Knowledge integration as co-creation in a high performance context. Ski-preparation as a knowledge intensive activity under uncertainty

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Abstract

The purpose of the present paper is to explore the process of knowledge integration and co-creation within an elite sport context characterized by uncertainty and ambiguity. The study was designed and carried out as a qualitative case study. Data were generated through documents and interviews with key actors within three ski-preparation teams (cross-country skiing, biathlon, Nordic combined) and the ski-preparation project led by the responsible organization for elite sports in Norway, Olympiatoppen. The study identifies three major types of knowledge co-creation. The first concern bridging scientific and experience-based knowledge, where scientists have a more optimistic view on cumulative knowledge development. The second highlight the role of shared testing procedures to compare and evaluate prototypes generated though scientific and practical knowledge. The third illustrate that the extent to which knowledge are used in the different teams depends on their strategies and is reflected in the gatekeeper role. A key finding is that close and trustful relationships are vital in order to allow for new ideas about how to improve. In highly competitive environments such as elite sport, where small variation in judgements matter, knowledge creation as co-creation has a fundament social dimension, where success depends on trustful interaction and shared values. However, the paradox is that although all ski-waxers have a strong commitment to continuous development and improvement, they demonstrate a strong need to control this process within the different teams. The control influence the degree to which close and trustful relationships are developed and hence the possibility for knowledge co-creation.

More precisely, they engage in an active search for fine-tuning within a set of assumption that are rarely questioned. Close relationships seem therefore to be important for rendering knowledge co-creation possible in ways that also questions fundamental assumptions.

Keywords – Knowledge co-creation, conceptual slack, ski-preparation, elite sports

Paper type – Academic Research Paper

1 Introduction

For knowledge intensive organizations in competitive environments a major challenge is to continuously develop and refine knowledge to obtain and sustain competitive advantages. A key to this is to take advantage of and integrate different types of knowledge in local practices. Ski-preparation, as a key element in international competitions, is about continuous knowledge development and its application under uncertainty. This involve a series of complex and highly sensitive judgements where even small variations may have major effects on athletes´ ability to perform. The quality of such judgements relies on the ability of different types of experts, researchers, engineers, leaders, and practitioners that rely on different types of knowledge to engage in interaction that allow for co-creation of new knowledge.

The concept co-creation is often used to study different types of value creation; involving different stakeholders, customers, patients or students in the production of goods and services and innovations (Kadazi, Lievens & Mahr, 2016; Aarikka-Stenroos & Jaakkola, 2011; Zhao & Wang, 2015). The underlying assumption is that such co-creation rests on the ability to bring together information and knowledge in a way that integrate different types of knowledge (Berggren et al 2011; Grant 2008; Lindkvist 2011; Sankowska & Söderlund, 2015; Tell at al 2017). There is a need for a better conceptual understanding of what knowledge co-creation and knowledge integration entails in terms of the mechanisms involved in such processes.

Knowledge development and application in ski-preparation in Norway is situated within a cluster, and this creates opportunities for exchange of ideas, information and experiences across boundaries. A key challenge for organizations that strive to develop excellence is to combine and integrate research-based expertise with experience-based knowledge (Andersen & Hanstad, 2013). Diversity of knowledge may provide a fertile ground for creativity and innovation. It introduces variations in assumptions as well as observations and interpretation (Schulman, 1993). However, actors from different knowledge domains also tend to interpret the same things differently. This may create obstacles to knowledge integration (Lindkvist, 2011).

Knowledge integration requires that actors communicate across knowledge domains, develop relationships based on trust that allow for open and frank exchanges and challenges. The concept is often linked to knowledge creation and innovation, but there is no consensus in the literature about what this concept covers. There are a few empirical studies, and most deal with knowledge integration of technologies, in product development or linkage between functions within an organization (Berggren et al., 2011). Such studies primarily look at the relationship between various fields of expertise. The ambition here is to develop a better understanding of how different types of knowledge is developed, shared, combined and tested in practice within specific local knowledge regimes within communities of practice.

The purpose of the present paper is to direct attention to how co-creation of knowledge takes place across different contexts of experience, and particularly between scientific and experience-based knowledge. The study takes place in a setting where extending and refining knowledge to improve the ability to match the wide variety of conditions and uncertainty. This also relates to the kind of mechanisms that increases capacities for knowledge sharing, knowledge transfer and the emergence of local context specific knowledge regimes that govern communities of practice.

2 The context and main stages of knowledge development

Ski preparation is a complex process and involves different types of knowledge. Scientific knowledge about how snow parameters (e.g. snow temperature, snow density, snow grain size, use of chemicals), weather parameters (e.g. air temperature, air humidity, solar radiation, wind), kinetic friction (e.g. speed, water film thickness, vibration, inclination), and ski parameters (e.g. ski base structure, ski base material, ski length, camber height) influence choices in the ski preparation process are vital when making the right decision about how to select and prepare the skis (Breitschädel, 2014). The importance of scientific knowledge about these parameters has been recognized by the responsible organization for elite sport in Norway, Olympiatoppen (OLT). In 1989, they established the first ski-preparation project. The ski preparation projects follows the Olympic cycle. Over the years, the ski preparation projects have provided the ski preparation teams in cross-country skiing, Nordic combined and biathlon with important knowledge about ski parameters, methodology related to how to apply different types of ski waxing products and a common test database.

The success of the projects is unquestionable and several leaders of Norwegian skiing have stated that these projects have been a major competitive advantage, especially for Norwegian cross-country skiing (Stensbøl, 2010). Knowledge generated in the projects is developed in close collaboration with scientists at the Norwegian University of Science and Technology (NTNU), often after input from the different ski preparation teams. However, the usefulness of scientific knowledge depends on the degree to which it is

actively utilized and supplement best practices in the ski preparation teams. In the ski preparation teams, new scientific knowledge meet rich and extensive experiences captured in personal logbooks, craftsmanship skills and working practices for conducting the ski preparation process. The overall knowledge base is extensive and incredibly nuanced, yet incomplete.

The ski preparation project has a key role in the network developing new and refined knowledge about all aspects related to ski preparation. The leader of the project is also the head of the ski preparation team in cross-country skiing. In addition, the steering group includes leaders of the ski preparation teams in Nordic combined and biathlon, sporting directors of cross-country skiing, Nordic combined and biathlon, representatives from OLT and a scientist who holds a PhD in aspects scientific and technical related to ski preparation. In order to implement new solutions in the ski preparation teams it needs to be tested against existing solutions. Nevertheless, even if the solution is proven better in tests, it is up to the ski preparation team to decide whether they will include the new solution in their repertoires of solutions. Previous evaluations of the ski preparation projects indicate that personal relations and the type of knowledge the messenger possess (knowledge barriers) influence the integration and co-creation of knowledge (OLT, 2010).

Knowledge development aimed at improving the basis for competitive advantages in ski preparation takes place at different levels of the knowledge system. The ski preparation project finance scientific search to develop new solutions and improved understanding of the challenges involved in ski preparation (e.g. the relationship between physical solutions and variations in snow and weather conditions). New ideas are engineered into practical solutions used to produce general physical prototypes. Such prototypes are tested against the existing collection of skis already in use within the ski preparation teams. Although the ski preparation project develop general knowledge and prototypes, the extent to which new solutions are incorporated varies between the three ski preparation teams. An important reason for this is that the teams have developed different strategies reflecting resources that allow for different ambitions. Such strategies constitute the framework for the accumulation of local knowledge. Consequently, the different teams can be viewed as communities of practice (Lave & Wenger, 1991; Wenger, 1998) governed by different local knowledge regimes.

In this comprehensive knowledge system outlined above, knowledge development partly takes place independently, in different domains. Everyone involved shared a common goal: contribute to improved competitiveness. In this sense they are all stakeholders. However, for different types of knowledge to contribute to improved practices it needs to be communicated and tested across knowledge boundaries. The key question in this paper is how representatives of different knowledge in the system can interact in ways that lead to successful co-creation and integration of knowledge.

3 Knowledge development and sharing as co-creation

The ability to create new knowledge is often at the heart of the organization's competitive advantage. Knowledge creation according to the Nonaka's SECI model is about continuous transfer, combination, and conversion of the different types of knowledge, as users practice, interact, and learn. Knowledge sharing and knowledge creation thus go hand in hand. Sometimes such processes are viewed as part of knowledge management (Wellman, 2009). In many cases, however, creation and transfer of knowledge are two aspect of the same process, where people involved indirectly or directly interact in ways that is better understood as co-creation, where the distinction between creation knowledge creation and use is less clear.

Sometimes co-creation of knowledge takes place in the same location simultaneously, in parallel or partly overlapping processes. However, co-creation may also be sequential. A typical case would be research and development inspired by practitioners problems, which leads to new solutions that may offer improvements in a practical setting. However, to be adapted and integrated as part of an improved practice, new scientific knowledge need to be translated or converted in a way that is understandable and comparable in a practical setting. This process may involve the development of prototypes and testing, but to be accepted and adapted by practitioners knowledge needs to be relocated in a social and practical context. The role of individuals with a double legitimacy, i.e. considered competent and trustworthy by both by representatives of both formal scientific and practical knowledge play a key role in such co-creation processes. Where knowledge is complex, it may be difficult to make precise judgements about reliability. This is particularly the case where practitioners face environmental uncertainty and where small variations in outcomes may have major consequences for the result.

Studies of social learning show that it may sometimes be difficult to dis-tangle the social from the conscious cognitive processes involved in learning. The implication is that actors involved in knowledge sharing and co-creation find it hard to distinguish between the quality of the knowledge offered and the quality of the social relationship(s) that is the context for learning. Judgements about the quality of knowledge and the willingness to accept advice and in-put in collective learning tend to reflect the perceived quality of relationships. Quality of knowledge refer to whether it is perceived as being precise, usable, tested, offering possible improvements and increased reliability. The likelihood that contributions are accepted and valued as part of knowledge co-creation someone increases when actors involved previously have demonstrated competence, trustworthiness, shares frame of reference, and experience from the practice field. In other words, actors may find it difficult to distinguish between their own and others' knowledge (Slomann & Rabb, 2016).

Diversity of knowledge may provide a fertile ground for creativity, innovation and co-creation. It introduces variations in assumptions as well as observations and interpretation. Schulman (1993) calls this conceptual slack. However, actors from different knowledge domains do not only know different things, they also tend to interpret the same things differently. This may create obstacles to knowledge integration (Lindkvist, 2011).

Knowledge co-creation requires that actors communicate across knowledge domains, develop relationships based on trust that allow for open and frank exchanges and challenges. The concept is often linked to knowledge integration and innovation, but there is no consensus in the literature about what these concept cover. There are a few empirical studies, and most deal with knowledge integration of technologies, in product development or different linkage between different functions in an organization (Berggren et al., 2011). Establishing such holistic understandings of new products or organization processes is a form of knowledge co-creation. Existing studies primarily look at the relationship between various fields of expertise. Andersen (2009; 2012) points to the importance of integrating these two types of knowledge in the Norwegian sport cluster. However, we are not aware of studies that cover the relationship between expertise and experience-based knowledge.

Various types of expertise represent articulated explicit and general knowledge covering different aspect of a practice domain. Evidence is validated through research procedures. Experience-based knowledge covers both articulated and tacit knowledge. It is embedded in a field of practice. The reliability of experience-based knowledge may vary. However, self-conscious, expectations-based approaches may greatly enhance reliability of learning (Sitkin 1992, Weick 2006). Pfeffer and Sutton (2006) argue for conscious experimentation in local context to establish practical reliable evidence-based knowledge. Successful combination of knowledge across areas of expertise, and between formal expertise and experience-based knowledge, may happen in different ways and contribute to both knowledge creation and application in practical situations (Andersen & Hanstad, 2013). In other words – knowledge co-creation require re-contextualization/ integration within a specific knowledge system – where assumptions may vary with respect to strategies/ risks etc. In this way, knowledge co-creation also lead to the development of contextualized practical knowledge that represent local knowledge regimes.

4 Method

The study was designed and carried out as a qualitative case-study of knowledge integration and co-creation in the context of three Norwegian ski preparation teams: Nordic combined, biathlon and cross-country. These teams are among the most advanced in their field and organized within the respective sport associations. There are a number

of formal and informal relationships and contacts across the different teams, and there is considerable mobility of personnel. Data consist of full access to internal reports and documentation as well as 10 individual and three group interviews with major actors involved. In addition, three follow-up interviews were conducted to clarify our initial understanding. The analysis had three major steps. The first was descriptive and identified different types of knowledge involved in the ski-preparation process. In step two, we related the challenges and opportunities related to knowledge integration and co-creation in the ski-preparation process to perspectives on learning in knowledge intensive organizations. The last step involved a more in-depth analysis of the how of knowledge integration and co-creation influenced the ability to cope with uncertainty and ambiguity.

Developing in-depth knowledge though conversational interviews is an iterative process, where preliminary interpretations of key facts, relationships and theoretical significance are tested in conversations of increasing detail. Like in statistical methods, constructing and structuring data is a complex process consisting of many steps of data reduction. Unlike in statistical methods, there are, however, no simple procedures for summarizing the underlying logics and present data that support the analysis. The conventional way to deal with this is to use typical examples of approaches, practices and arguments to illustrate essential elements of data structure and interpretation. This is also what is used here (Andersen, 2013; Silverman, 2005).

The study uses pattern matching as a main procedure for qualitative data analysis (Campbell, 1975; Yin, 2009). It applies both to preliminary interpretations of facts and relationships, and to overall interpretation and explanations. All interpretations imply additional, and increasingly detailed, empirical observations. As the analysis matures, assumptions and interpretations are validated in relation to ever more comprehensive empirical patterns to eliminate other interpretations and explanations. In this way it is possible to establish systematic relationships which exploit numerous observations in the case. However, in contrast to statistical analysis, it is not the number of observations that provide analytical control. It is the congruence between a rich set of implications that follow from assumptions and interpretations, on the one hand, and observed empirical patterns, on the other (George & Bennett, 2005).

5 Findings & Discussion

5.1 Main stages and mechanisms of knowledge co-creation and integration

The ski preparation project is designed to continuously develop knowledge and solutions that can be used to improve the competitiveness of Norwegian skiers. The project has two major roles. First, it initiates developments within two areas. On the one hand, they finance scientific research to better understand the main mechanisms that influence the ski preparation process. On the other, they encourage practitioners to test and use new solutions to improve or replace existing ones. Second, they have experts

with a practical background that are actively involved in testing new solutions developed either through research or based on initiatives from the ski-waxers. Different knowledge may be developed independently, sometimes sequentially or in parallel. This is also what we found in the knowledge system that we have studied.

The main stages in development is captured in Figure 1 below. The interaction between representatives for different knowledge domains have to some extent developed a common terminology and physical representations of knowledge as reference points for testing and comparison. These elements are essential in the conversion of scientific knowledge into the practice domain. Concepts with scientific or practical grounding seem to be only partly overlapping. However, testing regimes used to compare different physical prototypes represent a common ground. Such differences in the status of these two conversion mechanisms became were often mentioned in our interviews.

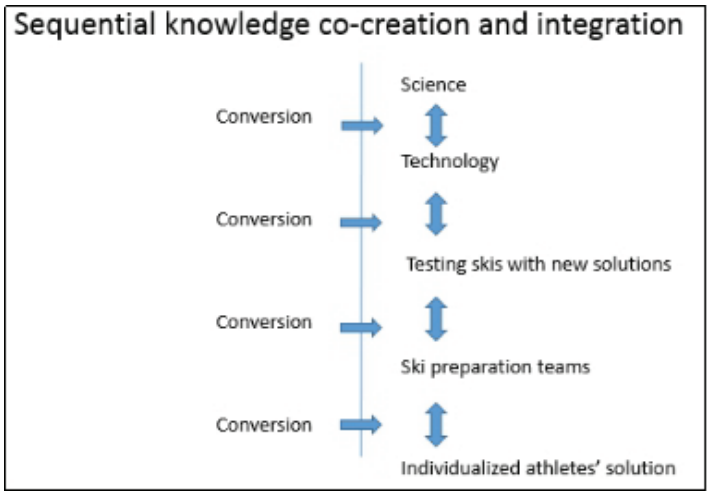

Figure 1: Schematic overview of the main phases in the knowledge development process. The stages illustrate how co-creation requires conversion that allow new knowledge operational and compared across knowledge boundaries.

Scientists may identify new ski base structures based on research about the interaction between various snow and weather conditions. This kind of knowledge enriches the knowledge base but it does not provide a basis for predicting best solutions. What appear to be promising solutions needs to be tested in practice. There is an engineering company that has developed a technology to grind suggested solutions onto the ski base so that the new physical prototypes can be tested against existing ones. This approach suggests that even well developed scientific knowledge are incomplete due to the complexity of factors influencing the conditions of use. An incident that was related by one informant illustrates this. "*After grinding a new ski base structure, we discovered that the grinding*

wheel was installed the wrong way. However, we decided to test the solution and found that it worked surprisingly well."

Converting different types of knowledge into comparable physical prototypes is an essential mechanism in knowledge co-creation across different knowledge types. This conversion process bridges between knowledge that has developed within different domains, based on a set of priorities that has emerged from a process of consultations and discussions. The initial development of new knowledge is not co-located. Different types of knowledge development takes place in different locations; at the university, at the factory that help transform new solutions into physical representations, in separate tests by representatives of the development projects and the three teams. In this sense a major part of the knowledge co-creation is sequential, although different actors occasionally meet and carry out tests in same location. In the ski preparation teams there are a parallel process of refining practical solutions. Sometimes, they suggest minor alterations in the existing ski base structure. New solutions are tested against what is considered the best solutions.

A common framework for the processes going on in research and within the practitioner field is that they have shared methodology for testing solutions against each other. The test regimes that cover various aspects of ski preparation serve to make various inputs and judgements comparable. This is similar to what Lindkvist (2011) has described in product development, where the systematic comparisons of physical prototypes becomes a focal point in a collective learning process. It helps actors representing different types of knowledge see how their input fits into a holistic solution. However, in ski preparation the process is incremental. Promising new prototypes are primarily compared to the existing repertoire of physical prototypes in use. The most promising ones are offered to the three different teams, but not necessarily accepted and used.

5.2 Local co-creation as integration of new knowledge in ski preparation teams

The three ski preparation teams face similar challenges, but they have chosen different strategies that govern the way they develop knowledge and apply it in competitions. Such differences partly reflect the resources available. The Norwegian ski preparation team in Nordic Combined has limited resources. For this reason their ambition is to provide the skiers with satisfactory skis compared to the competitors. They have a small organic team and a simplified system for search and implementation solutions. Their strategy is to have a platform restricted to 6 different ski base structures that are broad and less vulnerable for changing conditions. The ski preparation team in cross-country skiing, on the other hand, has more resources and their ambition is to provide the skiers with the very best solution of day. This requires a complex and time-consuming process, which is dealt with through specialized division of labour. This requires extensive and detailed procedures. The strategy is to have many and specialized ski base structures (10 or more different ski

base structures) covering a wide variety of special conditions. For biathlon, the ambition and strategy lies somewhere in between.

Whether or not a new solution is accepted for further testing within the different teams depends on their ambitions and strategies that affect the way new solutions are interpreted and fit into existing knowledge systems. Such systems not only reflects ambitions and strategies, but also the accumulation of practical knowledge build into physical solutions and procedures. In other words, what may be viewed as a possible improvement in one team may not be viewed as attractive, interesting or easily adopted in another team.

In our interviews it became clear that the relationship between representatives of the ski-preparation project that makes the offer and key people in the different ski preparation teams is essential for the willingness to engage in discussions about possible improvements. One representative of the ski-preparation project said that the personal background was the most important factor in gaining access to the gatekeepers (Allen et al., 1979; Carlile, 2004; Jones, 2006) within the ski preparation teams. Together with the other statements from our interviews, it seems that the quality of the relationship may be as important as the quality of the knowledge in question. In other words, an important mechanism for knowledge co-creation across experience-based knowledge systems is the legitimacy of the person representing the knowledge. Hence, the gatekeepers does not only pay attention to the credibility that the messenger carries but also the credentials of the messenger that create credibility and trustworthiness (Sankowska & Söderlund, 2015).

These findings are line with evaluations of earlier ski-preparation projects that touches upon knowledge development and application (OLT, 2010). Our study also points to another factor, how complexity in critical situations may lead to confirmation seeking where existing routines may create false reassurance that limit a search for new solutions. This means that there is less active boundary spanning than one could expect in teams that needs to engage in continuous development. This limit the co-creation of knowledge on the boundaries of the teams and at the same time strengthens the co-recreation within the teams. Strong team cultures, where members feel a strong loyalty to each other, seem to limit the exposure to alternative models for evaluating basic assumptions underlying everyday practices. As Schulman (1993) has pointed out, the ability to conceptualize practices from different perspectives, so-called conceptual model, provide major advantages in reliable experience-based learning.

6 Concluding remarks

In our findings, we discussed to major types of knowledge co-creation. One concerns the relationship between scientific and experience-based knowledge. Representatives of scientific knowledge have a more optimistic view than practitioners on how cumulative knowledge development can increase the ability to match solutions to a countless number

of demanding conditions. A key finding is that the conversion of scientific knowledge into physical prototypes which can be tested against existing solutions is essential for making different types of knowledge comparable. New and tested solutions add to a repertoire of experience-based knowledge. The second type of co-creation relates to how such new solutions can be accepted and used within existing experience-based knowledge within the teams. It turns out that the different teams utilize different types of knowledge that may influence the interest in identifying, developing and testing new solutions. Another key finding is that the relationship between representatives of the ski-preparation project and the ski-waxers is of critical importance for the openness to new ideas within the teams. The paradox is that although all ski-waxers have a strong commitment to continuous development and improvement, they demonstrate a strong need to control this process within the different teams. More precisely, they engage in an active search for fine-tuning within a set of assumption that are rarely questioned.

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