RELATING LEARNING, KNOWLEDGE CREATION AND INNOVATION: CASE STUDIES INTO KNOWLEDGE PRODUCTIVITY

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Session C-4

Abstract

This study explores the kind of learning processes that contribute to the improvement and innovation of an organisation's procedures, products and services. It aims to find the variables that promote or inhibit these learning processes. For this purpose a conceptual framework was developed. We present the results of 16 reconstruction studies deployed in various organisations in the Netherlands, China and Indonesia. The results confirm that the elements in our framework play an important role in developing and using new knowledge that is needed for improvement and innovation.

Keywords: knowledge productivity, learning, innovation.

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Suggested track: C

1 Introduction

In an economy where knowledge is dominant, daily operations in organisations should be designed to support *knowledge productivity* (Kessels, 1996; 2001). This process entails: identifying, gathering and interpreting relevant information, using this information to develop new skills and to apply these skills to improve and radically innovate operating procedures, products and services. Learning is at the heart of this process: tracing relevant information, and developing and applying new competencies are based on powerful learning processes. Can we cultivate the ability to be knowledge

productive systematically among individuals and teams? Can learning situations be designed that they promote knowledge productivity?

In our research programme, we are exploring how to stimulate and support the learning processes an organisation needs for the improvement and innovation of its products, services and processes. The key questions of this research are:

1. Which learning processes contribute to improvement and innovation of operating procedures, products and services?
2. Which variables promote or inhibit these learning processes?
3. How can these learning processes be stimulated by targeted interventions?

In this paper we describe our research framework, as well as the method and results of 16 case studies in various organisations in the Netherlands, China and Indonesia. We conclude with a reflection on the implications for further research.

2 Theoretical framework

The knowledge productivity concept is based on the view that knowledge is a competence that is linked to persons: 'knowledge needs to be understood as the *potential for action* that doesn't only depend upon the stored information but also on the person interacting with it' (Malhotra, 2000, p. 249). Knowledge productivity refers to the competence of individuals and groups to gradually improve and radically innovate operating procedures, products and services. In this research we focus on how organisations can develop the ability to achieve such changes: on the learning processes that contribute to the ability to be knowledge productive. A specific innovation, improvement or invention – possibly patented – may be of great economic value, but the true value lies in the *ability* to generate such improvements and innovations rather than in the actual innovation. This ability is closely linked to the ability to learn. As stated in the beginning of this paper, learning plays an integral part in the knowledge work that brings about these improvements and innovations. In this respect, the speed and cleverness of learning processes directly influence productivity of knowledge workers (cf. Drucker, 1999). Therefore, increasing the learning ability of individuals and organizations is closely linked to economic success.

The view of knowledge as a competence necessitates a critical re-examination of familiar ideas:

- the belief that knowledge can be imparted

  Competencies are not transferable. Each person needs to acquire and develop these independently. Knowledge transfer is the focus of many educational and training programs, where the instructional material is viewed as the container of explicit knowledge and the didactics as the transfer medium. Accepting the view that knowledge is a competence, from the perspective of knowledge productivity, deeply affects the structure of the surroundings where people work and learn.
- the idea that knowledge can be shared

  This idea has arisen chiefly in the context of the learning organization and is often invoked to justify the immense investments in electronic knowledge systems. Even the mythical assertions that knowledge can be shared infinitely with others without diminishing the supply of knowledge, however, have mainly the effect of a stencil machine. Knowledge as a competence cannot be shared.
- the distinction between explicit and implicit knowledge (e.g. Nonaka and Takeuchi, 1995)

  Viewing knowledge as a personal competence is incompatible with the notion of explicit knowledge. Explicit knowledge, which consists of codified, established, described, documented knowledge, is simply information about another person's competence. Gaining access to explicit knowledge, provides me with information about somebody else's competence. Reading a book or Lotus Notes entry, however, will not provide me with another person's competence: I will need to acquire and develop that competence myself.

These notions stimulated us to concentrate our studies on the learning processes in which individuals and groups engage in order to create innovations and improvements. We are trying to develop an understanding of the competencies that enable groups and organisations to create these learning processes: on the ability to be knowledge productive.

2.1 Towards a Framework for Knowledge Productivity

As a starting point for our research, we developed a preliminary conceptual framework for knowledge productivity, which we are now testing, improving, and validating. This framework is based on work and insights from various domains (Human Resource

Development, Organisational sciences, Learning theories). In this framework (see figure 1), we distinguish the following elements:

Outcomes for the organisation: The assumption behind the idea of knowledge productivity is that, in order to have long-term success in today's knowledge economy, an organisation needs to continuously improve and from time to time radically innovate its products, services and work processes (Drucker, 1993; Nonaka & Takeuchi, 1995). The distinction between gradual improvement and radical innovation is inspired by the work of Walz and Bertels (1995). Gradual improvement elaborates on what is already present and leads to additional refinement and specialization. Radical innovation is based on breaking with the past and creating new opportunities by deviating from tradition. Therefore, the results of knowledge productivity will be measured in terms of improvement and/or innovation of products, services and processes.

Knowledge processes: These results depend on the development and utilisation of the knowledge that is needed to realise the desired improvements and innovations (e.g. Leonard-Barton, 1995). In this (learning) process, we distinguish three processes/abilities (Kessels, 2001; Nonaka, Toyama & Byosière, 2001):

- identify, gather, exchange and interpret relevant information;
- use this information to develop new competencies;
- apply these competencies to improve and radically innovate.

This means that knowledge productivity not only comprises producing (creating) knowledge, but also making knowledge productive (application).

Competency development: Previous research (Kessels, 1996; Kessels, Van Lakerveld & Van den Berg, 1998) indicates that the competency development, which is at the heart of knowledge productivity, can be supported by *a corporate curriculum:* a learning environment that develops the competencies needed to be knowledge productive. This is not a formal curriculum prescribing the programs and courses that workers should attend. Rather, it involves transforming the workplace into an environment where learning and working integrate. Such a corporate curriculum serves seven related learning functions:

- acquiring *subject matter expertise* and professional knowledge directly related to the organisation's business and core competencies (e.g. a bank's financial services or the care provided by a hospital);

- learning to *identify and deal with new problems* using the acquired subject matter expertise (e.g. switching to a new tax system or introducing customer-oriented patient care);
- cultivating *reflective skills* and meta-cognitions to find ways to locate, acquire and apply new knowledge (asking questions like: how do we learn from our experiences? Why is it that we excel in developing sustainable energy but are unable to convince those around us of its value?);
- acquiring *communicative and social skills* that help people access the knowledge network of others, participate in communities of practice and make learning at the workplace more productive;
- acquiring skills to *regulate motivation, affinities, emotions and affections* concerning working and learning (it is important for knowledge workers to identify personal themes and ways to develop these);
- promoting *peace and stability* to enable exploration, coherence, synergy and integration; employees should receive the opportunity to master and elaborate a plan, idea or operating procedure. However, too much peace and stability might bring about overly one-sided specialization and an excessive internal focus, complacency or laziness;
- causing *creative turmoil*, which leads to radical innovation. Creative turmoil also results from a powerful drive to resolve a tricky question. The cause is often an existential threat: a matter of winning or losing, surviving or going under, being in or out. However, not all unrest is creative turmoil. Disturbance alone, without the drive to innovate, is irritating; too much creative turmoil may yield a thousand new ideas but leaves little opportunity to elaborate any of them. The learning functions peace & stability and creative turmoil are clearly conflicting, even though they are supposed to offset one another.

Work environment: As the corporate curriculum is not situated in an isolated learning centre, but integrated in the work environment, it becomes necessary to look at conditions in a work environment that support the learning functions of the corporate curriculum. Based on our research thus far, we can formulate three provisional development principles for a work environment that supports a corporate curriculum (Kessels, 2001):

- *Enhancing reciprocal appeal (the social context)*

  Knowledge-productive workplaces are rich learning environments in which the social context fosters collaborative efforts. No single manager, instructor or trainer, however, is exclusively responsible. Participants work hard to maintain their reciprocal appeal, which means that they do their best to provide each other with a fruitful learning environment. Important characteristics of this social context for learning seem to be: reciprocal respect, appreciation and integrity, sufficient safety and openness for constructive feedback and confrontations. The communicative and interactive skills of the participants are required to meet high standards.
- *Searching for a passion (the content component)*

  People are clever only if they want to be. A knowledge-productive environment encourages people to find their passion. Knowledge-productive environments encourage cultivation of a personal, substantive theme. Such an individual theme inspires curiosity and enables information to be traced more quickly. It facilitates establishing connections with attractive, professional networks and stimulates exceptional achievements where others might give up. Designers and knowledge workers need to become competent to navigate through the diffuse arena of affinity, motivation, passion and ambition to be able to apply their competence systematically.
- *Tempting towards knowledge productivity*

  Cultivating reciprocal appeal serves primarily to create a favourable social context. Searching for a passion establishes the foundation for substance. Promoting knowledge productivity also requires the competence to work systematically on the social context and the substantive component. The desire to guide, manage, control and monitor is becoming increasingly difficult to fulfil. The growing interest in self-guidance is apparent in both work and learning contexts. This leads us to ask how we can tempt each other towards knowledge productivity. The main objective is to acquire the competence to design a workplace that develops sustainable instruments, useful for dealing with future issues: the competence to become cleverer, learning to learn, organising reflection, increasing reflexivity and basically applying knowledge to knowledge development.

Context: The corporate curriculum and the design of a supportive work environment will be influenced by context of the organisation that influences the direction the organisation takes and the challenges that come up as a result from this. The triggers

for investing in improvement or innovation primarily come from outside the organisation (e.g. market, technological, social, environmental, political developments), but can also stem from internal challenges and ambitions (e.g. problems in work processes, worker satisfaction/retention, change in vision and ambition).

Interventions: In this research we are not only looking to clarify factors that facilitate or inhibit knowledge productivity. We are also exploring which kinds of interventions in work environment, corporate curriculum and knowledge processes can promote knowledge productivity.

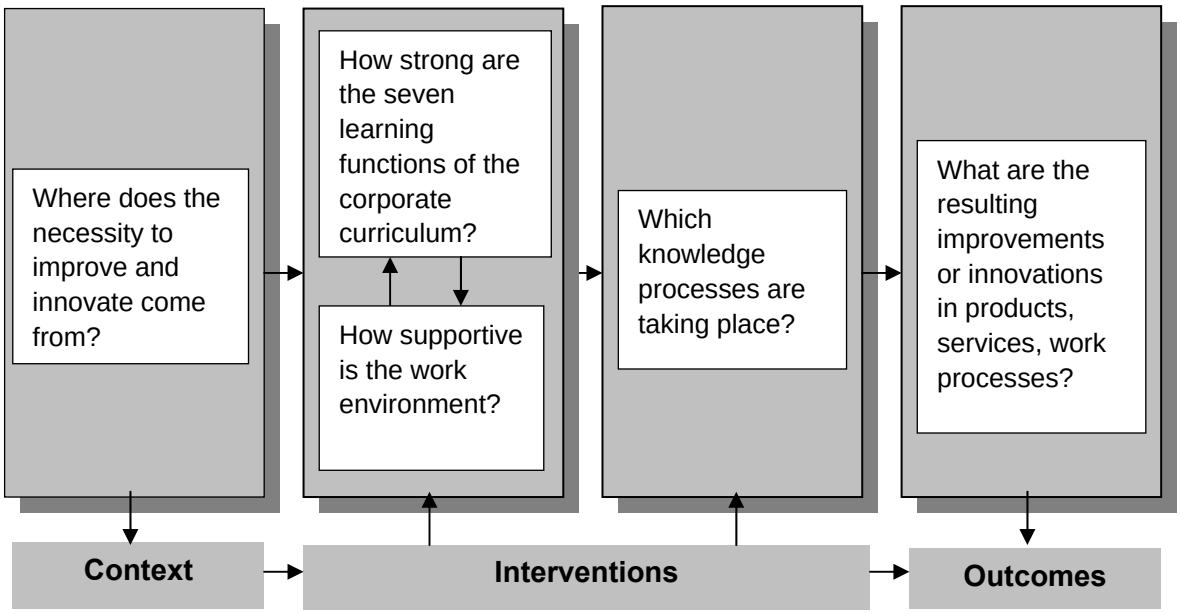

Fig. 1. conceptual framework for knowledge productivity

3 Research Approach

To research the relationship between the variables described in the conceptual framework, we engaged in an extensive research programme in which we are now using three research strategies:

- *Reconstruction Studies*. This type of studies is aimed at reconstructing the process of knowledge creation and utilisation that brought about important improvements or innovations. We research how a specific improvement or innovation was achieved and how knowledge development played a role in this.

- *Parallel Studies*. The parallel studies closely resemble reconstruction studies, with one difference: they are conducted during the innovation/improvement process in an organisation.
- *Development Studies*. In this type of studies, the researcher works together with an organisation to bring about the desired improvement or innovation. The design, implementation and evaluation of learning interventions in the organisation play an important role in development research.

Until now, 16 reconstruction case studies have been completed. Parallel and development studies have just been started. In this paper we focus on the methods and results of the reconstruction studies[i].

In this first 16 reconstruction studies, the cases vary widely across business sector and cultures. We deliberately chose to do the cases in this variety, to explore and validate our framework across contexts (see table I for an overview). In each case, a specific innovation was identified and reconstructed by interviewing all people involved and by document analysis. To allow for cross case analysis, we developed a list of questions, based on the conceptual framework described above, to be used by every researcher doing the case studies. For each case, a case report was written and validated. Based on these case reports, we made a within-case analysis using a matrix developed on the basis of the conceptual framework (c.f. Patton, 2000). A cross-case analysis was then carried out, especially looking for similarities across the cases. The focus was on two aspects:

- Are the elements of the conceptual framework recognisable in the cases and what role did they play?
- What are the critical elements in the cases that stimulated or hindered knowledge productivity?

This paper describes the results of this analysis.

Table I. Overview of the cases under study

Case	Project / type of innovation	Objective	Result / Impact	Persons directly involved
1. Multinational beer brewery (Netherlands)	David Dispense System / product innovation	Develop beer dispense system for low volume catering (=50% of the market)	Implemented new dispense system and increased sales volume by 10-15%	Cross functional core team of 8, 25 R&D people, involving suppliers
2. Multinational beer brewery (Indonesia)	Bintang World Class Manufacturing / process improvement	Meet increased market demands by optimising bottling line	Operational performance increased from 52% to 70%, breakdowns reduced and stock accuracy increased	Whole technical division, divided in action team, assist team and steering team
3. Natural gas producer (Netherlands)	Producing the Limit / process innovation	Maximizing production capacity while minimizing cost	Raise of gas production by 400 million m^3 gas	Core team of 6, cross functional, engineering backgrounds
4. Oil company (China)	Shangri La: new business model for distribution / process innovation	Regain control on distribution channel	New distribution system, optimise efficiency in distribution, new partnerships with retailers	Team of 14, sales and staff people
5. Foods and Home & Personal care multinational (Netherlands)	Integrating two production lines / process innovation	Combine 2 production lines into 1 that makes both products more efficiently	Reduction of operators and increased production	Cross functional team from engineering, operations, maintenance, HR, logistics
6. Foods and Home & Personal care multinational (China)	Hazeline Snow Cream / product improvement	Solve quality problem to satisfy loyal customers and attract new ones	Improved product (soap)	Cross functional team from R&D, Quality control, production and engineering
7. Foods and Home & Personal care multinational (China)	Phinda: develop and market new beauty soap / product improvement	Become market leader (in a fragmented market where it was loosing market share)	New beauty soap line introduced, leading market position	Cross functional team from marketing, R&D, purchasing, packaging and operations
8. Dutch Railways (Netherlands) *	New computer system for local planners / process innovation	Integral solution of planning problems and improve efficiency and timeliness	Stuck in dispute between advocates and opponents of a new direction	Group of 8: 1 designer of system and 7 local planners from different regions
9. Dutch Railways (Netherlands) *	New planning system for sharing infrastructure / process innovation	Standardising planning procedures throughout different planning stages (from long to short term)	New software design, accepted by participants and others in their work environment	Group of 7, 1 designer and 6 planners, participants checked new ideas with colleagues

10. Dutch Railways (Netherlands) *	New procedures for correcting imbalances / process innovation	Train availability where it is needed, more efficient use of trains	Not yet result achieved, stuck in exchanging and discussing	Group of 8: 2 designers of system and 6 local planners
11. Network for multiple land use (Netherlands) *	Living city / process innovation	New concepts for city planning and design, integrating various functions in a small space	Individual ideas and methods people use in their own practice, no integrative and common concepts yet	Community of Practice of ± 15 people from various organisations and disciplines
12. Network for multiple land use (Netherlands) *	Industrial area development / process innovation	Integrating various needs in the process of developing an industrial area	Common process model for the development of industrial areas	Community of Practice of ± 15 people from various organisations and disciplines
13. Network for multiple land use (Netherlands) *	Regional junctions / process innovation	Approach for integrating (often conflicting) demands and solving dilemmas	New process plan for the re-design of regional junctions	Community of Practice of ± 18 people from various organisations and disciplines
14. Hospital (Netherlands)	Cardio-diagnostic unit for General Practitioners (GP) / service innovation	Providing diagnostic facilities and expertise in a way that keeps control with the GP	Facilities and processes designed and implemented, but less patients than expected and sub-optimal cooperation	Core group of 3: 2 medical specialists and manager, limited participation by others in the process
15. Hospital (Netherlands)	Integrating care for various patient groups / process innovation	Improving patient oriented care and building a more flexible and multi-skilled workforce	Integration of two wards, cross-disciplinary protocols for patient care, multidisciplinary cooperation	Core team of 5 medical specialists and one manager, cross functional involvement of larger group
16. Hospital (Netherlands) *	Client orientation in concern staff / process innovation	Changing from prescriptive to client centred approach,	Better contact with clients, but also more uncertainty (innovation not yet finished)	Whole department, subgroups work on different assignments

The cases marked with '*' were reconstructions of a process that was not yet finished at the time of this research. From the table, it is already clear that the cases have one important characteristic in common: in every case internal people, working in cross-functional settings, were the driving force. The fact that internal people fulfilled a key role, was an element of our research design: we specifically looked for internally

developed improvements and innovations, and not for cases in which an externally developed solution was implemented. The reason lies in the focus of our research: we are looking at learning and knowledge productivity that is being developed internally.

4 Results

In this results section, we follow first the elements of our conceptual framework. At the end of this section, stimulating and hindering factors for the learning processes in knowledge productivity will be summarized.

4.1 Context and outcomes

In all cases, there was a clear need behind the initiative to innovate/improve, that was defined from the beginning:

- An urgent business problem (in cases: 2, 4, 6, 7)

  These problems came directly from external pressure, like: market demands that could not be met (case 2), breakdown of wholesaler network (case 4), unsatisfied customers (case 6). There was a need for direct action and a short-term solution. In these cases the organisations could not solve the problem with the kind of approach and solution they were used to, but needed to solve the problem in a new way. Innovation was a clear necessity, as a reaction to an urgent problem. In these cases, the innovation was handled in a very project-based manner. There was a high time pressure, which led to limited room for experimentation and exploring various paths. A clear direction was chosen very early in the process. As a result, the change that was realized was mainly incremental (in 3 of the 4 cases). In those three cases, knowledge development built on expertise that was already available inside the company (e.g. from technical centres or other business units). In one case, a radical new direction was chosen (case 4), which necessitated the development of new subject matter expertise.
- A perceived opportunity to innovate and to meet external demands (cases: 1, 3, 5, 8, 9, 10, 11, 12, 13)

  The opportunities also had an external trigger that became very noticeable for the organisations involved, like: new market opportunities (case 1), pressure on flexibility, efficiency and cost (cases 3 and 5), delays in train schedule (cases 8, 9, 10), and a nationwide problem with the use of the limited ground space (cases 11, 12, 13). In these cases the focus is not on short term: the external trigger is explicitly

combined with a strategic initiative of the organisation. Innovation was a deliberate choice: a pro-active approach in order to seize an opportunity. The choice was based on the vision that ‘more of the same‘ would not create a lasting solution and strong position.

In these cases, we see mixed results. In the contexts where the pressure was fairly high (in time or money) and desired results were well defined and known, the process had many characteristics of a project approach, but with new methods and extended cross-functional cooperation (cases 1, 3, 5). In the cases with a less clear idea about the desired output, there was more experimentation and also a search for the kind of approach and solution that would be best. The process was less smooth: half of the cases got stuck somewhere in the process, half of them came up with radical new approaches (sometimes after being stuck and creating a breakthrough out of this). In those cases, new knowledge was developed.

- A new ambition of the organization (cases: 14, 15, 16)

  In these cases there was a less tangible external pressure. The main drive for innovation came from the organisation’s vision. The lack of external pressure seems to hinder two of the three cases: new solutions and approaches were developed but the actual benefits of these in everyday work remain limited. One case was very successful, through capitalizing on personal motivation and by building a strong interdepartmental cooperation, involving almost all workers.

As a preliminary conclusion, we could state that external pressure is important to really make a difference in daily work. However, too much pressure could stimulate to work within known fields of knowledge and therefore limit innovation.

4.2 Supportive work environment

This section concentrates on the three development principles for a work environment that supports a corporate curriculum (Kessels, 2001) as mentioned in section 2.1.

Enhancing reciprocal appeal

Most cases show that a crucial basis for reciprocal appeal is the subject matter expertise that people posses: respondents from almost all cases report that it was attractive to work with people who are knowledgeable in other fields than they are. In two cases, we saw that people left the group when they felt they could not learn enough from the others. Personal contacts in a cross-functional setting seem to provide

an important basis for knowledge productivity: they created curiosity towards others and enabled the development of new patterns in interaction. Key characteristics of the social context that were reported are: openness to new ideas and input from others, tolerance for mistakes, care and respect. Working outside of the daily functional work contacts - in which position, hierarchical routines, and avoiding risk to loose face often play an important role - made it possible to develop such a social setting.

This does not mean that cooperation with people from different backgrounds automatically creates a stimulating social setting. Teams sometimes struggled to find productive ways to cooperate. Problems of misunderstandings, loss of time, and not being able to move beyond information exchange and discussion towards the development of common new ideas, were also apparent. Some projects even got stuck because of this (e.g. case 8 and 10). We encountered two types of interventions that helped groups to overcome these problems:

- Interventions directly addressing everyone's attractiveness for the team

  Ask direct and personal questions that invite people to make explicit what they expect from others and what they can bring to others, had a clear positive effect in some of the cases. This made the mutual attractiveness visible and oriented people to work on the basis of reciprocal appeal. For example: case 11 clearly shows how the intervention of a facilitator directly influenced the way the people involved dealt with the reciprocal appeal in the group. In this case, the facilitator asks the people within the community of practice explicitly to formulate what their contribution is to the process. By doing so, it became clear to one of the persons involved, that her contribution did not add something to that of the rest of the group. As a result she left the community.

- Introducing new methods of problem solving and cooperation

  In other cases, the introduction of a new methodology for the whole process or even a new method in one team meeting, stimulated the creation of more attractive patterns of cooperation. In case 3, a new methodology for problem solving gave a clear perspective on working together and created a context that was from the beginning on very different from everyday work. In other cases, a deliberate intervention in a meeting, like playing a game in case 9, got people out of the discussion mode and into a position of listening and more dialogue.

Searching for a passion

In every case there was a high commitment of the persons involved. They all had a personal interest: either an interest in the topic (like in cases 12, 13, 15), and/or an interest in the core challenge because they personally experienced the issues the project dealt with in their daily work (like in cases 4, 5). It is this intrinsic motivation that seems to be the driving force behind the innovation processes we looked at, and that creates the energy and commitment to get to a result in one way or another. In many cases, the intrinsic motivation was linked to a desire to share your qualities with others and at the same time learn yourself: being able to show, use and develop your knowledge was an important motivating factor. This personal passion provided in many cases a mix of curiosity and dedication to succeed.

Especially the combination of having a strong interest in the topic and having a personal stake in the solution/innovation that comes out of the process, seems to be very powerful. Where the curiosity in the content was limited, exploration of new paths and ideas was limited and a problem solving approach prevailed (case 2). We also saw a case (case 14) in which the personal passion of the key players for the subject matter of their work led to an unproductive definition of the ambition: they defined the desired outcome as a product/service innovation (new diagnostic centre) instead of a process innovation (new roles of general practitioners in the diagnostic process). This could happen because the problem owners (general practitioners and patients) where not involved in the innovation process. In the cases where the personal benefit in the solution is less apparent or even negative, it was often difficult to keep the energy (e.g. case 8, 11, 16).

Although the motivation concerned primarily intrinsic motivation, the cases show that pride, recognition and personal career motives are also important for keeping the process going. This motivation can be fed by extrinsic means such as attention or involvement of the management and by showing trust through explicitly giving responsibilities. This relates to the next development principle.

Tempting towards knowledge productivity

Being tempted towards knowledge productivity seems to be a crucial condition for an improvement or innovation to succeed. The strategies that worked in the cases, can be linked to the previous two principles:

Clear examples of ways to capitalize on reciprocal appeal and to create a positive social climate, were:

- Deliberately create and foster cooperation across functions and backgrounds (almost al cases).
- Create a new setting which opens up new interaction patters and invites participants to use new methods of working, like using the Community of Practice approach (cases 11, 12, 13).
- Make it a 'special event' for the people involved, which binds them together and at the same time makes them feel recognized. In one of the cases (case 3) the team that worked on the desired innovation were treated very special. They got their own room, clothing and lunches every day. In cases 5, 6 and 7 the results of the processes were added to a selection of 'hero stories'. This also supported a feeling of 'we are special and an attractive group'. They felt appreciated and connected to each other.
- Facilitate the process of working on the basis of reciprocal appeal by targeted interventions or methods (case 9, 11).

Examples to capitalize on the passion and personal motivation, are:

- Invite participants based on personal interest and expertise (instead of formal position or as representative of a functional group). This was done in most of the cases and it put the message across that expertise matters and was valued. People felt invited to use and develop their personal abilities.
- Link the core team to others inside and outside of the organization that have a clear stake in the results (managers, clients, colleagues). This contributes to a personally felt need (people you know and that are important to you are waiting for results) and to feeling recognized as doing important work. It also creates a challenge that triggers the drive to succeed.
- Stimulate participants to experiment and explore new ideas. This was mainly done by making explicit that experimentation is welcomed and also by deliberately choosing a new direction to solve the problem, for example: the decision to integrate production lines of different products (case 5) or the decision to change the distribution system fundamentally (case 4).

A common characteristic of these 'temptation strategies', is that none of these directly manage the innovation process: they are aimed at creating a setting and context for the innovation process to succeed.

4.3 Corporate curriculum

In this section we describe what was observed on the seven learning functions of the corporate curriculum in the examined cases.

Developing *subject matter expertise* played an important role in all the cases. Remarkable is that people in all the cases used diverse sources in order to gain subject matter expertise. This involved sources like books, internet, intranet, training, conferences, excursions to other departments within the company. Besides these data sources, also the personal network of people involved was heavily used to acquire subject matter expertise. In all cases, the process of finding and selecting information and developing subject matter expertise, was initiated and steered by the team members themselves.

There are two specific patterns that are worth mentioning:

- When time is short because of an urgent business problem (cases 2, 4, 6, 7) people tend to use knowledge that is already available within the organisation. The focus was more on finding and allocating subject matter expertise needs than on developing new subject knowledge.
- In change processes we reconstructed, we see that the subject matter expertise people posses, is one of the limited certainties in an uncertain process. That's why people tend to hold on to their subject matter expertise. It is then not easy to open up to new perspectives and conflicting views. In one third of the cases, it was hard for people to go beyond *exchanging* subject matter expertise (as was the case in cases 8, 9, 10, 11, 12, 13) in order to break with present ways of working and come up with radical new approaches.

Identifying and dealing with new problems is the second learning function. Using new ways of solving problems (meaning new to the persons involved) stimulated the participants to find new solutions. In the cases were experimenting and exploring was part of the process, the degree of innovation seems to be higher than in cases with a very focused problem solving approach. However, the chances of getting stuck and not produce a practical solution also seemed to increase.

In the interviews, it was striking that in their reflection in the way they worked and solved problems, the focus was very much on the content of the project. From these reflections, we can derive three ways in which people dealt with new problems. The

first is making use of available subject matter expertise, the second is developing and acquiring new subject matter expertise and the third is by means of the social network of the people involved. What is important in dealing with new problems is a sense of connectedness of the people involved with the experienced problem. When the people involved felt no urge to solve the problem, they were not very good at allocating the subject matter needed, developing this knowledge and/or involving the right people from their personal network.

Reflective skills and meta-cognitions were reported in the cases mainly during organised (group) meetings in which reflection was the main goal. This could for instance take the form of a workshop (case 4). What became clear is in that these organised meetings reflection was short and attention focused quickly on next steps to take in the process.
We could not trace specific examples of how people reflected on the way they acquire and apply new knowledge and to what extent individual reflection takes place (de also section 5). Our hypothesis is that most reflection was very task oriented: are we solving the issue and meeting our challenge; what is working well and what is not; what could we do next? In the next phase of our research we want to look further into this important learning function, which strongly supports the development of the ability to be knowledge productive.

Communicative and social skills play a crucial role in the cases. Almost all people mentioned open and good communication was essential in getting to results. In the examined cases, these skills served mainly three goals. The first is the use of your own network of colleagues and acquaintances in order to allocate the information you need. The second is to find the right people (people of whom it is expected that they can contribute to the process) and to involve them in a meaningful and for them attractive way. The third goal relates to the communication and presentation of your own ideas and opinion to others.

Skills to *regulate motivation, affinities, emotions and affections* play an important role in all the examined case. Personal motivation and affinity with a particular topic was the driving force behind innovations and improvements in the cases (see also what was discussed already in section 4.2).

Although the motivation, affinities, emotions and affections play a crucial role in the innovation- and improvement-processes, there was only one example (case 11) of how these motivations and affinities were explicitly used and developed by the people involved. The regulation of personal motivation and affinities seems to be done mostly implicitly.

With respect to *peace and stability,* the cases clearly show that peace and stability can influence the process negatively when there is too much a feeling of rest. The cases also show how peace and stability can be stimulating for the innovation process. Two examples illustrate this:

- Case 16 shows how too much peace and stability hinders knowledge development. In this case the people involved felt no urge to change. They wonder why the particular change process is already taking three years. This confirmed them in their thoughts that the particular process is not so urgent. Too much peace and stability was also hindering the process in the cases in which people found it hard to go beyond the exchange of information (cases 8, 9, 10, 11, 12, 13).
- Case 13 shows how a certain amount of peace and stability can help the innovation process to get a new impulse. In this case the existing stability (or rest) causes people to think in an open-ended way about the particular problem. Solutions that are brought up, do not necessarily need to be realistic. This allows people to think beyond existing frames.

Creative turmoil is recognised in the cases mainly when the people involved are under pressure. This pressure can exist because of the importance that is attached to the outcome of the process or because people themselves feel a strong urge to solve a particular problem. The creative turmoil is then responsible for a radical breakthrough.
Sometimes we clearly recognise restlessness without the creative turmoil. This was mainly caused by the fear to let go of safe and familiar way of thinking which always provided something to hold on to in the past. In the cases we recognised four ways of turning this unrest into creative turmoil:

- Organise an event. In case 11 a workshop is organised. Because people from outside the organisation are invited for that event, the pressure to “produce results” is increased, also because their reputation is at stake.
- Make an excursion. In case 13, where people try to innovate regional junctions, the group decided to meet each other at one of these regional junctions. That resulted

in a radical change in the way they thought about this junction and the way they talked about it.

- Produce something. In case 11 people started to work out in detail a particular design. After it was developed it became clear that not everyone agreed on the way this was done. This created an opportunity to go beyond the exchange of information and to negotiate about meaning.
- Experiment. In case 7 the people were stimulated to experiment with existing production lines. This raised a feeling of responsibility, because existing production lines were at stake. This caused a pressure to present results.

4.4 Knowledge processes

Based on the data we collected until now, it is difficult to really get a clear picture of the actual knowledge processes that took place. These processes are not directly visible, and take place in and between the heads of the people. For us, it was experimenting with ways to get the most out of the reconstruction studies. And for the people that were interviewed, looking at their work from a knowledge perspective was also new. It proved to be difficult to reconstruct, after a project was finished, what kind of knowledge processes occurred and when. In section 5.2, we will come back on this issue.

Still, there are some interesting results to report. The main observations are as follows. The process of identifying, gathering, exchanging and interpreting relevant information is a process that can clearly be seen in all the cases. These processes are practiced a lot and do not hinder the process of knowledge development at all. However, using the information in order to develop new competencies, is a difficult step in the process of knowledge creation. What we see in the case studies is that the effort to make the step from identifying, gathering, exchanging and interpreting relevant information to developing new competencies and to actually *use* each other's experiences and information in order to develop something new, is very hard. This part of the process is sensible for people to drop out or to loose their attention.

The cases in which people succeeded in actually using each other's experience and the information that is found, meet the challenge to apply these in order to improve and to radically innovate. In case of an urgent business problem (cases 2, 4, 6, 7) we see that this stage is more easily attained because it is clear who has an interest in solving

the experienced problem. Case 14 however shows how hard it is to radically innovate when not everyone is feeling an urge to solve the problem. In that case the cardiologists experience a real problem in the way things are organised right now. The other specialists involved in the innovation process, do not feel the same urge. It becomes clear that without a strong urge and an idea of the people who are attached to the outcome, it is very difficult for people involved to reach a breakthrough in the innovation process.

Besides the findings related to the specific knowledge processes, there is a more general finding that is worth mentioning: What did not become clear from the cases is how the people involved reflect upon these knowledge processes (see also section 4.3 where it relates to reflection). What we did see is that the interviews we did for the purpose of this research, served for the people involved as tools that help to reflect upon the processes they were going through.

5 Conclusion and reflection

The conclusions that can be derived from this study are twofold. The next section describes the learnings on knowledge productivity and section 5.2 describes how these findings influence future research on knowledge productivity.

5.1 Learnings on knowledge productivity

In the case analyses, the elements of the conceptual framework (figure 1) are clearly recognisable. This is in line with the conclusion of a large-scale survey research conducted by Van Lakerveld et. al. (2000). They proved that there is a clear relation between the seven learning functions of the corporate curriculum and the ability to improve and to innovate. The case studies reported in this paper supports this conclusion and add a more qualitative understanding of how the learning functions work in relation to specific improvement and innovation processes. An important addition to our understanding of knowledge productivity, is the conclusion that the three development principles (enhance reciprocal appeal, search for passion, an tempting towards knowledge productivity) seem to really support learning processes leading to improvement and innovation.

In the cases, the elements of our framework proved to have an important stimulating or hindering function. In the successful cases, many elements of our framework were present in a positive. However, we did not find many examples of deliberate and

mindful use of these elements. The were mostly created implicitly and on the base of personal choice and common sense. It would be interesting to research if a more conscious use of the conceptual framework in designing and facilitating innovation processes would lead to even more results, and especially to an increased ability to be knowledge productive.

With respect to the elements in the cases that stimulated or hindered knowledge productivity, we can conclude the following:

- Creative turmoil drives the innovation and improvement process. The urge that people feel to develop something new, together with an external pressure, creates the motivation to start and continue. At the same time, room for experimenting with new ways of working and problem solving offers energy and new perspectives.
- The substance of the innovation process is provided by the subject matter. Subject matter development was at the heart of most of the studied innovation processes.
- The autonomy and responsibility that was given to groups that are involved in a process of improvement or innovation, was crucial for the process to succeed. People involved needed the room to make their own choices and to decide on their own way of working. The communicative skills needed for doing this successfully, are of great importance but definitely not self-evident. People needed support in order to develop these communicative skills.
- Furthermore, people need to take time to reflect upon the process they are going through. Not only by deciding upon next steps to take but also they need to find time and ways to reflect upon the process itself.

The social context for knowledge productivity is provided by the cross-functional personal contacts, care and respect, and tolerance for mistakes. The personal passion leading to curiosity, the drive to work towards concrete results, together with the reward and recognition, serves as a reason for people to put an effort in knowledge development. The organisation and its management have an important role in supporting these innovation processes. This happens through inviting people and tempting them. Directly manage the process is impossible.

5.2 Learnings for researching knowledge productivity

Reflecting on the collected data, we see that it is hard for the people interviewed to make explicit what exactly happened in terms of knowledge development. People that were involved in the process are mainly concerned with the specific content and context of the innovation at hand. That is understandable, but also makes it hard for them to step back from that in order to talk about the process in terms of knowledge development. Also, looking back at these processes, several months after incidents happened, made it difficult to get to a level of detail necessary to pinpoint critical incidents. This limits the results of our cases. Further development of our research methodology is needed to develop a better understanding of the actual knowledge processes and of critical learning functions like reflection and self regulation of motivation.

Recently, we started large scale parallel and development studies (see section 3). In these studies we try to immediately hold on to important situations as soon as they take place in the process. In these studies we are now looking for ways to collect context rich descriptions of micro-situations that help to construct the story of what happened in an expressive, content rich and specific way. In order to do so we use the concept of discontinuities (Flick, 2002; Patriotta, 2003). Patriotta (2003, pp. 65) argues that "breakdowns, in the form of discontinuities, interruptions, and so on, create a cleavage between organization and disorganization, and therefore can be fruitfully deployed for an empirical investigation into knowing and organizing." Other authors like Weick, Perrow and Shrivastave (in Patriotta, 2003) also emphasize "the cognitive implications of major events such as crises, accidents and failures". Table II shows discontinuities that revolve around five main themes that we defined and that we are using in our research studies.

Table II. Overview of discontinuities

Kind of discontinuity	**Definition**	**Example**
Persons	A change in the composition of the group, the roles.	Someone decides to leave or an expert is introduced during the process.
Context	A change in the location where people meet, or in the way the location is arranged.	Instead of the usual meeting in their meeting room, they visit a location.
Thinking	A turn in the thinking-process that brings new frames of references and perspectives into existence.	New words are used, and sense making happens in a new way. The question is formulated again.
Action	A change in the strategy or tactics that are used, a new way of working or a new method.	A totally new way of working is adopted. Someone starts to make small reports after the meeting.
Time	Acceleration in the process, a delay, or large intervals in the process.	It is decided to organise a seminar. Everybody feels the time pressure and the process is accelerated.

We hope that tracking these discontinuities during the process, and directly building short and context rich stories around these moments, helps to get a deeper insight in the knowledge processes that take place and in the factors that stimulate or hinder these processes. We will also use the short stories that we build to facilitate reflection by the participants in the cases under study. Witherell et.al. (1995) argue that “stories invite us to come to know the world and our place in it” because of the engaging power of stories. This indicates that stories not only offer the researcher a powerful tool to understand the world of the people under study but also it helps the people under study by functioning as a mirror, or as a reflection-tool.

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