LEARNING ENVIRONMENTS FOR SUSTAINABLE INNOVATION

First Steps in Designing Organizational Settings for Learners and Teachers

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Abstract

Knowledge processes, such as knowledge sharing, knowledge use, knowledge creation or knowledge distribution are core components in sustainable innovation (Jorna, 2006), at both the individual and the group level. Knowledge creation refers to innovation and requires the possibility of learning (single loop, double loop or otherwise). A determinant for learning is the learning environment. The specific environment in which individuals and groups engage into the learning experience influences the effectiveness of knowledge use and knowledge transfer. 12 Strategic Inspiring Learning Opportunities (SILO), i.e., configurations of learning contexts, are distinguished, each triggering the learning experience of individuals and groups in a different manner. This article discusses the theoretical underpinnings of these 12 SILOs from a knowledge management perspective. The underlying dimensions of coordination mechanism (i.e. authority, standardization, and trust), direction of communication (uni-, bi-, and multi-directional), and knowledge type dominance (tacit or explicit knowledge, or sensory, coded, and theoretical knowledge) are identified for each of the SILOs. For instance, the "master class" SILO concerns a traditional configuration, applying an authoritarian coordination mechanism. Knowledge transfer typically is uni-directional, and concerns dominantly theoretical knowledge. At the opposite end of the spectrum, the SILO labelled "entrepreneur café" is based on trust and facilitates multi-directional knowledge transfer. Knowledge of the sensory type is dominantly transferred in this SILO. In between these two extreme forms, the ten other SILOs are positioned. Finally, implications for sustainable innovation and its effectiveness are provided.

Keywords

Learning context, sustainable innovation, knowledge, Strategic Inspirational Learning Opportunity

1. Introduction

Knowledge sharing, knowledge use, and knowledge creation are the processes that form the core of the concept of (sustainable) innovation (Jorna, 2006). The processes operate at individual and group levels. Especially the process of knowledge creation is of importance in (sustainable) innovation. This knowledge process generates new knowledge that enables an individual, group, or organization to deal with their dynamically changing environments (Faber, 2006).

Underlying knowledge creation is our (human) ability to learn. Learning is conceptualized as "the change in a subject's behaviour to a given situation brought about by his reported experience in that situation, provided that the behaviour change cannot be explained on the basis of native response tendencies, or temporary state of the subject (e.g., fatigue, drugs, etcetera)" (Hilgard & Bower, 1975, p. 17). The authors formulated their initial definition in the early 60s of the last century during the heydays of classical and operant behaviourism. Since the 70's "a subject's behaviour" is supplemented by "and by a subject's information processing system" (Estes, 1976; Posner, 1989; Wilson & Keil, 1999). Humans, as information processing systems, have, use and create knowledge. New knowledge enables changes of behaviour or a change of existing knowledge in our minds. This is what in other domains, such as education or psychology is called learning. Hence, to be able to understand how knowledge creation functions, a better understanding of learning in the context of knowledge creation is crucial.

With the abundant literature on learning, the learner and learning material in mind Hilgard & Bower, 1975), we want to focus on a less obvious aspect of learning, called the organizational context of learning. The context in which one learns is an important determinant of the effectiveness of learning (Billett, 2001). From learning theory, the learning environment is portrayed as a collection of opportunities that initiate the learning experience of learners. Traditionally, learners utilize the opportunities toward which they are directed by teachers. Billett (2001) indicates that individuals who learn in a workplace context have more freedom to select which opportunities they use in their learning tasks. This difference between learning in distinct contexts illustrates that the formation of the context affects the way learning takes place. This article focuses on the issue of organizing a learning context from a knowledge management perspective.

Although the “learners” issue is rarely explicitly mentioned in organizational and knowledge management literature, we follow Herbert Simon (1960), who stated that innovation is based on learning and that learning starts with individual minds. The abilities of the human mind enable knowledge creation and therefore learning. Stimulating or enabling innovation starts with human minds and with organizational settings in which learning takes place. Therefore, innovation, whether it is imitative, incremental or radical (new) (Jorna, 2006), basically is knowledge creation. However, innovations take place in organizational settings or contexts and contexts differ enormously. With the prefix “sustainable” in sustainable innovation, we mean a kind of organizational learning/innovation context that keeps learning going. The basic interpretation of sustainable is that it expresses a balance between system and environment. If the context of learning (environment) is in balance with the learning process itself (system), the learning situation is long-lasting, continuous and in balance, and therefore sustainable.

We identify three dimensions of a learning context that determine its configuration and consequently will affect the learning experience of learners. These dimensions are i) the used mechanism of coordination in an organizational context, ii) the various directions of communication between the learners, mutually, and the teacher and the learner(s) and iii) the type of knowledge that is used to transfer the content of knowledge between learners and teachers. Positions on the three dimensions will change the learning context and will hamper or endorse the learning activity. What the role of these dimensions is, is further developed in this article. At this moment we have no empirical data to support the preference or surplus value of one context over the other. This article is conceptual and theoretical. We have no empirical data at this moment. Furthermore, the article aims to answer the question what archetypical configurations of the identified dimensions are sensible and what the implications are for learning. We will call such archetypical learning contexts Strategic Inspiring Learning Opportunities (SILO).

2. Theoretical underpinnings of knowledge-based learning environments

In this section we will explain the three dimensions that can be distinguished for the various SILOs. A coordination mechanism is a managing device that organizes collaboration, dependencies and structures between individuals in a group or organization. It is a guarantee that “things are done”. The direction of communication concern the ways in which one human communicates or is related to another human: half duplex (one-directional), full duplex (bi-directional) or multi-directional communication. The variations in knowledge types concern the ways the content of knowledge is transferred, which can be done by demonstrating and imitating (the sensory knowledge type) by using words, pictures and

formulae (the code knowledge type) and by explanation and deliberation (the theoretical knowledge type). We explain the dimensions in more detail after which give an enumeration of the SILOs followed by a short description of every SILO.

Coordination mechanisms: With respect to coordination mechanisms we can distinguish three types:

- Standardization (impersonal);
- Power and authority based on various backgrounds, such as expertise, age, family relations, functional roles and more (personal);
- Trust, competition and distrust (personal).

Standardization is impersonal, while power, authority and trust are of a personal nature. Standardization means that a structure has been designed for tasks and processes which functions, so to speak, by itself. Here, we come close to 'institutional factors', as Williamson (1975) called them, both within organizations and in their environment. Of course in any organization people who act with intelligence are required. However, standardization goes further in that tuning and coherence of their actions is organized in such a way that the degree of freedom in the execution is minimal. Standardization can be designed for tasks, for example the layout of car factories, in which people and robots perform the work in a fixed order. Standardization also applies to call centers, which stipulate precisely which steps should be taken in a particular process. In this way coordination is interwoven with the tight standard order of tasks and processes. In all situations in which there is none or no complete standardization possible, coordination is based on personal relations.

There are many mechanisms of a personal nature that serve as coordination mechanisms within organizational forms. In the first place we have power and authority. In a hierarchy one person is the boss and the other person the subordinate. However, this situation requires a representation of this relationship that is understood and shared by both. Being the 'boss' can be based on a formal structure of the organization, but also on charisma, expertise regarding content or other forms of power. In this respect, the aspect of 'ruling' should not be underestimated. It makes coercion, imposing sanctions or granting awards possible. The boss, the ruler, decides.

In this context we can also mention the authority relation. Here, one can think of the sub-division in monarchy, bureaucracy, aristocracy, meritocracy, democracy and technocracy (see also Sorge & Warner, 2001). In their diversity the many forms suggest that the leading principle (the 'arche' or ruling principle) is interpreted by people as a representation of the leading entity/principle dictating how one behaves or should behave.

A large number of psychological notions are important as mechanisms behind the issues of coordination and organization. We mention here trust, distrust, competition, competitiveness and reliability in agreements. In this way a clan is based on trust. A market is based on competition and rivalry; every participant can continuously start new relations and end them on the basis of distrust. Bureaucracies are based on the reliability and acceptance of the rules.

Direction of communication: This dimension is quite simple. In a learning context communication can be from teacher to learner or from teacher to learner and back again. The first is called one-way or half-duplex communication, the second two-way or full-duplex communication. An extreme form of communication is that all learners communicate with one another. This is called a multiple-way communication: if every learner communicates. The interpretation of this dimension is not that it is exclusive. Even in a one-way communication there will always be some communication back. What we mean by one-way, two-way or multiple way is that it is the dominant direction.

Types of knowledge: Types of knowledge refer to way knowledge is expressed or presented. It is not about the content of knowledge. We distinguish sensory, coded and theoretical knowledge.

Sensory knowledge can also be called perceptive knowledge or knowledge that is exemplified in behaviour. The knowledge we possess is just as concrete as the perceptions we interpret with this knowledge (not only visually, but with all our senses). It is knowledge of concrete events. Sensory knowledge is the knowledge a person obtains using sensory organs. The knowledge is as concrete as the event that is interpreted. It is behavior. Examples of such knowledge are the smell of spices, or the sound of a bird's whistle, or the knowledge of somebody's face. The only abstraction is the fact that the representation has abandoned the 'now', and forms part of our memory. This knowledge cannot be put into words. In this case the process of representation consists of both our memory of a concrete situation, and our recognition of a new situation on the basis of similarity or analogy. Many of our daily activities are based on sensory knowledge, just as our capability to recognize places and faces. Therefore, with respect to memory a new situation occurs as a transformation, a change. This sensory knowledge is pointedly linked to context, and diffusion (dispersion) only takes place by imitation. Sensory knowledge partly coincides with tacit knowledge. Consider, for example, the master-apprentice relationship. Let us assume that this relationship involves the transfer of knowledge. This transfer partly takes place via imitation and examples, and partly by translating automated knowledge of the master. So, here tacit knowledge is more than sensory knowledge. Quite often sensory knowledge is

knowledge that ‘works’. Quantification of sensory knowledge is possible by determining the degree of detail of the knowledge. Sensory knowledge is more detailed as far as perception consists of various partial, more detailed, perceptions, on which in turn a richer repertoire of actions (or schemes) is based.

Coded knowledge consists of knowledge in the form of signs and symbols. A code links a concrete event – for example a sound, or a gesture – to a group, a category, or images. The concrete event becomes a sign, the category of images forms the meaning of that sign (for example, a word). A situation is not only recognised as image, icon or picture, but is now also categorized in terms of a general concept. Words and gestures have meaning thanks to codes (Morse, language, jargon, sign language, etc.). This also clarifies how conventional - because of the codes - the world of our categories is. When we take a small step aside, we have grasped part of the issue of innovation as knowledge creation. Often the big problem with both service as well as product innovations is finding terms for new artifacts, and if these are found, to have these terms accepted by other people. Coded knowledge is tied to context to a lesser extent than sensory knowledge is (Boisot, 1995). It is linked to the context of formulae, of a language, or of a collection of pictograms. In this way the dispersion of coded knowledge takes place much quicker and easier than that of sensory knowledge. Thanks to shared codes this knowledge can be transferred quite easily within a community: the one who knows the code, or can decipher it, can share the knowledge. A change occurs when an event can be placed within different categories, possibly even contradictory categories. This forces the sign user to reconsider the way in which he has classified his world, his schemes. Quantification of this coded knowledge is possible by analyzing the characteristics of the codes: the number of elements, the rules, and possibly the freedom of the sign user to ascribe meaning to it (Goodman, 1968). The more freedom the user has, the ‘weaker’ the code, the larger the degree of ambiguity. This can be illustrated by an example. Take a collection of pictures (for example, the icons on the desk top of a computer screen), a text in the Dutch language and mathematical formulae. In all three cases signs are used. In case of pictures, it is unclear how they are selected and whether more pictures will follow, and if this is the case, according to which design criteria. Also, the interpretation of a picture differs per person. Each picture is in fact unique. So, there is ambiguity in the size of the collection of signs, in concatenation rules and in their interpretation. A text in the Dutch language consists of letters of the alphabet, which are clearly defined. It can be determined whether the words and sentences are composed according to the rules of Dutch grammar. However, the interpretations evoked by reading a text differ per reader. This means that compared to the pictures the ambiguity in the construction of the signs has disappeared, but

that interpreting (understanding) the text still involves ambiguity. In case of mathematical notations both the ambiguity regarding which signs take part and how the signs are interpreted have disappeared. If we put the pictures, the letters and the mathematical signs in a row, ambiguity is decreasing. This means that the code used increases in 'strength': from pictures via text to mathematical formulations.

Theoretical knowledge concerns structural identity. It is the structure that can be formed on top of sensory and coded knowledge. All knowledge that reflects a structure, method, or pattern is theoretical. For example, physical laws are theoretical knowledge, but ideological or religious coherent structures are theoretical knowledge as well. "Theories" make it possible to understand the structure of our (constructed) 'realities', and to reason about and reflect upon these 'realities'. Theoretical knowledge, largely dependent upon graphic (drawn and written) signs, is according to some (e.g., Donald, 1991) the basis of the development of modern science. Changes in theoretical knowledge result from faults, incorrect predictions, contradictory hypotheses and facts that do not correspond with the theory. Learning processes take place by abduction (deriving new hypotheses), induction (generalization on the basis of characteristics that repeat themselves) and deduction (on the basis of combining expressions leading to conclusions). Theoretical knowledge can be made visible in asking and answering "why" questions. This third type of knowledge ranges from concrete to abstract theoretical knowledge; concrete theoretical knowledge consists of small "why-chains", whereas abstract theoretical knowledge consists of long and complex chains.

The dispersion of theoretical knowledge is on the one hand easier than that of coded knowledge, because this knowledge should in principle be universal, and not be tied to a regional culture or be language-bound. At the same time this knowledge is so abstract that it is for the greater part restricted to a (small) group of well-educated people. So, what is gained by abstraction on the one hand, is lost again in less dispersion on the other hand.

On the basis of the three dimensions it is possible to systematically make organizational distinctions in learning contexts. Everyone knows that a class(room) is a different learning context compared to an expedition. However, our ideas of the difference are vague and intuitive. In both contexts there are learners and teachers and there may be learning materials. But we want to get a more operational grip on these differences and therefore the three organizational and knowledge dimensions might help. The next section lists the learning contexts and discusses some of the details

3. Specific Inspiring Learning Opportunities/Occasions

The twelve types of SILOs that can be identified are i) Master class, ii) Clinic, iii) Workshop, iv) Laboratory, v) Academy, vi) Final rehearsal, vii) Entrepreneurs café, viii) Boxing ring, ix) Kitchen table, x) Utopia, xi) Study club, and xii) Expedition. These SILOs operationalize the concept of Inspiring Learning Opportunities by Gielen, et al. (2006). Table 1 summarizes all twelve SILOs. For each SILO its configuration of coordination mechanism, communication direction and knowledge type that is transferred are provided. In Table 1 we list every SILO and position them on the three dimensions, that is to say that every SILO can as such be classified. In the column about the knowledge type for transfer, the numbers have to be interpreted as the lower the number the more dominant the knowledge type. 1 means that that particular knowledge type is dominant.

The **master class** SILO refers to a group of learners who are instructed and guided by a master in their learning experience. The master distinguishes himself from the learners because of his particular experience and expertise on the topic. Provided instructions and guidance aim to create awareness for and provide alternatives for improvement for learners. The master class provides insight and experience to its learners. The coordination mechanism that is used in the master class is authority, based on the unique expertise of the master. Although interactions between learner and master occur, communication within the master class is essentially uni-directional from master to learner. The master is the one sharing his/her knowledge while the learner learns. Because the master class concentrates on a verbal transfer of experience, sensory knowledge is mostly absent in knowledge transfer. The main focus is on the transfer of general insights from master to learner, and not on specific cases. Transfer of theoretical knowledge is dominant over coded knowledge.

Specific, intensive training forms the core of the **clinic** SILO. A group of learners is trained by an expert on the improvement of specific skills. While interaction with the expert holds a central position, learning results are realized at the level of the individual learner. Similar to the master class, the clinic uses an authority based coordination mechanism, which originates from the experience of the expert. Communication follows a uni-directional pattern from expert to learner. Where the clinic differs from the master class is in the dominance of the type of knowledge that is transferred. For the clinic focuses on skill improvement, sensory knowledge dominates in transfer. In addition to skills, the expert aims to provide a general understanding why the presented skills lead to the intended effect, relating to the transfer of theoretical knowledge. Coded knowledge transfer does occur but is least dominant in the clinic.

Table 1 Characteristics of Strategic Inspiring Learning Opportunities

SILO	Coordination mechanism	Communication direction	Knowledge type transferred
Master class	Authority: content-based (small in size)	Uni-directional	TK CK SK
Clinic	Authority: content-based	Uni-directional	SK TK CK
Workshop	Trust	Multi-directional	SK TK CK
Laboratory	Authority: content-based	Multi-directional	CK TK SK
Academy	Authority: content-based (large in size)	Uni-directional	TK CK SK
Final rehearsal	Standardisation, Trust	Uni-directional	SK CK TK
Entrepreneurs café	Trust	Multi-directional	SK CK TK
Boxing ring	Authority: physical power or charisma	Bi-directional	SK TK/CK
Kitchen table	Trust	Multi-directional	SK TK/CK
Utopia	Trust, Authority: charisma	Multi-directional	SK TK/CK
Study club	Authority: content based, Trust	Bi-directional	SK CK TK
Expedition	Trust, Authority: charisma	Multi-directional	SK TK CK

Creativity, intuition, and the ability to express oneself are key features of the **workshop** SILO. Learners work on the development of new, future perspectives. Because learners are hindered by their daily affairs, the workshop challenges them to look beyond their current situation and break through their routines. The workshop focuses strongly on personal development, and not on feasibility or utility. Learners cooperate to develop new perspectives, where differences between learners set the direction of the learning experience. Coordination in the workshop is based on trust between participating learners. No expert, often only a moderator, is present to guide the learning process. Communication takes place among all learners, and is multi-directional. Similar to the clinic, transfer of sensory knowledge is dominant in the workshop. The transfer of theoretical knowledge is less present in the workshop. Coded knowledge transfer is the least dominant.

The **laboratory** SILO lets learners participate in research. Learning takes place through experimenting. In a controlled environment, learners try out new things, evaluate results, discuss and draw conclusions. Authority based on expertise coordinates learning in the laboratory. The expert sets out the central experiment(s) and provides direction to the learners. Communication is multi-directional; discussion among the learners is a critical facet of the learning experience. Most dominant in the laboratory is the transfer of coded knowledge. Results from the experiment(s) are communicated and discussed as central part of the learning experience. Next is the transfer of theoretical knowledge. Although less dominant, this type of knowledge is important in the laboratory, because general principles are searched through the experiments that are executed. Least present in the laboratory is the transfer of sensory knowledge, unless the content to be transferred explicitly concerns skills.

Bringing science to practice is the pivot point of the **academy** SILO. Scientific insights from multiple disciplines are applied in an integrated fashion. Scientific experts provide insight into developments and the current state of scientific knowledge to learners. Interaction between experts and learners ensures the multidisciplinarity of the academy. Coordination in the academy follows an authoritarian pattern, which follows from the expertise of the expert(s). The communication mode is mainly uni-directional from expert to learner. In the academy the transfer of theoretical knowledge is most dominant. Of lesser dominance is the transfer of coded knowledge. Hardly any sensory knowledge is transferred in the academy.

Practicing together, supervised by a director as in a play takes place in the **final rehearsal** SILO. Learners develop new routines with relevant stakeholders. From a diversity of perspectives, brought forth by each learner, possibilities and impossibilities to cooperate are determined. Experience is built and alternative solutions are sought through the motions of

rehearsing. The director analyses rehearsal progress and provides direction to participants. Coordination in the final rehearsal consists of a combination of standardization and trust. Routines for cooperation are fixed. Mutual trust resolves unforeseen situations, for which routines provide no adequate solution. Communication takes place from director to learner, but also between learners and therefore is multi-directional. Development of routines holds the central position in the final rehearsal SILO, linking to the transfer of sensory knowledge and to a lesser extent of coded knowledge. Theoretical knowledge transfer is mainly absent in the final rehearsal.

The **entrepreneur's café** provides learners with the opportunity for incidental learning and the creation of new networks between learners. The entrepreneur's café is the place for accidental encounters. Casual talks are interchanged with entertainment. In continuous changes in the configuration of groups of learners, the learning process is shaped. Learning outcomes are at the level of the individual learner. Trust is the coordination mechanism of the entrepreneur's café. Communication takes place solely among learners in various groupings and is therefore typified as multi-directional. The dominant knowledge type in transfer is sensory knowledge. Getting acquainted and exchanging personal experiences is the main purpose of the entrepreneur's café. Exchange of coded knowledge is less and theoretical knowledge is least dominant.

The **boxing ring** is a SILO that provides a competition based learning process. Performance of learners is rewarded. A coach aids learners to develop their knowledge. Through competition the aim is to stimulate each learner. The ultimate outcome of the boxing ring is collective learning. This however is not always reached due to time constraints; learning mostly remains located at the level of the individual learner. Physical power and charisma are the possible elements that provide the authority around which coordination is shaped in the boxing ring. Communication takes place between coach and learner and among learners in a multi-directional way. The coach gives indications and clues, but the same is done by the other learners. Mainly sensory knowledge is passed from coach to learner and between learners. Little present are knowledge transfers of coded and theoretical knowledge.

With **the kitchen table** SILO a learning opportunity is created that sets the learner in a safe position. Learner(s) and teacher meet in a quiet, secure context to discuss daily matters, as well as private issues (e.g., a learner shares doubts, uncertainties, vague plans, personal dilemmas, etc. with other learners and the teacher). The kitchen table facilitates learning at the level of the individual. Coordination in the kitchen table SILO is trust. Furthermore, communication is open between all participants and thus multi-directional. Sensory

knowledge is most dominantly shared at the kitchen table. Transfer of coded and theoretical knowledge is equal but little present.

In **Utopia**, learners aim to achieve a mutual goal, which is of a social nature and requires a joint effort by all participants to be realized. The learning process that is needed to achieve the goal is set out by the participating learners. Learning takes place at both the level of the individual learners and on the level of the group. Coordination of the learning experience in Utopia relies heavily on trust between participating learners and on authority based on charisma to overcome deadlocks in the learning process. Communication takes place between all participants and is multi-directional. In Utopia, transfer of sensory knowledge is dominant. There is low but equal presence of transfer of coded and theoretical knowledge.

The exchange of experiences between acquaintances is organized in **study clubs**. Participants provide a way to reflect on ones achievements. Together learners aim to plot a course for improving individual performance. Sharing of information and experiences surpasses cooperation in the study club. Learning exclusively takes place at the level of the individual learners. Authority based on certain expertise forms the main coordination mechanism, supported by trust among the learners. Each learner participates in the learning process, in multi-directional communication. In the study club, the exchange of sensory knowledge is most important. To a lesser extent, coded knowledge is shared between learners. Least dominant is the exchange of theoretical knowledge.

The final SILO that is distinguished is the **expedition**, moulded after the expedition concept knowledge from e.g., geographical explorations. Together, a group of learners set out on a journey to visit a particular physical or social place outside their own, daily context. The underlying rational is that new experiences in the world outside ones own context enables the development of new solutions and provides new insights. The expedition focuses on the learning experience of the individual learner through social interaction. Coordination in the expedition SILO consists of a combination of charismatic authority and trust. Learning builds on social interactions between learners, building on multi-directional communication. Dominance of knowledge types in transfer is of the order sensory, theoretical, and coded knowledge.

4. Discussion

The role of learning in sustainable innovation has been the start of our treatise. We indicated that sustainable innovation builds on the knowledge processes of knowledge use, knowledge sharing and knowledge creation. In all these processes, knowledge is handled; the handlers in all cases are human actors. In other words, human actors are identified to form the foundation of the mentioned knowledge processes and thus sustainable innovation.

A clearer understanding on the ways humans handle knowledge therefore is essential in order to understand sustainable innovation. In this article, we focused on the context of the human ability to learn. Learning is the process that enables human actors to change their perceptions and understandings of their environment and consequently change their interactions with it. “A clearer understanding of the ways humans handle knowledge” therefore requires a refinement. In order to understand sustainable innovation, and being able to influence or manage this, a clearer and deeper understanding of learning processes is needed. To contribute to this understanding, this article’s aim has been to provide insights in the way a learner’s learning experience is shaped by the context in which it takes place.

Three dimensions of learning contexts have been derived from the domain of knowledge management: i) the coordination mechanism used, ii) the direction of communication, and iii) the knowledge type dominance in knowledge transfer. These dimensions shape the basic structure of the twelve Strategic Inspiring Learning Opportunities presented in section three. Each SILO is associated with a specific configuration of the three dimensions. Although various SILOs appear to be similar, each SILO has a unique configuration on its dimensions. A SILO typifies the setting in which a specific learning experience takes place expressed in a specific coordination mechanism, communication mode, and knowledge type dominance. The uniqueness of a SILO limits the applicability of a SILO to a specific learning experience. For instance, if the learning objective is to teach a group of learners a set of practical skills, the Academy (SILO) appears less appropriate. The dominant knowledge type in this case is sensory, which by definition needs to be transferred by exemplifying and imitation; learners need to experience the same events as the teacher in order to acquire the knowledge. For current scientific insights, i.e., theoretical knowledge, are transferred and language, i.e., a code system, is the tool used in the Academy, the transfer of sensory knowledge is less likely. Similarly, the coordination mechanism seems to be fixed within a SILO. For instance, an Entrepreneur café will not provide an adequate environment for learning when standardization is used as a coordination mechanism. The learning experience of the Entrepreneur Café builds on spontaneous encounters between learners, which are not supported by a standardized process. Also the mode of communication is likely to be bound within a SILO; uni-directional communication during a Final Rehearsal, i.e., director or teacher to actors/learners, will probably end up in chaos. The essence of the Final Rehearsal is that learners attune their individual routines on those of the others. Central coordination will function poorly in such a case. When shaping a learning experience, the twelve presented SILOs provide possible arrangements that on the one hand aid in structuring the learning context, and on the other hand force one to carefully consider what

the learning experience is exactly about in terms of knowledge types, coordination mechanism, and applicable communication model.

Although our attempt has been to provide a complete enough sketch on learning, we have limited ourselves to one aspect of learning: the context of the process of learning. Learning has been presented as an experience in which a learner learns something. In this approach we have not been completely clear on two issues. First, we have not specified what the "something" is a learner learns; the domain in which the learning experience is situated has not been mentioned. And extending this content-related omission, we secondly have not indicated in what content-related direction (speeding up, widening, or deepening) the learning experience takes place in relation to the domain. We do not repair these shortcomings here. We merely provide a glimpse of the issues that would become relevant in case the content of a learning experience also is taking into account.

Learning, from an information processing system's view (discussed in the introduction), indicates a (deliberate) change of the body of knowledge and behavioural repertoire of an individual. Three such changes are recognized. The first form of learning involves a change of efficiency and speed of the application of knowledge. This form of learning relates to speeding up reasoning. Due to experience, long reasoning chains are replaced or complemented by heuristics, which simplify reasoning and enable the learner to more quickly respond to environmental stimuli. The second form of learning concerns a change of scope. The body of knowledge on a certain topic is widened. For instance, a shoemaker who is able to mend shoes extends his/her knowledge towards mending boots. The third form of learning denotes a change in the depth of the body of knowledge in terms of abstraction. Through this form of learning, the learner obtains deeper insights into a specific domain; s/he is able to see more abstract patterns and relations that explain phenomena within a certain domain. Linking these forms of learning to innovation we remark that all three forms are required. Loosely, these forms of learning connect to the innovation types of imitation, incremental, and radical. Imitation requires no new insights within a domain; being able to do things quicker within the domain suffices. Realizing incremental innovations builds on widening of scope, the second form of learning. Relatively small changes are made to existing products in this form of innovation. From what is already known, this innovation requires an extrapolation of knowledge to widen the existing scope. The most demanding form of innovation is radical innovation, which requires learners to obtain more in-depth knowledge within a domain. This form of innovation builds on the third form of learning involving a change of depth and abstraction.

All three forms of learning, identified above, relate to the content of learning, namely some body of knowledge or knowledge domain, and not to the process. The SILOs we present in this article have been defined without any reference to knowledge content. Content however, is relevant in shaping a learning context around a learning experience (and stands apart from the type of knowledge). The three forms of learning are to be seen as learning directions. Does a learner need to obtain a particular piece of knowledge in order to work faster, or should he be able to perform more similar tasks. Or is the objective to provide the learner with more in-depth insights into his area of expertise. The content of the learning experience is not a factor to disregard. Consider a situation in which a learner is trained in doing calculations. The learner is already familiar with subtractions and additions, and needs to learn multiplication. The learner would experience a change of scope in this learning experience. The teacher needs to configure a suitable learning context for this particular learning experience. From the twelve SILOs some will be more suitable than others. The Master Class for instance will provide a better context than the Boxing Ring. The teacher is able to carefully explain the concept of multiplication in the Master Class. Learners are given the ability to practice and the teacher corrects them when they go wrong. The Boxing Ring lets learners compete against each other in learning multiplication. No instruction is provided; the teacher only provides guidance as a coach. Though this example might appear trivial, it illustrates the inseparability of content and configuration of context of a learning experience.

Also on the level of sustainable innovation the distinction between content and process is known. This has been articulated in the concept of Sustainability of Knowledge, referring to the process-related side of sustainable innovation. The concept of Knowledge of Sustainability represents the content-related side of sustainable innovation. KoS indicates (i) knowledge content about causes that underlie environmental, organizational, social, and individual problems, and (ii) the knowledge by which such problems can be resolved. The improvement of an organization's behaviour, i.e. improving the sustainability of an organization, builds on the problem solving capabilities in which the firm applies KoS, and on the learning processes and its context based upon which the organization learns KoS. SoK on the other hand, focuses on the processes that govern the production, creation, and integration of KoS. For knowledge processes of an organization build on the learning processes of individuals within the organization, these knowledge processes depend on the effectiveness of learning experiences. The usage of SILOs enables an organization to not only improve learning processes of individual learners. Moreover, they provide an instrument to realize sustainability as well.

As indicated, this article presents a theoretical / conceptual deepening of our understanding of contexts of learning in the realm of sustainability and sustainable innovation. However, we have only discussed the process side of learning in detail. Hence, further theoretical exploration will be necessary. Additionally, the presented SILOs need to be studied in empirical settings for their relevance, applicability, etc. In order to take a step forward towards such empirical research, we formulate three expectations from the issues we have presented.

The first expectation concerns the relationship between coordination mechanism and appropriateness of a SILO. In this discussion we have provided an example in which a SILO has been tentatively said to fixate its coordination mechanism. Our expectation is that such fixation is generally the case. What we mean is that we expect that the Academy SILO will only function as a learning context in case authority is used as a coordination mechanism, as well as that a Kitchen table will not work without trust as the mechanism of coordination. The second expectation relates to the knowledge types that are transferred within a SILO. Carefully, we provided the example of the Academy SILO. From theory we derived that this SILO is less suitable to facilitate the transfer of sensory knowledge. Also here, we expect that the ascribed dominance of knowledge types within the various SILOs cannot be neglected. Whenever a certain knowledge type is dominant in knowledge transfer within a SILO, this needs to be obeyed. Reversely, applying the SILO to transfer knowledge of another type is expected not to function. For example, the Master class cannot be used to transfer sensory knowledge, nor will the boxing ring be suitable for the transfer of theoretical knowledge.

The third expectation concerns the content of knowledge. Though this aspect of learning has not been included in the core of this article, we want to address it. In this section we have indicated that the content of the learning experience limits the appropriateness of a SILO. This has been illustrated with the example of extending a learners knowledge on calculations; adding multiplication to his/her knowledge on subtraction and addition. Also here, we expect the relation between knowledge content and appropriateness of a SILO to exist. Some SILOs will be less suitable to facilitate learning involving a change of depth; others will not support learning in which a change of speed is the objective. For each of the formulated expectations, further empirical research will be needed.

References

Billett, S. (2001). Learning through work: workplace affordances and individual engagement. Journal of Workplace Learning 13 (5), 209-214.

Boisot, M. (1995). Information space: a framework for learning in organizations, institutions, and culture. London: Routledge.

Donald, M. (1991). Origins of the modern mind: Three stages in the evolution of culture and cognition. Cambridge, MA: Harvard University Press.

Estes, W.K. (1976). Handbook of learning and cognitive processes: Vol 4. Attention and memory. Hillsdale, NJ: Lawrence Erlbaum Associates.

Faber N.R. (2006). Knowledge in sustainable behaviour: using knowledge-based decision support systems for the improvement of sustainability. Published doctoral dissertation. University of Groningen, Groningen. Ridderkerk: Labyrinth Publications.

Gielen, P., Biemans, H., & Mulder, M. (2006). Inspirerende leeromgevingen voor ondernemers: Aanwijzingen voor ontwerpers en begeleiders. Wageningen: leerstoelgroep Educatie- en competentiestudies, Wageningen University Research.

Goodman, N. (1968). Languages of art. Brighton: The Harvester Press.

Hilgard, E., & Bower, G. (1975). Theories of learning. Century Psychology Series., Englewood Cliffs, NJ: Prentice-Hall.

Jorna, R.J. (Ed.) (2006). Sustainable innovation: The organizational, human, and knowledge dimension. Sheffield: Greenleaf Publishing.

Posner, M.I. (1989). Foundations of cognitive science. Cambridge, MA: Bradford Books, MIT Press.

Simon, H.A. (1960). The new science of management decision. Englewood Cliffs, NJ: Prentice-Hall.

Sorge, A., & Warner, M. (Eds.) (2001). The IEBM handbook of organizational behavior. London: Thomson Learning.

Williamson, O.E. (1975). Markets and hierarchies: analysis and antitrust implications. New York: Free Press.

Wilson, R., & Keil, F. (1999). The MIT encyclopaedia of the cognitive sciences. Cambridge, MA: The MIT Press