AGRIDEMO

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STATE-OF-THE-ART REPORT ON DETERMINING EFFECTIVENESS OF LEARNING APPROACHES

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COLOPHON

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1 | INTRODUCTION

1.1. CONTEXT

For agriculture to meet the multiple expectations emerging from society and contribute to tackling the challenges of food security, food safety, quality, sustainability and climate change in Europe, farming systems have to become more knowledge-based. In 'The Future we want' (United Nations, 2012) educational strategies improving agricultural productivity and sustainability through the voluntary sharing of knowledge and good practices is described as a necessity. 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 farming (e.g.: of soil fertility, crop genetic diversity, and natural resource management). Efficient, durable strategies for knowledge sharing among farmers and other specialists concerning agricultural innovations is essential to answer that call. Farmers need to be aware of, have access to, and be able to co-create the best practices available. 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, Emerick, Janvry, Sadoulet, & Dar (2016) state 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.

Currently there are many debates about how to organize the production, accumulation and distribution of knowledge to support innovative agriculture. Knowledge transfer has in the past been conceptualized as a rather linear process of passing on new research-based knowledge to farmers in the form of advice and recommendations for changes in the way they farm and manage their enterprises. However, a changing context with respect to extension, markets and challenges has initiated a more complex system of knowledge exchange. Rather than a linear model of innovation, this is now envisaged as a set of networks, in which innovation is 'co-produced' through interactions between all stakeholders in the food chain called AKIS - Agricultural Knowledge and Innovation System (EU SCAR, 2012). In industrialized countries, however, this collaborative learning has become increasingly marginalized (Hassanein, 1999; Campbell, 1998). Industrialized agriculture has drawn more individual farmers into supply chains where they often act more as competitors, in order to achieve a low-cost strategy. This may have contributed to a weakened collective culture that can sustain such learning through dialogue in certain industrialized countries (Bell, 2004). Notions of learning rather than simply knowledge transfer recognize that opportunities for observation, interaction and discussion play an important role in farmers' decisions, prompting an interest in both on-farm demonstration activity and monitoring of farm businesses as potentially effective interventions. Efforts are needed to develop their potential and prepare for European connectivity. Effective peer-to-peer learning occurs when the demonstration farm operates under the same conditions as average commercial farms, i.e. subject to normal regulatory constraints, and

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using the innovative production systems or agricultural practices/technologies in the course of its normal commercial farming activity (Bailey et al., 2006). Developing effective peer-to-peer learning processes is seen as an important strategy to enable policy to support farming systems and facilitate their transition (Iles and Marsh, 2012). Furthermore, an increased understanding of such learning processes will help to develop institutions and programs that can foster innovation dissemination and learning for sustainable practices (Lankester, 2013). Therefore, AgriDemo-F2F focusses on the learning effectiveness of demonstration activities within the commercial farming community to foster improvement of farmer-to-farmer learning on demonstration farms in Europe.

Currently, there is no one theory or conceptual framework of farmer-to-farmer learning claiming to cover the most relevant and effective learning approaches and their processes and characteristics during a DA.

1.2. AIM OF THE REPORT

TThe overall aim of AgriDemo-F2F (H2020 project funded n°728061) is to enhance peer-to-peer learning within the commercial farming community. The aim of this document is to summarize the latest findings on the determining of effectiveness of learning approaches, relevant in a context of European on-farm demonstrations, with a focus on farmer-to-farmer learning.
The report is structured as follows: In section 2 we focus on the effectiveness of learning approaches. We start with discussing two recent key publications in educational literature investigating effective learning practices, approaches and effects. We also determine learning effectiveness in the AgriDemo-F2F context and we define what we understand as learning approaches and learning processes. In section 3, we analyze and compare three theoretical building blocks suggesting effective learning processes relevant to our research context and focus. This report ends with a conceptual framework showing the relevant effective learning processes and their interrelations in the context of peer-to-peer learning within the commercial farming community.

2 | DEFINING EFFECTIVENESS OF LEARNING APPROACHES AND PROCESSES

First we address two contemporary extensive international publications addressing learning effectiveness in evidence-based research as a core element. Secondly we define effectiveness in the context of the AgriDemo-F2F research project, with these two publications in mind.

2.1. INTERNATIONAL LITERATURE ON EFFECTIVENESS OF CONTEMPORARY LEARNING APPROACHES.

A recent key work on learning effectiveness is John Hattie's 'The Applicability of Visible Learning to Higher Education' (Hattie, 2015). Evidence, based on nearly 1200 meta analyses, shows that 195 different practices with an influence on learning. Hattie narrows these down to those particular practices and arrangements that have shown especially impressive effect sizes[1]. Some examples with the highest impact 'factors' and relatable to adult learning, are: teacher estimates of achievement, collective teacher efficacy, self-reported grades, conceptual change programs, teacher credibility and classroom discussion.
Hattie studied six areas that contribute to learning: the student, the home, the school, the curricula, the teacher, and teaching and learning approaches. If we take a closer look at the category 'teaching and learning approaches', 'providing formative evaluation' has the biggest effect size. Other relevant influences in this category are: providing feedback, meta-cognitive strategies, direct instruction, cooperative vs. individualistic learning, and peer tutoring.
First questions we could ask, drawn from Hattie's work, to identify and investigate effective learning at on-farm demonstrations are for example:

- Related to teacher efficacy: 'What does the demonstrator expect the group of farmer-learners to learn?', 'Does the demonstrator believe that he can make other farmers learn something?',
- Related to self-reported grades: 'Does the demonstration exceed the learning expectations from the farmer-learners?',
- Related to conceptual change programs: 'Is there enough surface knowledge provided during the demo to be able to move to deep or conceptual understanding?',
- Related to teacher credibility 'Does the farmer-learner trust the demonstrator as a knowledgable source?',
- Related to classroom discussion 'Was there any discussion about the demo content?'.
- Related to formative evaluation: 'Does the demonstrator check somehow if the farmer-learners understood what he/she is demonstrating during the process?',
- Related to providing feedback: 'Does the demonstrator provide feedback during the demonstration?' and 'Do farmer-learners give feedback to another farmer-learner or to the demonstrator?'.

Important in the context of learning for sustainable farming practices, metacognition is a key idea that is shared by many of the visible learning strategies and is characterized by knowledge of one's own thinking and learning processes, awareness of feelings and attitudes, and of one's cognitive processes. It refers to thinking about thinking. Additionally, cooperative learning strategies are promoted because they enhance interest, collective problem solving and incorporate high levels of peer involvement. This does not mean that direct, explicit instruction where the demonstrator explains the content in clear small linked steps is outdated. Lastly, as it seems relevant to our research context, we looked at Hattie's findings on peer tutoring. It seems quite effective, however the concepts knows different interpretations. Some approaches to peer tutoring are more than twice as effective as other approaches (Hattie, 2009). For example, it seems important that one of the peers has an adequate level of relevant knowledge and it should be clear to peers what they are expected to achieve.

The above is non-exhaustive list of practices found by Hattie to be effective and modelled into examples possible in our research context. Some of these practices can be clearly linked to a specific learning approach, while other practices

1 Hattie defines 'effect sizes' as the best way of answering the question 'How much influence does this practice have on student learning?'. An effect-size of 1.0 is typically associated with advancing learners' achievement by one year, or improving the rate of learning by 50%.

can be linked to multiple learning approaches. Historically, three distinct holistic and relevant viewpoints on learning dominate the literature: behaviourism, cognitivism, and constructivism (Ertmer & Newby, 2013).

In short (after Ertmer & Newby, 2013):

- Behaviorism: Learning is accomplished when a proper response is demonstrated following the presentation of a specific environmental stimulus.
- Cognitivism: stresses the importance of knowledge and internal mental models acquisition and addresses the issues on how information is received, stored and retrieved by the mind.
- Constructivism: equates learning with creating meaning from (social) experiences.

In many ways these viewpoints overlap, yet they are distinctive enough to be treated as separate approaches to understanding and describing learning. Today, there seems to be an endless amount of 'learning approaches', situated within one or more of these viewpoints. Since there's a lot of overlap in important practices of learning approaches (e.g., the importance of stimulating metacognition and feedback is shared by many), we choose to look at learning processes constituting the approaches, such as the incorporation of specific effective practices (e.g. room for discussion, provision of feedback,...), instead of looking at broad theoretical learning approaches.

A second important recent work is the OECD report on innovative learning environments (2013). It looks at 125 cases in more than 20 countries. These cases have been identified within their own system as significant departures from mainstream learning arrangements for younger children or older teenagers, while promising to meet the ambitious objectives needed for the 21st century. In this report, a "learning environment" is as an organic, holistic concept that includes the activity and the outcomes of the learning. The underlying message of Hattie (2015) accords closely with this international report. Both want to 'open up' education. The Innovative Learning Environments (ILE) principles state that in order to be most effective, learning environments in the 21st century should:

- Make learning and engagement central.
- Ensure that learning is social.
- Be highly attuned to learner motivations and emotions.
- Be acutely sensitive to individual differences.
- Be demanding for each learner but without excessive overload
- Use assessments consistent with learning aims, with strong emphasis on formative feedback
- Promote horizontal connectedness across activities and subjects, in and out of school.

Lessons for effective learning processes we can draw from these two educational key works are the importance of an active, motivated and engaged learner who's aware of his or her own learning and a confident and trusted teacher who's aware of learner differences and places his or her expectations high enough. The learning content should be explained in clear linked chunks and attention should be given to linking the content within a broader 'real world' context, discussing about the content and supporting metacognitive thinking. Social learning strategies such as cooperative and peer learning can be effective under certain conditions.

2.2 DEFINITIONS

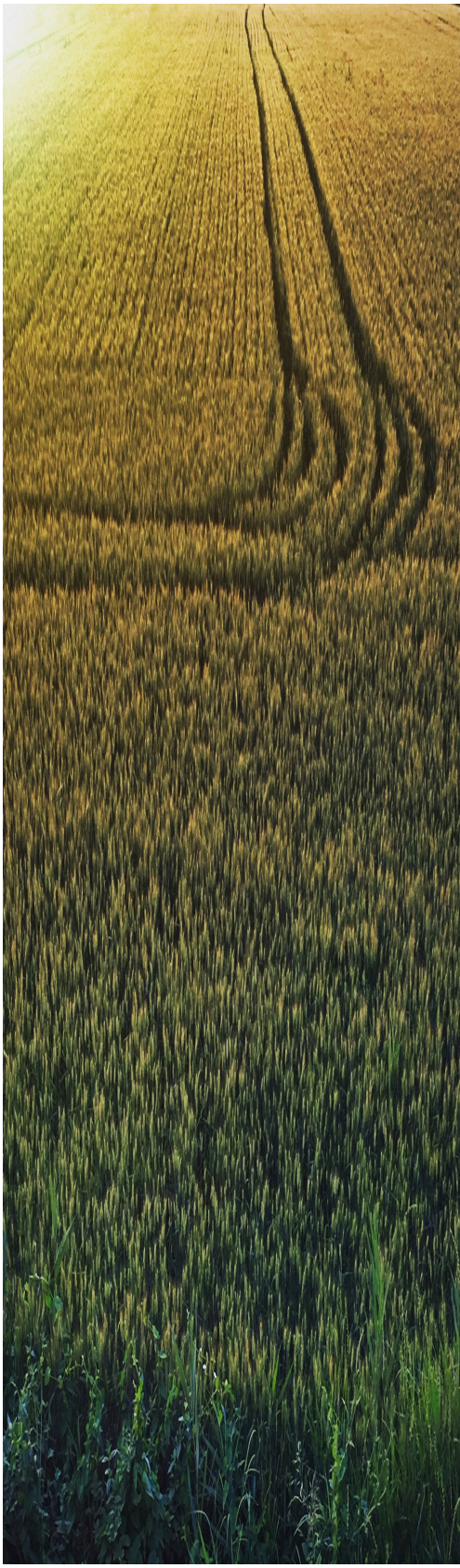
As a guideline and to avoid confusion, we defined important but often ambiguous concepts relating to educational theory and learning, as we understand and use them in this report.

A learning approach may be understood as a patterned set of generalized ingredients and relationships that are promoted as desirable for the learner and the learning outcomes (OECD, 2013). Approaches vary in terms of for example student-teacher relationship, individual versus community emphasis, active and passive knowledge building and so on.

Learning processes typically lie at the foundation of a learning approach and refer to 'how learning takes place' regarding a learning approach or theory. E.g.: In a behaviorist approach, learning processes are what causes change in behavior. In a cognitivist approach, learning processes are referring to internal mental processes (including insight, information processing, memory, perception, metacognition). In a constructivist approach, learning processes are linked to processes of interaction, communication and observation in social contexts (after Merriam & Caffarella, 1991).

Learning practices or methods have the ability to stimulate learning processes. An instructor can deliberately use learning practices such as direct instruction, group discussion, asking students certain types of questions, or demonstrate a certain behavior to stimulate certain learning processes.

Peer to peer learning refers to a reciprocal, at least 'two-way', learning approach between equals. Important and characterizing is what Cooper (2002, p.54) explains: '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 traditional teacher role to the student".



2.3 DETERMINING THE EFFECTIVENESS OF THE LEARNING

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. It can 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 pressing questions that need to be addressed according to the community.

The AgriDemo-F2F project proposal defines learning effectiveness through factors representing the extent and nature of learning.

2.3.1 The extent of learning

The extent can be addressed by numbers of for example participants stating they have learned after an on-farm demonstration activity (DA) took place. Additionally, the amount of participants expressing change in behavior 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'. 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 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'. 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.

2.3.2 The nature of learning

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. (a.o. 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 (a.o. getting insights in the question: "Why is my farming system the way it is and should I change my farming system?").

3 RELEVANT LEARNING APPROACHES FOR PEER TO PEER LEARNING WITHIN THE COMMERCIAL FARMING COMMUNITY

A lot of learning approaches can be described as 'research-based' yet the research drawn on gives rise to widely different approaches. Just as Hattie (2015) found that almost all practices can be found to have a positive association with learning outcomes, research findings can be harnessed in support of a wide variety of differing approaches. Drawing on research can augment the predictability of positive results but it cannot show the 'one best way' (OECD, 2013). Therefore, we start by taking a closer look at the AgriDemo-F2F context and use the defining elements (referred to as building blocks) of the context as the starting point to explore relevant effective learning approaches. We elaborate on the suggestions from educational literature (paragraph 2.1) and how they fit in the AgriDemo-F2F research project and content.

To address the goal to search for and capture the learning processes suggested to be effective in this research context, a conceptual framework integrating the main corresponding processes between the different building blocks is suggested at the end of this report, presenting effective learning processes, inspired by both theory and practice, in a farmer-to-farmer learning environment during an on-farm demonstration activity (DA).

To grasp the learning processes at stake in this learning environment, embedded in the modern paradigms of agricultural innovation and sustainable agriculture, we discuss three main building blocks for our framework. Therefore we first investigate and explore the concept of peer learning and its processes in educational and agricultural literature. Our literature search for 'effective peer learning processes' from an educational point of view led us to 'the peer assisted learning (PAL) process model' as presented by Topping & Ehly (2001), as a first main inspiration for our conceptual framework. Additionally, the relevance of adult learning theory as outlined by Knowles (1980) and 'learning for sustainable development theory' (Tilbury, 2011) as understood in an agricultural context are investigated and proposed here as the second and third main building block.

3.1 BUILDING BLOCKS

3.1.1 The relevance of peer learning between farmers

The concept of peer learning between farmers suggest 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 reciprocity presents a first important shift with traditional learning approaches. 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. Furthermore, peer learning, in educational theory, involves learners learning from and with each other on a scale anywhere between informal and formal learning. The emphasis is on mutual learning since the roles of teacher and learner, commonly referred to in educational literature as tutor and tutee, are not necessarily defined and can alternate throughout the learning experience (Boud, Cohen, & Sampson, 1999). 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 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.

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.

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 (K. J. 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 in 2.2.1. 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 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, in contrast to Topping and Ehly (2001), who tried to get a holistic overview of the processes underlying peer learning. They 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 organized and somehow structured beforehand, peer assisted learning strategies can be part of the organized 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 also occur, but are a lot harder to map, let alone intentionally organize and study. As Emerick et al. (2016) mentioned, simply

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

relying on farmers (or others) to just share knowledge without further intervention will very likely not do adoption of new knowledge and skills much good.

Topping and Ehly (2001) synthesized 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 organizational features, cognitive conflict, knowledge scaffolding, communication, and affect.

Their first category 'Structural and organizational 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 individualization of learning and immediacy of feedback possible within the small group or one-on-one situation. In this report, we focus on the learning processes more than on the 'enabling environment conditions', so we won't go in depth on this category. However, the 'enabling environment' is included in WP 4 and in thus in our framework presented at the end of this report. 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. The individualization 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. 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 changing unwanted 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, knowledge scaffolding (Vygotsky, 1978) refers to a constructivist view on learning. It addresses the mediation of learning content, meaning the content is offered in chunks small 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. The difference with personal constructivist is presented by Piaget, who stated that knowledge must be assimilated in an active process by a learner with matured mental capacity, so that knowledge can build in complexity by scaffolded understanding. Understanding is scaffolded by the learner through the personal process of equilibration, whereby the learner tries to incorporate new knowledge with previous understanding. (Ashman & Gillies, 2003)

Fourth, peer learning addresses inevitably 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, summarizing, speculating, and hypothesizing are all valuable skills. Scientific evidence confirms that teaching is a great way to learn (Duran, 2016).

Fifth, the affective component proves clearly 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 pair motivated.

Educational 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 this perspective, peer-to-peer approaches at on-farm demonstrations seem promising to be part of durable strategies for knowledge sharing and co-creation between farmers, because apart from ownership, it requires engagement and communication between the learners about the learning content (K. J. Topping & Ehly, 2001). These processes foster improved understanding of the learning content (SLL) ((Murphy J Higgs B, 2010; Griffin & Griffin, 1998; Ritschoff & Griffin, 2001), and supports awareness and critical reflection (DLL).

3.1.2 Farmers as adult learners

For a second building block to support our design of a conceptual processes framework, we again asked ourselves what particularly distinguishes this learning situation from a 'usual' educational environment. Since much of the educational literature addresses 'child' education, we decided it would be relevant to take into account the characteristic that our target group 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-centered 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 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 for example: Brookfield, 1995).

Fourth, pragmatic problem-centered 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 unidirectional is thus seen as preferable and more effective.

3.1.3 On-farm peer learning for sustainable agriculture

A main goal of our research is to scrutinize to what extent participation in demonstration activities on farms influences farmers' understanding of and actions towards sustainable agriculture. 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 transformative learning, 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 sus-

tainability 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, characterized 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."

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 organization of a DA are important regarding the effectiveness of a DA. Since this refers to the enabling environment, it will be addressed in WP3 and integrated in the 'enabling environment' section of our framework.
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 prioritizes 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.

3.2 TOWARDS A CONCEPTUAL FRAMEWORK

3.2.1 Comparing the views

To summarize, the discourse behind ESD 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. Ownership of the learning process by the learner, 'empowerment of the learner' as it were, interactive hands-on learning, learning together as equals in dialogue, and the preference for informal learning activities to name the most evident ones.

Peer learning approaches are suggested to be effective because of their social character and their call upon learners to be active and engaged in the process (OECD, 2013), which reflects an idea shared with ESD processes. Furthermore, peer learning not only leads to increased learner performance and achievement in diverse subjects, but also to more higher-order thinking and double loop learning. Peer learning gives rise to more meta-cognitively skilled, which promotes effectiveness according to Hattie (2015) and self-regulated learners, reflecting the important adult learning principle of ownership (Knowles, 1980). This is relevant in view of lifelong learning and officially recommended in many curricula.

Secondly, peer learning leads to advantages in intergroup and communicative behaviour. Cooperation skills are needed for effective participation in our 21st century knowledge society, and for creating sustainable development opportunities (Topping et al., 2017).

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

Table 1. Effective learning processes derived from main defining 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	ownership	cognitive conflict
	stimulation of innovation	based on experiences	scaffolding and error management
	active and participatory learning	immediate relevance	communication
		problem-centered	affect
Enabling environment	engaging the whole system	call for input (ownership)	organization and engagement

3.2.2 Key processes

We defined the processes in our framework according to relevant processes mentioned regarding the three building blocks in the literature review, which could be adapted to the context of on-farm learning in the light of learning for sustainable agriculture (Table 1). The clusters of processes we defined are constructed for the sake of the focus of our research and should not be considered covering every possible process. The conceptual framework we constructed shows the interrelations between the key processes and the subprocesses they contain (Fig. 1).

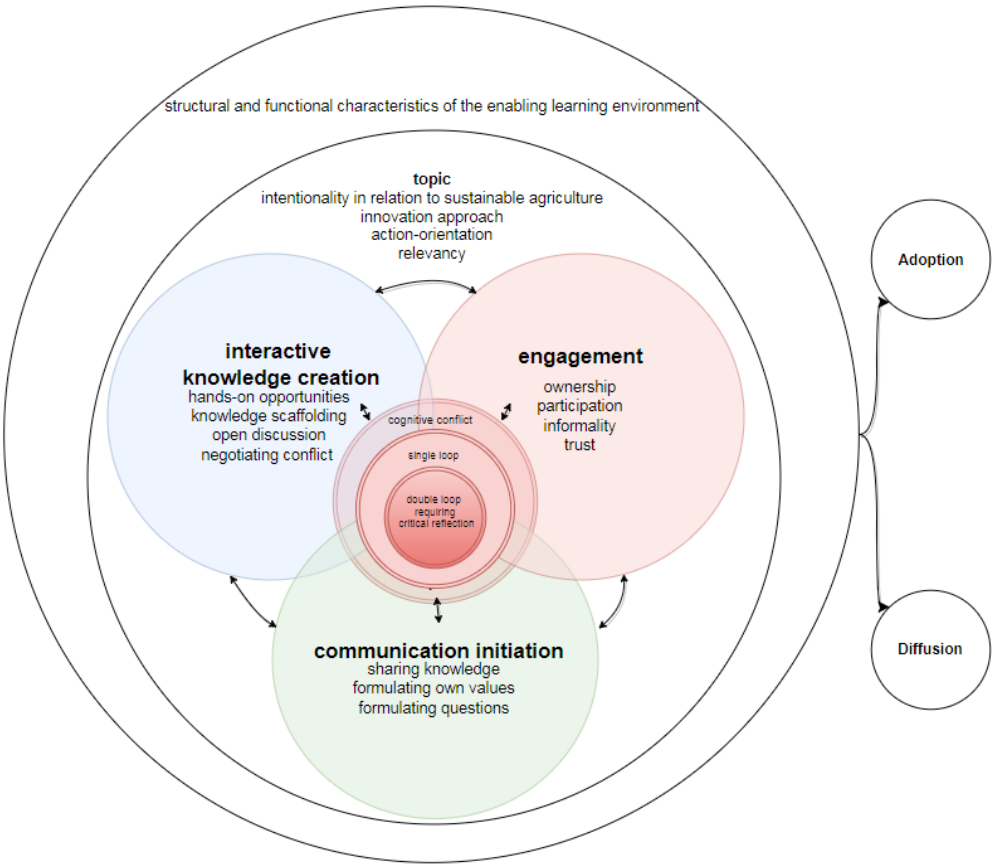


Figure 1: Main building blocks of the analytical framework of AgriDemo-F2F

As a result from the literature review focusing on the goals of Agridemo-F2F, peer to peer learning during on-farm demonstrations can be more effective if processes such as engagement, communication initiation, interactive knowledge creation are stimulated. All three contain processes addressed by all three main building blocks. These processes foster cognitive conflict and critical reflection (Fig. 1) and provide both immediate learning opportunities (SLL) but also allow reflection (DLL) and help to build competences and capacity over time:

As **key aspects of the engagement processes** we defined:

- Ownership (e.g.: adult learning; Knowles, 1980)
- Participation (e.g.: ESD; Tilbury, 2011)
- Informality and trust (both after 'affect' as explained in the PAL model by Topping & Ehly, 2001; Ashman & Gillies, 2003; Hattie, 2015)

As **key aspects of the communication initiation processes** we defined:

- Sharing knowledge (e.g.: adult learning; Knowles, 1980)
- Formulating own values (e.g.: ESD; Tilbury, 2011 and after 'communication' as explained in PAL model by Topping & Ehly, 2001)
- Formulating questions (after 'communication' as explained in PAL model by Topping & Ehly, 2001)

As **key aspects of the interactive knowledge creation processes** we defined:

- Hands-on opportunities (Problem-centered, Knowles, 1980; learning-by-doing, Dewey, 1938; Millar & Curtis, 1997; Lankester, 2013)
- Knowledge scaffolding (PAL, Topping & Ehly, 2001; after Vygotsky, 1978)
- Open discussion (after 'communication' as explained in PAL model by Topping & Ehly, 2001; Bohm, Factor, & Garrett, 2004; Hattie, 2015)
- Negotiating conflict (ESD, Keen, Brown, & Dyball, 2005 in Chapter 9, Wals et al., 2007; Beers, Mierlo, & Hoes, 2016)

By building upon these processes, following effective processes can be induced:

Cognitive conflict (addressed in the PAL model of Topping & Ehly 2001 and based upon the theory of Mezirow on transformational learning (1991)). Learners who are confronted with information that doesn't fit with their own previous knowledge and believes, through for example a new demonstration or discussion, can learn effectively from this surprising experience.

Metacognitive skills and double loop learning. 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).

Since the processes in our model are referred to as effective by literature, and effective learning is often characterized by some change in knowledge, skills and/or behaviour, we will investigate the link between the processes and the adoption and diffusion of what is addressed during the DA.

4 CONCLUSION

We started off by looking at two recent key works in educational literature investigating effective learning. Next we constructed a theoretical effective learning processes framework based on the AgriDemo-F2F research context and focus. For the development of the framework, we compared three main building blocks at the foundation of the AgriDemo-F2F 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).

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