Nurturing Communities of Practice for Effective University-to-Industry Technology Transfer: Two Exemplar Cases from the Cauca Region of Colombia

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Abstract

This paper's primary aim is to demonstrate how university-industry technology transfer can be achieved effectively by nurturing and bridging communities of practice amongst recipients of technology and stakeholders concerned with technology diffusion, productivity and economic development. Its empirical evidence is from an intervention initiative targeting two small-scale industries, namely fish farming and coffee production, in the Cauca region of Colombia. Results show how barriers to transfer have been overcome and the intervention's design elements and outcomes are discussed.

Keywords: University-to-industry technology transfer, Community of practice, Small scale production, Knowledge diffusion

Introduction

The main aim of this paper is to demonstrate how technology transfer from university to industry can be effected via nurturing and bridging communities of practice (CoPs) (Lave and Wenger, 1991) amongst recipients of technology and academic and governmental organisations concerned with innovation, productivity and economic development. Evidence from an action research programme involving two small-scale industries, namely fish farming and coffee production in the Cauca region of Colombia is used to illustrate the design elements and outcomes of this intervention, which was undertaken by the University of Cauca/PIRC (translated as Production and Innovation Regional Centre).

By considering university-industry technology transfer as a learning programme that involves nurturing and bridging the CoPs comprising academic actors, regional government officials and small-scale producers, this paper attempts to synthesise and contribute to two streams of literature. The first relates to the body of knowledge on university-industry technology transfer, while the second concerns the scholarly debate on the constructability and performative advantages of CoPs. Given the potential of university technology transfer for promoting innovation and competitiveness at regional and national levels (Bennett and Vaidya, 2005) and the recent surge of interest in CoPs (Storberg-Walker, 2008) this paper addresses significant domains of inquiry. The following section discusses the theoretical approach underpinning this intervention.

Theoretical Approach

Although diffusion of new technology constitutes one of the main activities undertaken by universities, the technology transfer process is fraught with challenges (Markham et al., 1999). On this issue, Decter et al. (2007) highlight "cultural difference" between university and business as one of the main barriers to technology transfer and report that "lack of entrepreneurs" and "need for more technical support" constitute moderate barriers. Other scholars (Gourlay and Pentecost, 2002; Greiner and Franza, 2003; Bercovitz and Feldman, 2006; Albors-Garrigos et al., 2009) have identified specific challenges, closely related to those identified by Decter et al. (2007). These refer to clearly defining end-user needs, demonstrating the benefits of new technologies to potential end-users and the role of government institutions and networks in influencing user acceptance. These findings are echoed in recent research on university-industry technology transfer in rural areas of Colombia (Department of Cauca, 2008), which indicates that research institutions charged with propagating new production methods face particular difficulties in dealing with rural communities. The main reasons include:

- Potential recipients of new technology have difficulties in expressing their knowledge on the methods they use in appropriate language to those concerned with technology diffusion;
- The benefits of new technologies are not immediately evident to them;
- The institutions have incomplete knowledge about the new methods and how to connect them with existing practices;
- There is no systematic process in place to obtain information about how the technology transfer happens and to document the gains of technology transfer.

In order to overcome these barriers in its effort to transfer new technology to small-scale fish farmers and coffee producers in the region of Cauca the University of Cauca/PIRC in Colombia sought to nurture a community of Practice (CoP), comprising itself two regional Government Agencies and the regional Chamber of Commerce. This coalition CoP was concerned with technology diffusion in the region. Subsequently, the second CoP comprised fish farmers, while the third encompassed the region's coffee producers. Situated learning/CoP theory has recently gained momentum, providing an alternative to conventional approaches to diffusing knowledge. Its primary tenet is that learning is a fundamentally social phenomenon reflecting the social nature of human beings capable of knowing and 'it is understood as the development of a new identify based on participation in the system of situated practices' (Gherardi et al., 1998: 276). The central construct within situated learning theory is the notion of 'community of practice'. "Communities of practice are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger et al., 2002: 4). For Wenger, the construct 'community of practice' constitutes a point of entry into a broader conceptual framework, which underscores the importance of community, practice, learning, meaning and identity as elements that '…are deeply interconnected and mutually defining' (Wenger, 1998: 5). These components illuminate the learning process – e.g. learning to diffuse or absorb a new technology - pointing out what matters about learning and placing emphasis on the tacit component of knowledge.

Situated learning/CoP theorists (Wenger 1998, 2000; Brown and Duguid, 1998, 2001; Wenger et al., 2002; Brown, 2004) argue that the ability of a CoP to create new meanings as to what matters in pursuing an enterprise or learn new competencies (in this instance. optimising diffusion and absorption of a new technology) depends on three factors. First, the strength of the community; second, the quality of its 'boundaries' (the spaces where different CoPs interface); and third, the health of the communal identity that enables the creation of new meaning and learning. The strength of a CoP refers to how well members of a CoP engage and socially participate in the community's efforts towards the achievement of a common purpose. It also relates to how well a CoP can coordinate perspectives, interpretations and actions so that higher goals are realised. Leadership that promotes connectivity, active membership and artifacts such as symbols, documents and tools enhance the strength of a CoP. The quality of the boundaries on which different CoPs socially interact is determined by the establishment of 'brokers' (i.e. mediators with an understanding of the interacting CoPs), the presence of common 'boundary objects' (e.g. agendas, action plans and assessment frameworks in use) and the potency of boundary encounters (i.e. how well these events allow for meaningful interaction among interfacing CoPs). Healthy identities are characterised by connectedness (i.e. uniting members), expansiveness (i.e. allowing space for new perspectives) and effectiveness (i.e. enabling participation and action).

Conceivably, fish farmers and coffee producers constitute distinct networks of practice, or CoPs (Brown and Duguid, 2001; Gherardi and Nicolini, 2002; Swan et al., 2002). Although the challenges they face may vary, as these largely hinge on the, age and stage of development of the firm (Storey, 1994), at a broad level each of these groups is concerned with a certain type of enterprise. Conversely, members of the two regional Government agencies, the regional Chamber of Commerce and PIRC, all belong to different networks of practice or transnational 'epistemic cultures' (Knorr-Cetina, 1999). As such, they represent different competencies, views, repertoires and priorities as to technology diffusion in the region. To a certain extent this explains the aforementioned challenges entailed in university-industry technology transfer. Drawing on situated learning/CoP theory, it follows that such challenges can be attenuated and learning to diffuse technology effectively (by academics and government officials) or absorb technology successfully (by fish farmers and coffee producers) can be enhanced by nurturing and bringing together such CoPs. In fact, prescriptive recommendations relating to functionalist interventions concerned with 'structuring spontaneity', constructing and directing communities of practice to increase organisational performance are becoming increasingly common (Lesser and Everest, 2001; Wenger et al., 2002; Plaskoff, 2003).

However, there has been a growing tension in the literature around the question of whether communities of practice – earlier portrayed as spontaneous forms of organising, thriving in informality (Brown and Duguid, 1991; Lave and Wenger, 1991) - can be constructed and managed. Moreover, whilst the formal and informal intra-organisational social relations characterising such professional networks have been considered in the literature linking CoPs with learning and innovation (Brown and Duguid, 1991), rarely have inter-organisational relations been examined empirically (Swan et al., 2002). More critically, some cast doubt on the usefulness of situated learning/CoPs theory (Roberts, 2006), while others more emphatically claim that it does not provide an operationalisable framework (Storberg-Walker, 2008). This intervention – by nurturing a coalition CoP and bridging it with a fish farmer and a coffee producer CoP to undertake successful university-industry technology transfer - constitutes a modest attempt to apply situated learning/CoP theory in practice and respond to the above concerns. The following section delineates the action research approach adopted to design and implement effectively a programme of technology transfer from the University of Cauca/PIRC to fish farmers and coffee producers in the Cauca region of Colombia.

Research Approach and Methods

The study reported here is interventionist in nature, being undertaken by the University of Cauca/PIRC. It is regarded as a Mode 2, inter-organisational action research programme combining research with practice with the dual purpose of bringing about change and advancing knowledge (Reason and Bradbury 2001). A similar approach has been adopted by Theodorakopoulos et al. (2005) in nurturing and facilitating the interaction of CoPs comprising corporate purchasers and small suppliers. The study takes a longitudinal approach towards diffusing new technologies to fish farmers and coffee producers in the region. More specifically, PIRC acted as a catalyst in nurturing three CoPs over a period of two years. The first CoP was a coalition comprising PIRC, two regional Government Agencies and the regional Chamber of Commerce. The members of this coalition had a vested interest in innovatory technology diffusion amongst fish farmers and coffee producers. Both groups are considered significant in the region in socio-economic terms (Department of Cauca, 2008) and the adoption of the technologies in question amongst fish farmers and coffee producers aimed to increase their cost savings, productivity and quality of produce. More than this, the technologies in question are novel and eco-friendly, addressing innovativeness and environmental considerations, which are rated highly in the regional agenda of economic development, social cohesion and sustainability. The second CoP consisted of 44 fish farmers, whilst the third included a total of 35 coffee producers. These enterprises were small, employing between 5 and 37 workers, with size being subject to seasonal variation.

The outcomes of this university-industry technology transfer, with regard to innovativeness, cost savings, productivity and quality of produce among members of the latter two CoPs, were achieved through cycles of action-reflection on ‘what works and how’ (Coghlan, 2001). Focus was on the ‘key components’ of the programme i.e. the coalition’s steering group and the workshops delivered to participating fish farmers and coffee producers, in conjunction with the follow-up visits to them. The steering group was designed to nurture the coalition CoP, while workshops and follow up visits were designed to create generative boundary interfaces between the coalition and the fish farmers and coffee producers and strengthen the latter two CoPs. Knowing how to optimise these components is seen as instrumental for the success of future community engagement projects of similar nature. Learning ‘what works and how’ occurred through each participant CoP assessing the impact of technology transfer programme through recurrent action-reflection. The three CoPs, i.e. the coalition, the fish farmers and coffee producers, had to inquire into their operations practices, as a basis for better informed actions all round. During the programme, through steering group meetings, members of the coalition CoP were learning 'what works and how' in designing and implementing a technology transfer programme, so that they can engage more effectively with each other and with recipients of technology in the future. Fish farmers and coffee producers, as CoPs interfacing with the coalition in workshops and one-to-one visits were learning how to absorb 'know-how', adopt more effectively innovatory technologies and develop their production capabilities.

Data collection and analysis were guided by situated learning/CoP theory in the context of university-industry technology transfer. This helped PIRC researchers to be explicit about their assumptions and values. Triangulation of sources was achieved by considering the accounts of the different stakeholders involved in this intervention. Overall, every effort was made to provide an 'audit trail'. A database documenting data collection and analysis procedures, containing data available for re-analysis, was kept for validity and replicability purposes (Eden and Huxham, 2002).

Application of Situated Learning Theory in Technology Transfer

Nurturing a Coalition CoP for University-Industry Technology Transfer

Prior research conducted by PIRC in the local community and its perceived status as an academic, non-profit entity, helped PIRC establish credibility and trust with participating stakeholders. Engaging the two regional Government Agencies and the regional Chamber of Commerce in shaping the coalition's steering group has been a demanding task, as there is an inherent difficulty in forming collaborations. Collaborative structures are beset by ambiguity, complexity and dynamism that present practitioners who convene them with enormous challenges (Huxham and Vangen, 2000). In this intervention, the creation of the steering group demonstrably presented considerable challenges. Working with entities that have to a certain extent their own agendas, use different professional languages, and operate within different organisational structures and paradigms, as well as managing power relationships and accountabilities in securing commitment and agreeing goals, is far from easy. "How to achieve the right mix of individuals and organisations; how to involve members in different practices or with different status without alienating them; how to ensure that the desired interests are represented; and how to maintain a stability of membership are among the many challenges…" (*ibid*, p.796). These were germane considerations in the establishment of the steering group.

Furthermore PIRC, as a coordinator of this coalition CoP, pushed for a common agenda and a set of goals as soon as possible. Determining the membership structure and the agenda of the steering group was a delicate consultation process, instrumental in securing commitment. The agenda, goals, action plans and technology diffusion assessment frameworks served as common artifacts or 'boundary objects' for the members of the coalition, who represented different CoPs. These were intended to enable participants systematically to go through cycles of action-reflection on the university-industry technology transfer programme, negotiate their relationships, connect their perspectives and develop a common, expansive and effective identity

(Brown and Duguid, 1998; Wenger, 2000). Members of the coalition agreed to participate in the 12 workshops that PIRC delivered to fish farmers and coffee producers, so that the latter two CoPs have the opportunity to familiarise themselves with new technologies, learn about their management and support available. The next section deals with the workshops and follow-up visits to participating fish farmers and coffee producers. These, in conjunction with each other, constitute the second key component of the technology transfer programme.

Workshops and Training/Technical Assistance Visits as Boundary Encounters

With regard to the second and third CoPs - the fish farmers and the coffee producers - throughout the duration of the programme, PIRC delivered six workshops to 44 fish farmers and six workshops to 35 coffee producers. New technologies were showcased and explained to participating fish farmers and coffee producers. These events were followed by PIRC team members visiting participant fish farmers and coffee producers to provide one-to-one assistance with technology adoption and training. The 12 workshops and follow-up visits (on average 11 visits to each participant) are viewed as significant boundary encounters between the CoPs involved - i.e. members of the coalition/PIRC, fish farmers and coffee producers (Brown and Duguid, 1998, 2000; Wenger, 1998, 2000). Such boundary encounters were designed to strengthen these two CoPs by providing a forum where their members can interact socially and learn from each other about adopting the innovatory technologies in question.

As mentioned earlier, according to situated learning theory, the quality of boundaries as spaces of interaction between different CoPs, is influenced by the presence of specific factors that can inhibit or enhance engagement and alignment of interfacing CoPs. ‘Boundary objects’ and ‘brokering’ constitute instrumental elements of a social strategy for promoting the learning of CoPs interacting at boundaries (Brown and Duguid, 1998; Wenger, 1998; 2000). With regard to the former, in these events representatives of the coalition put forward boundary objects such as the strategic and technology plans for the region, explicating how the types of technology on offer link with these plans. The presentations, demonstration of technology and communications, in workshop events and training/technical assistance visits exhibited a repertoire that was unambiguous. Overall, the content of these workshops and visits aimed at identifying precisely the participants’ needs, getting across clearly defined technological solutions, rationale, values, opportunities and benefits for fish farmers and coffee producers. It also pointed out the procedures and prerequisites that are necessary to adopt the innovatory technology diffused by the programme in ways that serve best the participants’ needs.

Of important significance is the role the APROPESCA fish trade association and the Regional Committee of Coffee Producers played as brokers in the organisation of these events and in building trust and engaging meaningfully with the community. Moreover, they assisted participant fish farmers and coffee producers to understand how the different types of technology on offer can serve them and how such technology fits within the wider regional agenda of productivity and innovation held by the coalition. Conversely, these brokers assisted the coalition in making these events more effective in cycles of action-reflection., by providing the perspective of their members as potential adopters of technology.

Through these workshops and visits, fish farmers and coffee producers were able to expand their identities as innovatory technology adopters and reap the benefits. The following section discusses the types of technology adopted and the outcomes.

Technology Adoption Among Participant Fish Farmers and Coffee Producers

The technology transferred in both cases – to fish farmers and coffee producers - is a non-complex process technology, oriented toward the needs of small scale suppliers and appropriate to rural conditions. Using Leonard-Barton (1990) typology all types of technology adopted fall under simple diffusion (i.e. characterized by narrow technology scope with many number of users per technology application). These technologies were transferred in packages, entailing soft and hard components. Tables 1 and 2 below illustrate the types of technology transferred and extent of adoption by participant fish farmers and coffee producers, as a result of this intervention.

Table 1 Fish Farmers - Technology Adopters and Resultant Benefits

Technology Type	Number of fish farmers that adopted technologies on offer	Number of adopters that entered new markers/supply chains as a result of adopting these technologies	Number of adopters achieving at least 10% cost savings	Number adopters achieving a substantial increase in quality (by main buyer standards)	Number adopters achieving at least 10% increase in productivity
Sand Trap	32	32	25	32	26
Center for Gutted (shared by the network)	44	44	44	44	44
Environment Management Systems	44	44	30	39	42
Fish tank system	15	15	15	12	15
			44	44	44

Table 2 Coffee Producers - Technology Adopters and Resultant Benefits

Technology Type	Number of fish farmers & coffee producers that adopted technologies on offer	Number of adopters that entered new markers/supply chains as a result of adopting these technologies	Number of adopters achieving at least 10% cost savings	Number of adopters achieving a substantial increase in quality (by main buyer standards)	Number of adopters achieving at least 10% increase in productivity
Twigs Sucker	20	20			
Shadow Systems	35	35			
Pulping Machines System	35	35			
Mechanical Stirrers System	System 1: 26 System 2: 9	35			
Solar Parabolic Dry Method	26	26			
Dry Method Silos	9	9			
			31	33	31

The majority of fish farmers and coffee producers adopted combinations of different technologies that are usually applied concurrently. The types of technology not adopted by certain participants were the ones that were not suitable to the individual circumstances. It is worth mentioning that the water quality in the case of fish farming and the climatic conditions in the case of coffee production favour the adoption of the transferred technologies, so maximising their benefits.

The transferred technologies had a considerable impact on the competitive performance of the participant fish farmers and coffee producers. The vast majority of the participants in this technology transfer programme reported significant increases in productivity (up to 40% in some cases), as well as cost savings and considerable quality improvement by main customer standards. Moreover, The adoption of these new technologies and certification allowed both fish farmers and coffee producers better integration within networks that offer high quality products, and made them capable of reaching new markets that command better prices, so resulting in higher profit margins.

Indicative are the quotes below:

> *"The experts that show us how to implement the technology helped us to decrease the cost of adoption of the new systems…Now we use less to produce more. With the new technology the production cost is lower, much lower, in my case…like 20% but also the quality is much better".* (Coffee Producer C15)

> *"Sure the costs are much lower now and the quality has improved. Now these technologies are very important because we can operate better as a network and reach customers we couldn't access before. So, costs are down, the whole process is easier, it feels good to know that you apply new staff in your business and sales are up…"* (Fish Farmer F8)

Overall, this intervention is regarded as successful by all stakeholders involved and future university-technology transfer programmes in other regions are informed by its generative mechanism – i.e. what works and how in nurturing and bridging CoPs of transferors and adopters of innovatory process technology.

Conclusion

This paper demonstrates how barriers to university-industry technology transfer can be overcome, through the presentation of an intervention comprising two cases. This intervention is deemed 'exemplar' or instrumental (Yin, 2003) in that it demonstrates how CoPs of different stakeholders concerned with technology diffusion from academia to industry can be effectively nurtured and interfaced. In order to undertake university-industry transfer successfully, PIRC nurtured a coalition CoP comprising itself, two regional Government Agencies and the regional Chamber of Commerce. Subsequently, this was interfaced with a CoP of fish farmers and a CoP of coffee producers in the region, enhancing the absorptive capacity of the latter two. The utility and significance of the key components used to nurture and bridge distinct CoPs in order to remove technology transfer barriers are critically treated. Overall, PIRC activities relating to forming and facilitating a steering group, conducting workshops events in conjunction with follow-up visits were focal action-reflection points. They enabled the transfer of 'know how' by recurrent action-reflection and generated new meaning as to what successful university-technology entails for PIRC/the coalition and the participant fish farmers and the coffee producers.

Furthermore, the types of technologies adopted and the innovation capabilities developed by these two groups of producers are discussed. Although relevant literature underscores the challenges involved in evaluating the effectiveness of technological diffusion (Albors et al., 2005), the intervention reported in this paper is deemed successful by all the stakeholders involved. Certainly, there are intangible benefits which are not amenable to quantification (e.g. development of innovation capabilities and network participation capacities amongst fish farmers and coffee producers that may pay dividends in the future). Beyond such benefits, the adoption of the technologies discussed have brought about cost savings, as well as improvements in quality and productivity for participants that are commendable and ameliorate their strategic position.

Moreover, in reporting on this intervention, this paper explicates how constructs/design features posited by situated learning theorists can be applied in practice, in order to nurture CoPs receptive to university-industry technology transfer. Emphasis is placed on the design elements of CoPs, including boundary interaction, brokerage, boundary objects and the development conducive identities and meanings (Brown and Duguid, 1998, 2001; Wenger, 1998, 2000; Swan et al., 2002). In so doing, the paper contributes to the debate on the constructability of CoPs and their performative advantages, responding to concerns about the usefulness of situated learning/CoPs theory. Finally, it is purported that the lessons drawn from nurturing and bridging CoPs to effectively undertake university-industry technology transfer are transferable to similar contexts involving community engagement programmes of this nature.

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