# Development process of 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 appraches 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 work towards an integrative framework of effective farmer-to-farmer learning processes at on-farm demonstrations in the light of sustainable agriculture. Based on this framework, an instrument to investigate case studies will be developed in a next step. In this theoretical paper, we show the common ground between effective processes as found in our literature research on three main scientific fields we describe as our three main 'building blocks': peer assisted learning (PAL) process model, adult learning theory, education for sustainable development (ESD). We link these theories with supporting previously investigated farmer-to-farmer practices. The comparison of the three building blocks led to core interacting effective learning processes defined as engagement, interactive knowledge creation and initiated communication, fostering cognitive conflict and critical reflection, which support single loop learning (SLL) and double loop learning (DLL), and subsequently adoption and diffusion.*

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

*A list with abbreviations is provided in Appendix A*

## Introduction

We determine the request for agricultural development to ensure the promotion of an economically, socially and environmentally sustainable future as urgent and worldwide, as indicated by different international bodies (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 (International Assessment of Agricultural Knowledge Science and Technology for Development (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 (e.g.: of soil fertility, crop genetic diversity, and natural resources). Efficient, durable strategies for knowledge dissemination and creation

among farmers and other specialists concerning agricultural innovations is essential to answer that call from our point of view.

Unfortunately, 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). Furthermore and despite the firm establishment of peer learning in research literature and in agricultural practices (EIP-AGRI, 2015), Emerick, Janvry, Sadoulet, & Dar (2016) states that there is still room to find ways to make farmer-to-farmer learning more effective. Simply relying on farmers to share information with others without any further intervention will 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). This explains why within the European Horizon 2020 research program, two similar projects have been granted funding: PLAID and AgriDemo-F2F[1]. They focus on the learning effectiveness of demonstration activities (DA) within the commercial farming community to foster improvement of farmer-to-farmer learning on demonstration farms in Europe. This exploratory and theoretical paper is based on research done within the AgriDemo-F2F project and complements two other papers in this IFSA session which examine the functional and the structural enabling environment of on-farm demonstration activities (Ingram et al., 2018 & Pappa et al., 2018).

Theories capturing effective learning processes related to peer learning between farmers at on-farm demonstrations with the potential to foster learning for sustainable agriculture are explored and discussed in this paper. The main goal is to search for and capture the learning processes suggested to be effective in our research context. Therefore, we start this paper explaining shortly our methodology. Secondly, we address how we view the concept of effectiveness 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 branches of scientific literature, referred to as our 'building blocks'. In conclusion, we present the main corresponding learning processes between the different building blocks, 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. From this search, we concluded that there is 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 scientific branches, our building blocks, underlying our research context and thus the learning environment and it's characteristics at stake. Our three main building blocks are: peer learning, learning for sustainable development (in agriculture) and adult learning. We added a third focus on adult learning, since this target group is not obviously linked with peer learning in research literature, which is more often focussed on classroom settings for minors. A narrative conceptual literature review for each main building block using the same databases was carried out (1980-present), eliminating irrelevant fields (such as medicine and computer technology). We decided to base the relevance of a process addressed within literature on the three building blocks on their potential and role in supporting the effectiveness of a DA.

1 AgriDemo-F2F - Building an interactive AgriDemo-hub community: enhancing farmer to farmer learning, runs from 2017-01-01 to 2019-06-30; PLAID - Peer-to-peer Learning: Accessing Innovation through Demonstration, runs from 2017-01-01 to 2019-06-30.

## View on effectiveness

Effectiveness refers to 'proving' that something has worked and is a positive improvement on previous methods. However, this is especially problematic to grasp for learning contexts that are often relatively small-scale and short-lived, and commonly in situations of limited resources (OECD, 2013), such as on-farm demonstration activities.

'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 of the range of practices and of the learning outcomes that should define contemporary education (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 because of the on-farm demonstration, and indicators on 'how much' they've learned) and as adoption rates (putting in to practice what was learned). The research context is obligated to make decisions in which variables to take into account and which not to include when investigating effectiveness, because it's practically impossible to include every influencing variable and possible outcome. The measurements used to determine effectiveness should be first of all relevant to the context and the particular questions.

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). To complete the picture, we are also interested in the spreading of knowledge and skills in relation to attendance at a DA, by for example how many participants acknowledge, after some time, having learned something because of the DA, and the people who didn't attend the DA the participants have talked to about it. The latter refers to the term 'diffusion' (Rogers, 1995). 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. In other words, we'll investigate the level of adoption and diffusion of knowledge and skills by participants, supported by the attendance at a DA, not the mere adoption or diffusion of farming practices as such.

Secondly, the nature of learning will focus on the appearance of different levels of learning as defined by Argyris and Schön (1996). They described different 'levels' of learning as single and double loop learning, which in practice are often intertwined. Single loop learning (SLL) refers to generating factual knowledge and developing skills, comparable with surface learning as mentioned in 2.1. (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, Rodela, & Ecker (2016) regarding this distinction. Their research showed a high level of popularity of Argyris and Schön's (1996) model, being frequently used for the analysis of learning process dynamics and outcomes 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 (peer) learning processes in relation to SLL and DLL outcomes. We will discuss both levels further in depth in each of the three main building blocks 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 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 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 reciprocality presents a first important shift with traditional learning. It requires initiative, active participation and engagement of the learner towards the own learning process, in contrast with traditional learning where learners are rather required to passively soak up knowledge transferred to them by a hierarchically more knowledgeable person. For peer learning to succeed, a certain autonomy regarding the own learning process is thus needed. Cooper (2002, p.54) adressed 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 form learners, 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 is an important distinction in comparison with more traditional learning approaches. 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 situations, usually hard to investigate, also presents a distinctive trait in approach. Additionally, the emphasis 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 and can alternate throughout the learning experience (Boud, Cohen, & Sampson, 1999). This results in the recognition of the learning experience being valuable for the tutor too, not only in learning through having to explain the content, but also potentially through thoughts and insights shared by the tutee, previously unknown to the tutor.

Using the concept of peer learning in the context of farmer learning, it brings to the fore the idea of a bottom-up approach requiring engagement and ownership regarding the own learning process. According to a peer-to-peer approach farmers are required to take responsibility for their own learning. This is in contrast with the more traditional 'transfer of knowledge' view, where the teacher (usually researchers in this context) doesn't expect input that can significantly change the focus the of the learning process by those listener-learners. As an example of research supporting a peer learning approach between farmers, Curry et al. (Curry, Ingram, Kirwan, & Maye, 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.

Regarding the effectiveness of peer learning in the farmer community, research on the adoption and diffusion of innovations has consistently confirmed that one of farmers' most commonly cited sources of information and ideas are other farmers (Oreszczyn, Lane, & Carr, 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, Ledermann, Rist, & Fry, 2009; Warner, 2007). This kind of research also suggests that farmers are open to and value the practice of peer learning. Importantly, the European Innovation Partnership 'Agricultural Productivity and Sustainability' (EIP-AGRI) is one of five EIPs launched by the European Commission in a bid to promote rapid modernisation by stepping up innovation efforts. They too suggest peer-to-peer learning as a powerful approach for knowledge building networks between farmers, based on practical experience of actors in the field, and even provide tangible tips to facilitate this to which we will refer back later (EIP-AGRI, 2015).

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, Murgai, & Quizon, 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). These are practices that include peer learning, and it is important to emphasize here, that peer learning is not 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 needs of a particular learning context (Topping, 2005). The question we ask ourselves here is what learning characteristics and processes a peer learning practice requires to be effective in the way we defined at the beginning of this paper. Which processes make peer learning between farmers at on-farm DA's stand out from the traditional learning methods at DA's, like ownership?

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 and 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 and Ehly (2001), who tried 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. 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 demonstrations to be organised and somehow structured beforehand, peer assisted learning strategies can be part of the organised demonstration and are more likely to occur, observe and aim for in the instructional design, then is the case with informal unstructured and unplanned peer learning activities. 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.

Topping and 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 other context relevant theoretical insights.

Their first category 'Structural and organisational features' of the learning interaction, includes elements such as the need toward increased time on task (t.o.t.) and time engaged with the task (t.e.t.), the need for both parties to elaborate goals and plans, the individualisation of learning and immediacy of feedback possible within the small group or one-on-one situation. The individualisation of learning is understood as addressing prior knowledge and has a place in the main concept of ownership, both of which will be addressed later on in the paper. In this paper, we focus on the learning processes more than on the 'enabling environment conditions', since another complementing paper in this IFSA session will discuss this in-depth (Ingram et al., 2018) as a part of the AgriDemo research framework. We can summarize that this includes variables such as the need for both demonstrator and farmer to elaborate goals and plans so they can take into account each other's expectations and the availability of feedback and follow-up. Influences of group size, and the network the demonstration and/or farm is part of will also be taken into account in the structural and functional characteristics of the enabling learning environment.

Secondly and cognitively, qualitative peer learning questions and challenges personal mental models of the engaged learners, which is referred to as the concept of ‚cognitive conflict' (Topping & Ehly, 2001), upon which a learner is stimulated to think critically about his or her points of view. This leads to more deep-level learning (Ashwin, 2003), such as DLL (Argyris

& Schön, 1996). This described 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 surprising 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, Cramer, Exner, & Shour, 2003) and facilitating different learning outcomes. According to Mezirow (2000) critical reflection is fostered by 'cognitive conflict' and involves reframing of the assumptions of others and 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, meaning the content is offered in chunks small and clear enough to be apprehendable 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 were farmers feel safe to share their positive and negative experiences (EIP-AGRI, 2015).

Literature (Topping, 2005) suggests that this learning process usually starts off for both unconsciously, and when the learning relationship develops, both tutor and tutee can become more aware of what is happening in their learning interaction, and 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).

From these perspective, peer-to-peer approaches and underlying processes 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 J Higgs B, 2010), and support awareness and critical reflection (DLL).

## Farmers as adult learners

For a second building block to support our design of a conceptual framework, we again asked ourselves what particularly distinguishes this learning situation from a '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 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.

When we put Knowles' principles into practice in our context, farmers should be involved in the planning and evaluation of their instruction, fostering their sense of ownership regarding their learning and supporting a bottom-up approach. Adult learning should be self-directed and fostering learner autonomy. That this also counts as relevant and effective for farmers is already stated and supported by Millar and Curtis in 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 our research in mind. The lack of acknowledgement given to the construction of individual learning through complex and varied social, cultural and physical processes, in which the individual actively participates (Loeber, van Mierlo, Grin, & Leeuwis, 2007) is too important to ignore. The experiential learning cycle by Kolb (1984) lacks a profoundly present social learning element to our point of view, to take on a more holistic perspective on relevant learning processes.

Third, like other adults, famers 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. Taking account of the variation in learning capacities and learning styles of individual farmers and their diversity in (prior) knowledge and skills (Grange, Titterton, Mann, & Haynes, 2010; Millar & Curtis, 1997) is an important part of enabling their learning (SLL). 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. Allowing the participants to think for themselves by giving them a problem to solve, either alone by posing qualitative questions or to be discussed in group, instead of transferring knowledge unidirectionally is thus seen as preferable and more effective.

## On-farm peer learning for sustainable agriculture

To address the call for supporting innovation in agricultural sustainable development, we explore farmer learning about the topic of sustainable agriculture during DA. Learning for sustainable agriculture could be or could not be intentionally pre-set as one of the learning goals of current on-farm demonstrations. Even if they're not expressed as an obvious goal or outcome of the demonstration, it could still be that the DA fosters unconsciously learning for sustainable agriculture. This could mean that even though participants are not consciously aware they are learning about sustainable agriculture, what they've learned could still be

supporting it. Of course not every DA will support learning for sustainable agriculture, either on purpose or unconsciously. 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 in our third building block.

An influential and elaborated definition constructed by UNESCO (2010) determines agriculture as sustainable when it is 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 futures 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 farmer learning about sustainable agriculture.

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 (Diduck, Sinclair, Hostetler, & Fitzpatrick, 2012) and transformative learning (Mezirow, 1997), is about. An additional note made by Wals et al. (2007, p.83) 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, R. & 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 design challenge (Wals, A., Dyball, R., Brown, V., & Keen, 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 dialogue (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.

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, Factor, & Garrett, 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 been 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, 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 a transformative process of learning as a possible indication of effectiveness in learning for sustainable development.

## Comparing the building blocks

An overview of the most important learning processes and characteristics according to our three main building blocks is presented in table 1.

**Table 1.** Learning processes supporting effectiveness derived from main building blocks

| | **MAIN BUILDING BLOCKS** | | |
|---|---|---|---|
| | **ESD: Key processes in Education for sustainable development (Tilbury, 2011)** | **Adult learning: The Andragogical model (Knowles, 1980)** | **Peer assisted learning model (Topping & Ehly, 2001)** |
| **Key processes** | collaboration and communication<br>stimulation of innovation<br>active and participatory learning | ownership<br>based on experiences<br>immediate relevance<br>problem-centered | cognitive conflict<br>scaffolding and error management<br>communication<br>affect |
| **Enabling environment** | engaging the whole system | call for input (ownership) | organization and engagement |

To summarize, ESD (Tilbury, 2011) shows a lot of similar ideas, concerns and focus points with andragogy (Knowles, 1980) and peer assisted learning (Topping & Ehly, 2001) on what would be considered effective learning processes.

To illustrate, we found that peer learning approaches are widely suggested to be effective because of their social character and their call upon learners to be active and engaged in the process (Topping & Ehly, 2001; OECD, 2013), which reflects an idea shared with ESD processes (Tilbury, 2011). More concrete, peer learning leads to advantages in intergroup and communicative behavior, while cooperation skills are needed for effective participation in our 21st century knowledge society, and for creating sustainable development opportunities (Topping et al., 2017).

To guide further research within AgriDemo-F2F and beyond, we reflected upon the three building blocks and defined clusters of similar processes. These processes will form the foundation of a conceptual framework of core interacting effective learning processes, relevant to the focus of our research. This will allow us to investigate the dynamics between

these learning processes and our effectiveness variables. Since these processes are specifically constructed for the sake of our context and focus, they should not be considered covering every possible effective learning process.

This reflection led to the definition of the effective core processes as: engagement, communication initiation and interactive knowledge creation. All three contain processes addressed by all three main building blocks, 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 building blocks, which are not grounded in the agricultural field.

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

| Core processes | Key aspects | Exemplary building block | Exemplary supporting references |
|---|---|---|---|
| **Engagement** | ownership | Adult learning (Knowles, 1980); PAL (Topping & Ehly, 2001) | (Curry et al., 2012) |
| | participation | ESD (Tilbury, 2011) | (Warner 2007; La Grange et al. 2010; Kenya Market Trusts, 2016) |
| | trust | PAL (Topping & Ehly, 2001) | (Ashman & Gillies, 2003; EIP-AGRI, 2015) |
| | informality | PAL (Topping & Ehly, 2001) | (Wood et al., 2014; EIP-AGRI, 2015) |
| **Communication initiation** | sharing knowledge | Adult learning (Knowles, 1980); ESD (Tilbury, 2011); PAL (Topping & Ehly, 2001) | (United Nations, 2012; Curry et al., 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, Cramer, Exner, & Shour, 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, Factor, & Garrett, 2004) |
| | negotiating conflict (to arrive at consensus) | ESD (Tilbury, 2011) | (Wals et al., 2007; Beers, Mierlo, & Hoes, 2016) |

By building upon these processes, cognitive conflict and metacognition as effective learning processes can be induced, and provide both immediate learning opportunities (SLL) but also allow reflection (DLL). Cognitive conflict (PAL; Topping & Ehly (2001), based upon Mezirow on transformational learning (1991)) 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, Cramer, Exner, & Shour, 2003). Peer learning gives rise to more meta-cognitively skilled and self-regulated learners, reflecting the important adult learning principle of ownership (Knowles, 1980).

## Next steps

Since effective learning is often characterized by some change in knowledge, skills and/or behavior, we aim to investigate the link between the processes, SLL & DLL and the adoption and diffusion of what is addressed during the DA. Therefore, we will construct a conceptual

framework showing the interrelations between the key processes and the key aspects they contain as defined in this paper. Next, a measuring instrument is constructed and pilot tested for the case studies (including DA) selected from the inventory of farms conducting demonstrations in Europe, developed in 2017-2018 by the AgriDemo-F2F and PLAID project. The selection of the case studies aims to cover the most important variety in structural, functional and learning variables and they will take place between April 2018 and October 2018.

## Conclusion

We defined and constructed novel theoretical learning processes clusters and their key aspects, to investigate peer learning during on-farm demonstrations between farmers. For this construction process, we compared three main building blocks in literature, at the foundation of 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, Buchs, Duran, & Van Keer, 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. Next steps will include the development of a tool 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 effectiveness variables we defined as single and double loop learning, and adoption and diffusion. 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, in the light of learning for sustainable agriculture.

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# APPENDIX A: List of abbreviations

| | |
|---|---|
| DA | Demonstration activities |
| DLL | Double loop learning |
| ESD | Education for sustainable development |
| IAASTD | International Assessment of Agricultural Knowledge Science and Technology for Development |
| PAL | Peer assisted learning |
| SLL | Single loop learning |
| TLL | Triple loop learning |