scholar. We started by combining the terms 'peer learning processes', 'farmers' and 'sustainable agriculture' using Boolean operators. This search revealed no one theory or conceptual framework of farmer-to-farmer learning claiming to cover the most relevant learning processes and their characteristics during a DA. Therefore, we decided to determine and start from main subfields in literature on learning environment and it's characteristics at stake for farmers. The three main subfields we focussed on are: peer learning, learning for sustainable development (in agriculture) and adult learning. We added this third focus on 'adult learning' since this target group of adults is mostly not explicitly elaborated on in educational research literature on peer learning. Often peer learning literature is focussing on classroom settings for minors. A narrative conceptual literature review for each main subfield using the same databases was carried out (1980-present), eliminating irrelevant fields (such as

medicine and computer technology). For each of the subfields, we came to descriptions of effective learning processes. We compared these emerging descriptions and decided on which ones we had to take into account in relation to our particular focus on peer-to-peer learning of farmers during a DA.

View on effectiveness: Effectiveness in a broad sense refers to ‘proving’ that something has worked, and is an improvement compared to a previous situation. However, this concept is especially problematic to grasp for learning settings such as on-farm demonstration activities. These activities are relatively small-scale and often short-lived events, and commonly organized in a context of limited resources (OECD, 2013).

‘Effectiveness’ in education has different interpretations. Much of the work in the search for measurable links between educational practices and outcomes, becomes highly reductionist both in terms of the range of contemporary educational practices as in terms of the kind of learning outcomes that are taken into account (OECD, 2013). Effectiveness can be interpreted in many different ways. For example, it can be interpreted as the level of engagement (e.g.: extent of learning understood as attendance numbers, efforts participants make to take part...), as ‘value-added’ assessments and measurements (e.g. the extent of learning understood as number of participants stating having learned something because of the on-farm demonstration, and indicators on ‘how much’ they’ve learned) and as adoption rates (putting into practice what was learned). Researchers are obligated to make decisions on which variables to take into account and on which to exclude when investigating effectiveness. This is necessary because it’s practically impossible to include every influencing variable and possible outcome in a learning system.

Building upon the experience of Bailey *et al.* (2006), we decided to look at learning effectiveness through the concepts of the extent and nature of learning. The extent can be addressed by numbers of for example participants stating they have learned something after the DA took place. Additionally, the amount of participants expressing change in behaviour or practices at their own farm and the extent of the change(s), (partially) due to the DA, will count as effectiveness variables and are addressed with the term ‘adoption’ (Rogers, 1995). However, also participants stating for example not having made any changes on their farm as the result of a careful examination process, including the

knowledge gained at the DA, should be seen as an outcome related to adoption and thus effectiveness. To complete the picture, we are also interested in the spreading of knowledge and skills in relation to attendance at a DA. How many participants acknowledge, after some time, having learned something because of the DA, and did participants also talk about the DA to people who didn’t attend the DA? The latter refers to the term ‘diffusion’ (Rogers, 1995). In other words, we’ll investigate both the level of adoption and diffusion of knowledge and skills by participants, supported by the attendance at a DA. This is then different from a focus on the mere adoption or diffusion of farming practices as such.

In addition to the extent of learning and in relation to the nature of the learning process, we will also focus on the appearance of different levels of learning as defined by Argyris & Schön (1996). They defined different ‘levels’ of learning as single and double loop learning, which in practice are often intertwined. Single loop learning (SLL) refers to acquiring factual knowledge and developing skills in order to manage problems on a daily basis (e.g. knowing how to apply an irrigation scheme/technology or pesticide). Building on SLL, double loop learning (DLL) explores the underlying values and assumptions, and requires critical reflection on the processes by which learning takes place. This refers to a deeper level of learning, requiring metacognitive skills to develop an awareness of own thinking and learning how to learn (E.g. getting insights in the question: “Why is my farming system the way it is and should I change my farming system?”).

A critical note is made by Siebenhüner *et al.* (2016) regarding this distinction. Their research showed a high level of popularity of Argyris & Schön’s (1996) model, being frequently used for the analysis of learning process dynamics and outcomes of social learning, and according to our definition, peer learning can be understood as a more specific kind of social learning. Despite this, their research states that: “while the model is useful for developing explanations, future research is needed to better understand the connections between learning processes and expected outcomes, as this information would allow comparisons between interventions.” This supports our choice to investigate different carefully specified (peer) learning processes in relation to SLL and DLL outcomes. Deeper insights in the relation between specific learning processes and SLL

and DLL outcomes can support not only more thorough comparisons between DA designs, but also the design of more effective DA's in the future. We will discuss both SLL and DLL further in depth in each of the three main subfields we present in the next sections.

The relevance of peer learning between farmers: To grasp the relevant peer learning processes at stake in this learning environment, embedded in the modern paradigms of agricultural innovation and sustainable agriculture, we first explore the concept of peer learning and its processes in educational and agricultural literature.

The concept of peer learning between farmers suggests a two-way (or more), reciprocal learning experience. One farmer can be more knowledgeable on a certain topic, but can still learn through explaining, listening, discussing and working together with the other, who might be more knowledgeable on another topic. This reciprocity presents a first important shift with traditional learning. It requires initiative, active participation and engagement of the learner towards his own learning process. This is in contrast with the more traditional 'transfer of knowledge' view, where the teacher (usually researchers in this context) doesn't expect input by those listener-learners and that can also significantly change the focus of the learning process. For peer learning to succeed, a certain autonomy regarding the own learning process is thus needed. Cooper (2002, p.54) addressed this feature by explaining: "Peer learning represents a major shift in focus from what is being taught to what is being learned, and transfers great responsibility for knowledge acquisition, organization, and application from the teacher to the student". This responsibility requires autonomy and initiative towards learning manifested by learners themselves, in other words, it reflects being in charge of their own learning. This concept is addressed as 'ownership' of the learning process by the learner, and it is an important characteristic in comparison with more traditional learning approaches. As an example of research supporting a peer learning approach between farmers, Curry et al. (Curry et al., 2012) reports on the importance of networks in which farmers develop knowledge and innovation from the 'bottom up', through mechanisms of sharing experiences and learning together.

Furthermore, peer learning, in educational theory, involves learners learning from and with each other on a

scale anywhere between informal and formal learning. Acknowledging the importance of informal learning, usually harder to investigate than formal and structured learning contexts, and also often neglected in research on agricultural knowledge sharing (Mars & Ball, 2016), this represents a challenge compared to more traditional assumptions on where and how effective learning takes places.

Additionally, the emphasis in peer learning is on mutual learning since the roles of teacher and learner, commonly referred to in educational literature as respectively tutor and tutee, are not necessarily defined as such and can alternate throughout the learning experience (Boud *et al.*, 1999). This results in the recognition of the learning experience being valuable for the tutor too, not only through having to explain the content, but also potentially through thoughts and insights shared by the tutee, previously unknown to the tutor.

One of the most cited, recent articles when reviewing educational literature on 'peer learning' is 'Trends in peer learning' by Topping (2005) which contains the 'Peer assisted learning' effective processes model of Topping & Ehly (2001). Other frequently cited authors like David Boud (Boud *et al.*, 1999) focus more on peer assessment or other aspects linked with peer learning. This is in contrast to Topping & Ehly (2001), who try to get a holistic overview of the processes underlying peer learning. Such an overview applicable to our learning context would be a useful starting point in the attempt to reach our main goal. Topping & Ehly (2001) describe 'Peer assisted learning' (PAL) as group of strategies that involve the active and interactive mediation of learning through other learners who are not professional teachers. In doing so, PAL distinguishes itself as a peer learning practice between equals, stressing not being a surrogate to professional teaching, but consisting of structured activities by teachers, wherein both tutor and tutee have the opportunity to learn with each other. Since we assume that demonstrations are organised and somehow structured on beforehand, peer assisted learning strategies can be part of the organised demonstration and are more likely to be deliberately included in the instructional design of a DA. This is then different from peer learning activities that are informal, unstructured and unplanned. They undoubtedly occur too, but are a lot harder to map, let alone intentionally organise and study. As Emerick *et al.* (2016) mentioned,

deliberately supporting farmers (or others) to share knowledge might do adoption of new knowledge and skills good, and could assist knowledge co-creation processes.

Literature (Topping, 2005) also shows that the learning process usually starts off for both tutor and tutee unconsciously. When the learning relationship develops, both tutor and tutee can become more aware of what is happening in their learning interaction. This makes both more able to monitor and regulate the effectiveness of their own learning strategies in different contexts, which reflects the process of DLL. This development into fully conscious explicit and strategic metacognition not only promotes more effective onward learning, it should make tutor and tutee more confident that they can achieve even more, and that their success is the result of their own efforts, strengthening the process of ownership (Topping & Ehly, 2001). Topping & Ehly (2001) synthesised the existing research on PAL into a single theoretical model of processes influencing effectiveness (Theoretical underpinnings of Peer Assisted learning; as described in Topping, 2001). Based on their extensive literature review, they defined five categories of 'core' processes: structural and organisational features, cognitive conflict, knowledge scaffolding, communication, and affect. Next, we discuss each of these processes, while complementing them with theoretical insights based on previous research on DA's. The first group of processes 'Structural and organisational features' of the learning interaction, includes the time needed for the learner to spend on a learning task (the so-called time on task (t.o.t.)), , the relevance for both parties to elaborate on goals and plans, the individualisation of learning and immediacy of feedback, which is more feasible within small groups of learners or in one-on-one situations. The individualisation of learning is understood as addressing prior knowledge of a learner and finds its relevance in relation to the concept of ownership of the learning process. In other words: the more a learner feels his prior knowledge seems relevant in a learning situation, the bigger the chance that he will feel motivated to take action towards learning within this learning situation. In this paper, we focus on the learning processes more than on the 'enabling environment conditions', since another complementing paper discusses this in-depth (Ingram *et al.*, 2018) as a part of the AgriDemo research framework (Koutsouris *et al.*, 2018).

Secondly, qualitative peer learning activities can question and challenge mental models of the engaged learners. This process is referred to as 'cognitive conflict' (Topping & Ehly, 2001). After experiencing a 'cognitive conflict', a learner can feel stimulated to think critically about his way of looking at reality. This leads to more deep-level learning (Ashwin, 2003), such as DLL (Argyris & Schön, 1996). This cognitive process reflects ideas of social cognitivists with Piaget as a leading theorist (Tudge & Winterhof, 1993) and Mezirow on transformational learning (1991). An effective strategy for surfacing and potentially changing prior knowledge, supporting SLL, involves confronting learners with situations that enable them to experience a 'disorienting dilemma' or 'cognitive conflict' (Mezirow, 1991). This might be caused by a person acting in a way that is unexpected, or by the presentation of a carefully designed science demonstration (e.g. on-farm demonstration) that cannot be explained in the usual way. The subsequent confusion causes the learner to doubt his or her prior knowledge or to discover a certain lack of knowledge. In this way, new knowledge is able to influence former knowledge, leading further into deeper levels of learning (Grudens-Schuck *et al.*, 2003) and facilitating different learning outcomes. According to Mezirow (2000) critical reflection is fostered by 'cognitive conflict' and involves reframing of assumptions made by others and made by our own, and thus a key process fostering DLL.

Third, and following cognitive conflict, knowledge scaffolding (Vygotsky, 1978) refers to a constructivist view on learning, which equates learning with creating meaning from (social) experiences (Ertmer & Newby, 2013). Knowledge scaffolding addresses the mediation of learning content. This means offering the content in chunks that are small and clear enough to be apprehensible for the learner, but still causing the learner to reach a new level of knowledge or skill, with the help from a more competent other. To successfully scaffold knowledge, it's important that the learning content or activities take place right above the current 'level' of the learner, meaning that with some assistance, the learner can reach the next level. This refers to the 'zone of proximal development' (ZPD) as defined by Vygotsky (1978) in a social constructivist way.

Fourth, peer learning inevitably addresses communication skills of peers learning from each other. Someone might never have truly grasped a concept until

having to explain it to another, converting thought into language, which is a Vygotskian idea. Listening, explaining, questioning, summarising, speculating, and hypothesising are all valuable skills. Scientific evidence confirms that teaching is a great way to learn (Duran, 2017), which again confirms that also the tutor, more knowledgeable peer or e.g. farmer-demonstrators in our case, can learn effectively within peer-to-peer learning approaches.

Fifth, the affective component proves very powerful here. Success is frequently attributed to the empathetic relationships inspired by credible peers who participants trust based on familiarity and similarity compared with their own background (Ashman & Gillies, 2003). The 'stronger' peer's modelling of enthusiasm, competence, and the possibility of success can influence the self-confidence of another peer (Topping & Ehly, 2001). A sense of loyalty and accountability to each other might help to keep the peers motivated. A big challenge within our research context, referring to this affective component, lies in the creation of a trusting environment where farmers feel safe to share their positive and negative experiences (EIP-AGRI, 2015).

Considering these underlying processes, peer-to-peer approaches at on-farm demonstrations seem promising to be part of durable strategies for knowledge sharing and co-creation between farmers. Apart from ownership, it requires engagement and communication between the learners about the learning content (Topping & Ehly, 2001). These processes foster improved understanding of the learning content (SLL) (Murphy, 2010), and support awareness and critical reflection (DLL).

Farmers as adult learners: To decide on the inclusion of thoughtful insights from a second relevant scientific subfield, we critically considered what particularly distinguishes the learning situation of a DA from an 'usual' educational environment. Since much of the educational literature addresses minors as target group, we decided it would be relevant to take into account the characteristic that our target population consists of adults. Therefore, we took a closer look how the widespread Andragogical model from Knowles (1980) proved to be of relevance concerning the design of a (peer) learning initiative for adult farmers. The four adult learning principles described by Knowles and explained below are: ownership, experience as the basis for learning activities, subjects that have immediate relevance and impact to their job or personal life and

pragmatic problem-centred rather than content-oriented.

First, when we put Knowles' principles into practice in our context, the learning of farmers should be self-directed and fostering learner autonomy. An example is that farmers are involved in the planning and evaluation of their instruction, fostering their sense of ownership regarding their learning and supporting a bottom-up approach. That these principles also counts as relevant and effective for farmers is already stated and supported by Millar & Curtis (1997). They developed a framework presenting critical factors in social learning between farmers, based on case studies.

Secondly, effective and preferred farmer learning processes are often characterized in agricultural literature as experiential (Kolb, 1984) or as learning-by-doing (Dewey, 1938) (Millar & Curtis, 1997; Lankester, 2013). Hands-on experimenting proved to effectively mediate knowledge and skills, as is one of the principles of Knowles. Some criticism on experiential learning is worth mentioning here, with the context of DA's in mind. The acknowledgement that individual learning is always connected to a complex and varied social, cultural and physical processes, in which the individual actively participates (Loeber *et al.*, 2007) is too important to ignore. The experiential learning cycle by Kolb (1984) lacks the recognition of the importance of the embeddness in social learning to our point of view. To bear in mind social learning processes is crucial to be able to take on a more holistic perspective on relevant learning processes.

Third, like other adults, farmers have different goals and values which are influenced by a range of personal, social, cultural, physical and economic history, current factors and capacities (Pannell *et al.*, 2006). This implicates that demonstration activities should be aware of the immediate relevance for the multiplicity of life worlds, interests and many frames of meaning in the farming community. The ability to link new knowledge to prior knowledge of the farmer supports thus the learning process and is also emphasized in adult learning theories (see also Brookfield, 1995).

Fourth, pragmatic problem-centred rather than content-oriented links with the previous principles of the learning content being of immediate relevance and an experimental interactive approach during the demonstration. Addressing real problems that fit the needs of the attending farmers during DA's is an

effective characteristic that is mentioned by multiple previous studies (Bailey *et al.*, 2006; Millar & Curtis, 1997; Hancock, 1997). Additionally Millar & Curtis (1997) found that the emergence of local knowledge benefitted from interactions between different stakeholders. These interactions were highest when hands-on activities were used, the complexity of issues was addressed, time for dialogue was allowed and when actual on-farm figures were used. Lankester (2013) stated that beef producers main learning sources were their own experiences, observing others' practices and sharing experiences with peers and family members. This indicates that active authentic experimentation and seeing real life examples are preferable learning methods. Allowing the participants to think for themselves by giving them a problem to solve, instead of transferring knowledge unidirectionally is thus seen as more effective.

On-farm peer learning for sustainable agriculture:

Learning for sustainable agriculture during DA's can be intentional as well as unplanned or not present at all. However, since the explicit call for knowledge sharing on farming for sustainable development (IAASTD, 2009; United Nations, 2012), we decided to include learning (processes) for sustainable development in agriculture as a third subfield. So how can we unravel the role of peer learning processes at on-farm demonstrations in effective learning for sustainable agriculture? That's the main question we seek to address by including this third scientific subfield.

An influential and elaborated definition constructed by UNESCO (2010) determines agriculture as sustainable when it leads to long-term farm profitability, improvements in the quality of life of farming families, the vitality of communities and the protection and conservation of the natural environment, especially soil, air and water. It should consider a future perspective but also include the wisdom from the past, the impacts of transporting food to markets, the social and environmental costs of food processing, the health of the people involved and the quality of the food.

Additionally, sustainability is often graphically represented around three linked dimensions or pillars: economic, social and environmental (Tavanti, 2010). Tilbury (2011) comments on this model by stating that "although sustainability does promote holistic thinking, this representation is a simplification. It is more about transforming current systems than about merely linking

them. Sustainability is about challenging our mental models, policies and practices." Notably, that's what DLL, and further along the process triple loop learning (TLL) (Diduck *et al.*, 2012) and transformative learning (Mezirow, 1997), is about. An additional note made by Wals *et al.* (2007) points out that each of these three dimensions may be understood in various ways, regardless of the domain it's been applied to, such as agriculture. This balancing between three domains is inherently ambiguous: sustainable development may accommodate potentially conflicting values, beliefs and points of view on what is the desirable and feasible thing to do. Taking a closer look at sustainability in literature, it appears to be an "inevitably ill-defined and ill-structured concept, representing what some refer to as wicked problems" (Gibson & Fox, 2013). These are problems that have no single generalizable 'right or wrong' solution, are ambiguous and submerged in conflicts of interest among multiple stakeholders. This reflects why learning about and teaching sustainable agriculture can be seen as an educational challenge (Wals *et al.*, 2007).

What we found interesting and relevant to our focus and purpose, is the expert review that Tilbury (2011) has conducted on processes and learning related to sustainable development. Often learning in ESD is interpreted as "gaining knowledge, values and theories related to sustainable development", but this expert review shows that also learning to ask critical questions, envision more positive futures, clarify one's own values, think systemically, respond through applied learning opportunities, and to explore the dialectic between tradition and innovation are crucial. Furthermore, Tilbury (2011) defines key processes underpinning ESD frameworks and practices: processes of collaboration and communication (including multi-stakeholder and intercultural dialogue), processes which engage the 'whole system', processes which stimulate innovation within curricula as well as through teaching and learning experiences and processes of active and participatory learning. We will elaborate on these key processes to find out how these can be translated to the learning context of DA's.

The common ground between processes of communication between peers and processes of dialogue and collaboration in ESD is obvious. According to Keen, Brown, & Dyball (2005) effective learning dialogues need to be processes that create the space and

time for a range of different types of dialogue, characterised by an open, explorative and listening approach (Bohm *et al.*, 2004). Interestingly, Dyball, Brown & Keen state in Social learning towards a sustainable world (Chapter 9, Wals *et al.*, 2007) that “competing opinions and evidence are to be welcomed as creating the conditions for generating new knowledge“. Research of Beers, Mierlo, & Hoes (2016) supports the statement that ‘antithetical interactions’ potentially create strong learning opportunities. Brown *et al.* (1995) already took a positive perspective on conflict regarding learning. They claim “that conflict is an inevitable part of change and a step towards a solution. Conflict is a shared process and should not be seen as the sole responsibility of any one person or group or as an excuse.” Another similar important aspect here is the involvement of the viewpoints of all actors in dialogue and collaboration, this presents a crucial element in learning for wicked problems such as sustainable agriculture issues (Dyball *et al.*, in Chapter 9, Wals *et al.*, 2007).

The processes referring to engaging the ‘whole system’ means in our context that not only specific learning approaches and techniques used during the DA deserve attention, but that the involvement of multiple stakeholders in different levels of the organisation of a DA are important regarding the effectiveness of a DA. Since this refers to the enabling environment, it will not be a point of discussion in this paper, but in the

complementary paper of Ingram *et al.* (2018).

With regard to processes which stimulate innovation within curricula, Tilbury (2011) says: ‘ESD learning is sometimes interpreted as the process of gaining knowledge, values and theories related to sustainable development, but it also prioritises the changing of mind-sets and active engagement of the learner in matters relating to more sustainable futures.’ The latter refers to reflecting on the ‘way we are doing things at the moment’ and the ability and responsibility to change these current ways if they do not prove to be effective enough. This asks for DLL and TLL and thus a transformative process of learning as a possible indication of effectiveness in learning for sustainable development.

Finally, processes of active and participatory learning reflect again the already mentioned concepts of active, engaged, hands-on learning and ownership. The learner is required to participate and interact, in contrast to passively soaking up ‘transferred’ knowledge.

Towards a conceptual framework: Based on the three scientific subfields discussed above, we first present an overview of the most important learning processes and characteristics in table 1. To guide further research within AgriDemo-F2F and beyond, we reflect upon the three scientific subfields and define clusters of similar processes. These processes form the foundation of a conceptual framework of core interacting effective learning processes, relevant to learning context of DA’s.

Table 1. Learning processes supporting effectiveness derived from main subfields.

	Main Builders		
Key processes	ESD: Key processes in Education for sustainable development (Tilbury, 2011) collaboration and communication stimulation of innovation in curricula Active and participatory learning	Adult learning: The Andragogical model (Knowles, 1980) Ownership based on experiences Immediate relevance problem-centered	Peer assisted learning model (Topping & Ehly, 2001) cognitive conflict scaffolding and error management communication affect
Enabling environment	engaging the whole system*	call for input (ownership)	organization and engagement

*Not within the scope of this paper. See Ingram *et al.* (2018).

To summarize the literature review, the three subfields (ESD - Tilbury, 2011; andragogy - Knowles, 1980 and peer assisted learning - Topping & Ehly, 2001) show a lot of similar ideas, concerns and focus points on what would be considered effective learning processes, as presented in Table 1.

This observation led us eventually to the definition of the effective core processes as: engagement, communication initiation and interactive knowledge creation. All three contain processes addressed by all three subfields, as presented in table 2. In this table, we also refer to exemplary supporting references. Some of

these were found in research literature on farmer practices, as an addition to the more theoretical perspectives derived from the scientific subfields.

The core processes thus each contain elements of effective processes suggested by the three subfields. 'Engagement' contains the needed trustworthiness of the peer and his knowledge. Conceiving the learning environment as informal is closely related to the concept of trust so we decided to cluster these together. Our hypothesis is that both aspects are beneficial to feeling engaged and thus support learning outcomes. Additionally, we propose the perceived level of ownership and participation related to the own learning process as two factors contributing to learner engagement. With the core process 'communication initiation', we cluster sharing knowledge, formulating own values and formulating questions as factors contributing to an effective learning experience. The ability to communicate own thoughts is strongly related to learning (Vygotsky, 1978) and a starting point for peer learning and processes of communication (ESD, Tilbury, 2011). Autonomy and self-direction towards the learning process which is claimed to be important for adult learners, is reflected in the 'initiation' of the communication. Our hypothesis here thus suggests that DA's could be more effective if the DA somehow supports learners to initiate communication themselves. As a third core process we chose the concept of interactive knowledge creation to capture the the importance of hands-on experimentation, open discussion, negotiating conflict and scaffolding knowledge. They all include interaction through which knowledge can be shared.

By building upon these core processes, cognitive conflict and metacognition as effective learning processes can be induced, and can provide both immediate learning

opportunities (SLL) but also allow reflection (DLL). Since we believe SLL and DLL are stimulated by certain conjunctions of the three core concepts we placed these learning outcomes in the center of the framework.

We put forward cognitive conflict as a strong inducing process for DLL (PAL; Topping & Ehly (2001), based upon Mezirow on transformational learning (1991)). Cognitive conflict refers to the process of learners being confronted with information that doesn't stroke with their own previous knowledge and believes, through for example a new demonstration or discussion. People can learn effectively from a similar surprising experience. Metacognitive skills and DLL put critical reflection forward as an important process. Critical reflection fostered by for example questions, discussions and cognitive conflict can improve awareness of underlying values connected to the topic and awareness of the own learning process (Mezirow, 2000; Grudens-Schuck *et al.*, 2003). Peer learning gives rise to more meta-cognitively skilled and self-regulated learners, reflecting the important adult learning principle of ownership (Knowles, 1980). Adoption and diffusion are defined as learning outcomes demonstrated mainly after attending DA's, therefor we placed these outside the core circle. Since effective learning is often characterized by some change in knowledge, skills and/or behavior, we aim to investigate the link between the core processes and the four learning outcomes defined as: SLL & DLL and the adoption and diffusion of what is addressed during the DA. Therefore, we constructed a conceptual framework showing the interrelations between the key processes and the key aspects they contain as defined in this paper (Figure 1). Obtaining better insights in how these core processes relate to the learning outcomes will be an important focus of future research based on this framework.

Table 2. Constructed core processes and key aspects relevant in the AgriDemo-F2F research context.

Core processes	Key aspects	Exemplary subfield	Exemplary supporting references
Engagement	ownership	Adult learning (Knowles, 1980); PAL (Topping & Ehly, 2001)	(Curry <i>et al.</i> , 2012)
	participation	ESD (Tilbury, 2011)	(Warner 2007; La Grange <i>et al.</i> , 2010; Kenya Market Trusts, 2016)
	trust	PAL (Topping & Ehly, 2001)	(Ashman & Gillies, 2003; EIP-AGRI, 2015)
	informality	PAL (Topping & Ehly, 2001)	(Wood <i>et al.</i> , 2014; EIP-AGRI, 2015)

Communication initiation	sharing knowledge	Adult learning (Knowles, 1980); ESD (Tilbury, 2011); PAL (Topping & Ehly, 2001)	(United Nations, 2012; Curry <i>et al.</i> , 2012)
	formulating own values	ESD (Tilbury, 2011); PAL (Topping & Ehly, 2001)	(Vygotsky, 1978; Mezirow, 2000)
	formulating questions	ESD (Tilbury, 2011); PAL (Topping & Ehly, 2001)	(Mezirow, 2000; Grudens-Schuck <i>et al.</i> , 2003)
Interactive knowledge creation	hands-on opportunities	Adult learning (Knowles, 1980)	(Dewey, 1938; Millar & Curtis, 1997; Lankester, 2013)
	knowledge scaffolding	PAL (Topping & Ehly, 2001)	(Vygotsky, 1978)
	Open discussion	ESD (Tilbury, 2011); PAL (Topping & Ehly, 2001)	(Bohm <i>et al.</i> , 2004)
	negotiating conflict (to arrive at consensus)	ESD (Tilbury, 2011)	(Wals <i>et al.</i> , 2007; Beers <i>et al.</i> , 2016)

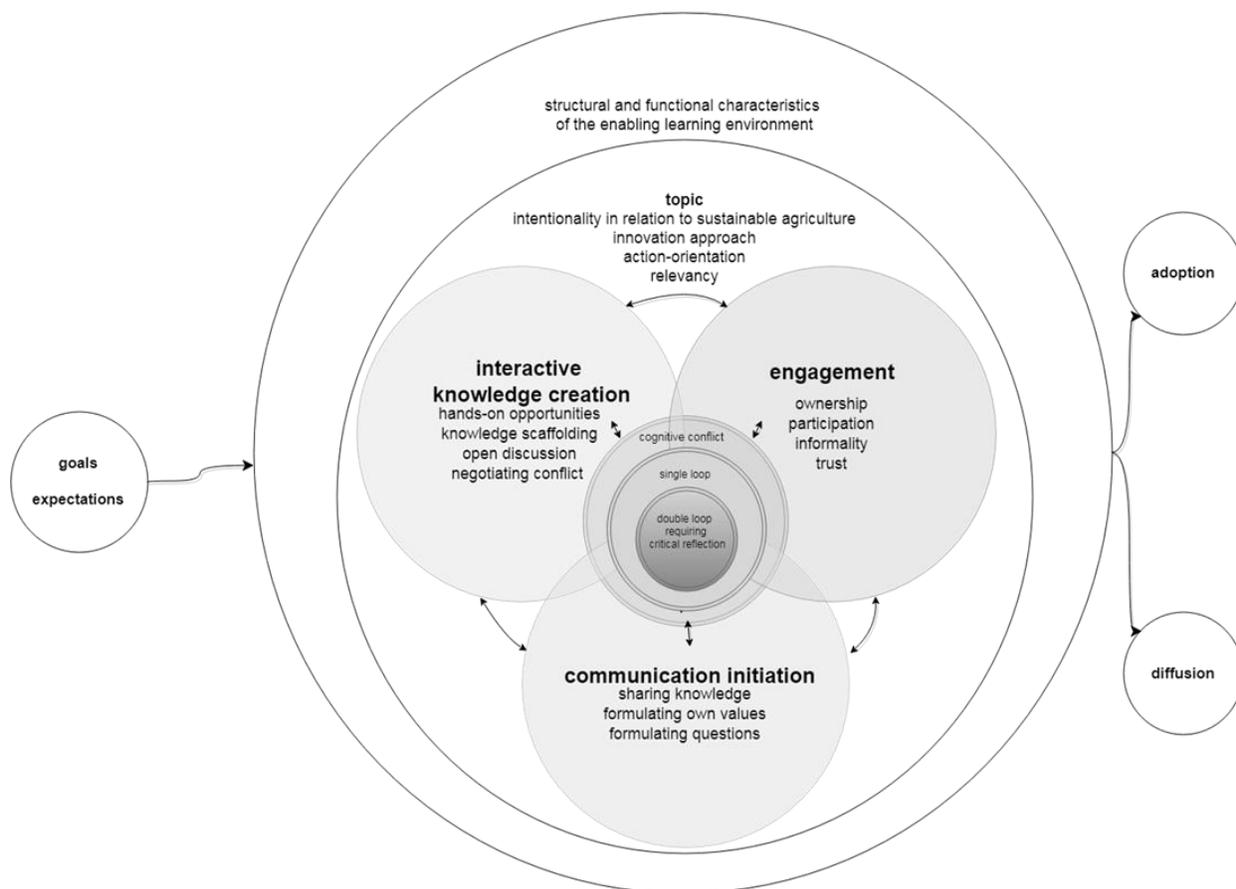


Figure 1. Conceptual Framework.

Next steps: The conceptual framework will allow us to investigate, and reflect upon, the dynamics between the present learning processes and the four learning outcomes defined as SLL, DLL, adoption and diffusion. Since the core processes are specifically constructed for the sake of our context and focus, they should not be considered covering every possible effective learning process or as stand-alone processes. Furthermore, a measuring instrument is constructed

based upon the theory represented in the developed conceptual framework as presented in Figure 1. This measuring instrument is pilot tested for the case studies (including DA's) selected from the inventory of farms conducting demonstrations in Europe, developed in 2017-2018 by the AgriDemo-F2F and PLAID project. The selection and conduction of the case studies will take place between April 2018 and October 2018. The analysis of these case studies will be used to validate and revise

the proposed conceptual framework.

CONCLUSION

To be able to investigate peer learning between farmers during on-farm demonstrations, we defined and constructed a conceptual framework. To build the underpinning of the framework, we compared three main subfields relevant to our research focus: adult learning, peer learning and education for sustainable development. Theoretically, we see that peer (assisted) learning shares similar ideas on effective learning processes with education for sustainable development processes and adult learning processes. They all foster 'soft' skills, such as engagement regarding the own learning process, which are needed for effective participation in our 21st century knowledge society, and for creating sustainable development opportunities (Topping *et al.*, 2017). Based on the comparison, we constructed and defined the effective core processes as: engagement, communication initiation and interactive knowledge creation, each with different defined key aspects. At the center of our framework we included SLL and DLL as learning outcomes mainly related to the individual learner and situated during the DA. Outside the circle of effective processes, we added adoption and diffusion as two additional learning outcomes, mainly happening after the DA took place.

Next steps will include the development of an instrument to investigate real on-farm demonstration farmer-to-farmer learning situations. With this tool, we aim to get in-depth insights in how these processes relate to the defined learning outcomes. This is the first time, to our knowledge, that peer (assisted) and adult learning processes as understood in educational literature will be investigated to this extent in a practice context of on-farm demonstrations, and in the light of learning for sustainable agriculture.

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