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The Importance of Space in Knowledge Sharing Online: The QUBE Approach

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Abstract: In this conceptual paper, we look at certain weaknesses in conventional understandings of the concepts of "knowledge sharing" and "collaboration" and propose some improvements; furthermore, we explore certain unrecognised strengths of 3D platforms and finally we present a 3D system called QUBE that exemplifies how the insight discussed contributes to improving online knowledge sharing and collaboration. Firstly, clarifying the concept of collaboration will allow us to show that knowledge sharing has an important role to play in collaboration. Secondly, with the help of our *presence model of knowledge sharing* (cognitive presence, social presence and leading presence), we can better understand the role and the importance of space in knowledge sharing, explain why collaboration is more successful on 3D than on 2D platforms and show how this can lead to improved collaboration in online interactions. Finally, we present QUBE, a 3D system that implements these ideas by smoothly integrating both suitable interaction methods and a properly designed 3D platform provided with avatars, rooms, audio, video, writing and other useful functions.

Keywords: e-collaboration, knowledge sharing, presence, 3D platforms, knowledge and space, QUBE

1. Introduction

Knowledge sharing and collaboration are becoming more and more important for working in our rapidly evolving Knowledge Society and our increasingly networked business world with ever more geographically dispersed teams (Schmeil 2012) and this is leading to an increase in the number and frequency of interactions (synchronous and asynchronous), both online and in person. As far as online interactions are concerned, the need is growing exponentially. Why? Why should we interact online instead of in person? The problem is that *face-to-face interactions* suffer from some relevant limitations. First, if we consider that they require travelling to the meeting location and back (which is becoming more and more time and energy consuming), two main limitations appear (Bettoni & Obeng 2016). One is less time flexibility (fitting collaborative events into the busy schedules of a group) and the other is less ecological sustainability (pollution and a waste of fuel energy due to travelling many kilometres, multiplied by the number of participants travelling). Then there are also limitations related to infrastructural resources (like rooms, tables, whiteboards, posters, etc.) because these cannot easily be modified (quantity, location) in a physical environment.

In the case of *online interactions*, the megatrends are well represented by Second Life and Facebook which were launched quite at the same time (2003 and 2004). It is Facebook which, for the time being, won this race between 3D and 2D interaction platforms, but what does that mean for online collaboration in a professional context? Is 2D interaction better than 3D? We doubt this, in fact we see that social media platforms like Facebook do not contribute much to supporting knowledge sharing and collaboration for the benefit of online professional work. Why? On one side, there are fundamental characteristics of 2D platforms (text-based interaction) which are good for making *inquiries* but ineffective for *problem-solving* interactions. On the other side, since developers and users of 3D platforms did not recognise the true potential for professional interactions of this kind of platform, their use up to now has not been satisfactory. How can we improve knowledge sharing and collaboration in online interaction settings? With its plans to provide an innovative 3D virtual interaction environment, Facebook is showing the way.

Interaction via a 2D platform (e.g. Confluence, Drupal, Basecamp, Intraboom or similar) has long been part of daily professional practice. Unfortunately, this solution leads to 'text-based' or rather 'text-heavy' interactions: you need to be able to write well and better still, enjoy writing and not everyone does. Moreover, text-based interactions are good for inquiry tasks, but they are ineffective for problem-solving tasks. In fact, experience has

shown that the interaction required for collaboration is lacking or inefficient, especially in cases where the main task, like in projects, consists of collaborative problem solving. Therefore, it is not surprising that teams use 2D platforms solely as a storage space for documents. There is a lack of team interaction (Bettoni 2003) and the question is why. We think that flat platforms do not meet the requirements of rich collaborative interactions. So which are these requirements and how can we better support collaboration to fulfil them? One important step for answering these questions consists of clarifying what we mean by "collaboration" (and its relationship with knowledge sharing) and another important step involves a better understanding of the true potential of 3D platforms. Hence, in this paper our aim is to address two aspects: a conceptual clarification of the terms knowledge sharing and collaboration and some unrecognised strengths of 3D platforms when considered as "collaborative knowledge spaces" (Hug & Maier 2010). In this sense, we intend to contribute to our main purpose, i.e. to improve online collaboration practices within 3D platforms. This is an important topic because online collaboration is rapidly becoming the predominant mode in which organisations accomplish their work (Boughzala et al. 2012).

2. Related work

Ten years ago, it was unclear which enhancements were needed to make a 3D collaborative virtual environment a good platform for serious distributed collaborations (Bainbridge 2007). Surprisingly, this is still the case today. 3D virtual spaces as workplaces are still in their early phase of development and little research exists about their use in working and collaboration (Vartiainen 2015, p. 142). By examining the methodological and theoretical choices of empirical studies on 3D virtual environments (3D VE) and focusing on social and group phenomena (Sivunen & Hakonen 2011), the authors were able to identify four major trends. First, attempts to demonstrate the applicability of real-life, social behaviour norms in 3D VEs. Second, a lack of work group studies using 3D VEs. Third, the micro-level treatment of social phenomena and groups at the expense of broader phenomena like leadership. And fourth, a lack of covering theory relating to group processes in 3D VEs. In fact, most research performed on 3D VEs has been game-based and few empirical studies have been published on their professional usage (Bosch-Sijtsema & Sivunen 2013). Despite this lack of research, we agree with Bosch-Sijtsema & Sivunen (2013) that, thanks to their new ways to support collaboration and communication, 3D VEs provide several very interesting opportunities for work groups in professional global settings. For example, they can foster collaborative creativity (Alahuhta et al. 2014) through seven affordances (Alahuhta, Sivunen & Surakka 2016): 3D avatars which allow team members to express themselves, the feelings of co-presence and immersion which engage users, a simulated reality environment that can be modified, multimodal communication channels and rich visual information which enhances users' ability to collaborate. Another opportunity offered by 3D VE and one which is of special interest from a knowledge management point of view has been recently investigated in an educational context (Burton & Martin 2017; Burton, Martin & Thomas 2012), starting from the hypothesis that interactions in a 3D virtual environment serve as knowledge capital that may contribute to a knowledge spiral for the four modes of knowledge conversion (Nonaka & Takeuchi 1995). It would also be interesting to continue a strand of research that was started about ten years ago during the Second Life hype but was abandoned after the decline of Second Life (Schmeil & Eppler 2008; Eppler & Schmeil 2010). It developed a systematic description and classification of collaboration patterns (group interaction scripts) in 3D collaborative environments. By providing reusable patterns that leverage the ample possibilities only 3D virtual environments offer, this research sought to help facilitate and enhance team collaboration and knowledge management.

3. Collaboration and knowledge sharing

As a starting point for clarifying the term collaboration, we suggest distinguishing it from the term cooperation. Practitioners often use the two terms synonymously but experience shows that they are not synonyms. Sometimes definitions explain the difference through the degree of "alignment" in working together ("*Collaboration is very similar to, but more closely aligned than, cooperation*", Wikipedia, 2017). But this also does not bring more clarity; it just introduces the new question of what "*closely aligned*" means. Cooperation can be defined by considering that working together is accomplished by a division of labour among participants in which the task is split into pieces and each person is responsible for one piece (see Roschelle & Teasley, 1995, p 70). The main success factors of cooperation then are subject matter competence of the individuals involved to ensure that they deliver a high level of quality. Collaboration is different: the task remains as a single unit; each participant works on it and is responsible for it as a whole. He or she cannot pull out because then the task as a whole will be jeopardised. Moreover, during collaboration, individuals are "*mutually engaged in a conscious, continuous effort to construct and maintain an underlying shared knowledge structure as a basis for accomplishing their task.*" (Bettoni et al. 2016, p 159).

In Fig. 1 we see a string game played by young people: if one pulls out, either the structure as a whole will break or no more progress will be made. The task is accomplished by all participants; they work on it as a single task unit, so knowledge should also be a unit; to obtain this, the participants have to share their knowledge and this sharing of knowledge becomes all the more important. The main aim here is to build up a knowledge resource or knowledge structure that is common to all participants in the collaboration. By the way, knowledge sharing as well as other knowledge processes become more important so that clearly knowledge management could play a key role in promoting collaboration.

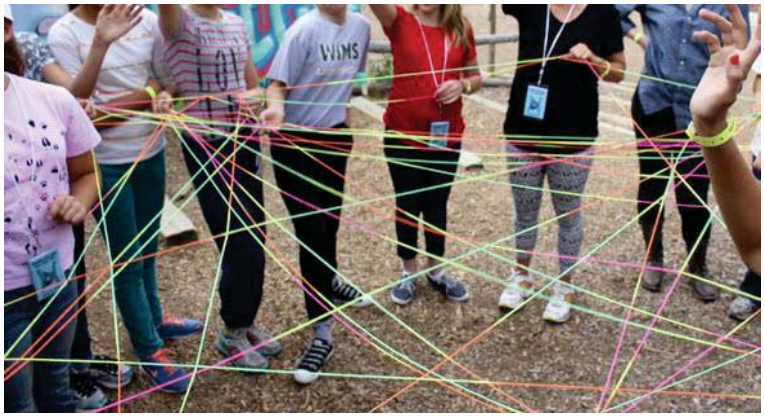

Figure 1: A string game

Now the question is how to implement knowledge sharing and specifically the sharing of tacit knowledge (Kharabsheh et al. 2016) in a collaborative situation, as we have defined it. The model that we suggest here assumes that a successful knowledge sharing experience occurs through the integration of three essential elements: cognitive presence, social presence and leading presence (see Fig. 2). This approach is inspired by the Community of Inquiry (CoI) framework, a process model of the collaborative construction of knowledge in a community of learners (Swan, Garrison & Richardson, 2009).

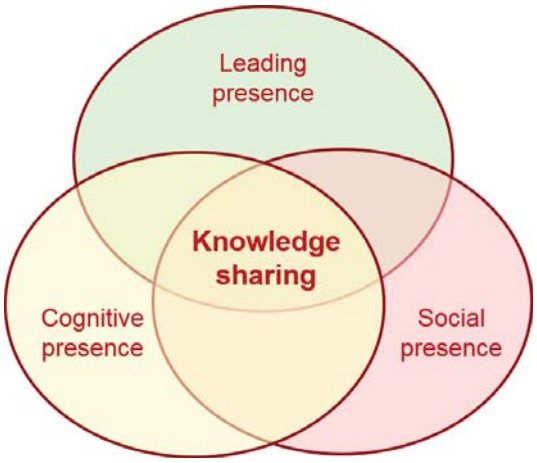

Figure 2: Presence model of knowledge sharing (adapted from Garrison et al. 2009)

Cognitive presence is defined as the extent to which participants of the collaboration succeed in constructing and sharing knowledge (meaning) through sustained interaction and reflection. *Social presence* is defined as the extent to which participants of the collaboration succeed in projecting their personal characteristics onto the group (team, community), thereby presenting themselves to the other participants as "real people". Finally, *leadership presence* is defined as the design, facilitation and support of cognitive and social presence (of the related processes) for achieving personally meaningful and organisationally worthwhile collaborative outcomes.

4. Space and knowledge

Continuous advances in computer technology have led to the availability of sophisticated platforms that support the replication on screen of three-dimensional physical spaces, movable objects, movements, #navigation and communication between digital representations of humans (Schmeil & Eppler, 2008). Space, in this context, means simply "*the three-dimensional extent in which objects and events have relative position and direction*" (Encyclopedia Britannica 2004). In existing "flat" platforms, only experienced users are able to effectively and

efficiently use the available communication and collaboration tools; in all the other cases (the majority), interaction is rather absent, and this is of course a big problem for online collaboration. One reason for this absence of interaction is that, on flat 2D platforms, users cannot interact in their usual, *natural* way. On the other side, there is evidence that interaction becomes much more intense and collaboration easier on 3D platforms (Burton et. al 2012; Burton & Martin, 2017): why? Could it be that space itself contributes to these improvements? But how? Following our *presence model of knowledge sharing*, we try to answer this question by splitting it into the three more specific questions, one for each of the three elements of the model.

First, which is the role of space in *cognitive presence*? At the beginning of his theory of mental activity, Kant explains: "Space is a necessary a priori mental construct, which underlies all outer perceptions (Anschauungen)" (Kant 1787, p 38) and knowing, he adds later on, always requires a combination of perception and conception (ibd. B 74). Thus space will be contained in any knowledge item and consequently also in any human thought. Many examples taken from modern science and from daily life also provide evidence for this view. In an interview from 1916, Albert Einstein tells Max Wertheimer that he thinks in images and feelings and very rarely in words (see Wertheimer 1959, p 213-228). In a letter to J. Hadamard, he wrote that the elements of his thought were "of visual and some of muscular type" (Hadamard 1945, p 142-143). A part of the motor system, so-called mirror neurons are involved in understanding the actions and intentions of others (Ferrari & Rizzolatti 2014). In the method of loci, a mnemonic method (known from Ancient Roman rhetoric), each item to be remembered is placed in space along an imaginary route, at familiar locations. Moreover, visual metaphors and figurative language are widely used in communication to facilitate the understanding of abstract ideas. Finally, if knowing is inseparable from activity and context (situated cognition) then the related knowledge "*is stored not in the form of answers, but in bit and pieces of the experience we have accumulated*" (Dixon 2013). Hence, a subsequent question or problem will be answered or solved by pulling together suitable bits and pieces, thus constructing knowledge in the moment and in a way which will also be situated in (influenced by) space, time and experience (De Michelis 2016).

Second, what is the role of space in *social presence*? A first component of social presence is the ability and confidence *to express emotions* like closeness, warmth, attraction. Other examples of emotional expression that contribute to social presence in a group are humour and self-disclosure (Garrison et. al. 2000). Humour, in particular, decreases social distance and can as a result act as an invitation to start a conversation. A second component of social presence is *open communication*, like for example mutual awareness, which tacitly indicates interpersonal support, acceptance of the other, encouragement and based on these type of expression, contributes to building group cohesiveness. Recognition is another example of open communication, achieved by explicitly expressing appreciation and agreement as well as complimenting and encouraging others. Finally, group cohesion is also an indicator of social presence. It appears in activities that build participation and empathy, thus helping participants to see themselves as part of a group, not only as individuals. These three components of social presence are all related to space in the sense of "what connects and separates" (De Michelis 2016) the persons involved. Thus, space appears to be essential as the medium that enables social presence. If space is so ubiquitous both in cognitive and social experience, then in online situations where people need to interact (learning, working), we could make collaboration more efficient and effective by providing spatial clues. This requires an appropriate design of the collaboration event (meeting) which makes sure that people and activities use spaces and movements. It also requires a suitable three-dimensional technology, for example a desktop-based 3D Virtual Environment providing places, buildings, rooms, background objects, fixed and portable objects (whiteboards, tables, etc.), audio and video communication and avatars able to navigate the environment and come together.

This is how we come to the **third** question: what is the role of space in *leading presence*? A first component of leading presence is *collaboration management* which is concerned with designing, planning and assessing collaborative events. A second component of leading presence is *facilitation*. The leader tries to be neutral and not to use the decision-making authority accorded by the formal position. His/her main task is "to help the group increase its effectiveness by improving its process and structure" (Schwarz, 2005), like in group facilitation. Finally, a third element of leading presence is *support* in reflecting on the state of cognitive and social presence, providing feedback and helping the group in balancing the other two kinds of presence in order to achieve the planned objectives. When a leader designs a new collaborative online session, he or she must define *what* the next step in the problem-solving process will be (a matter of methodology), *why* this step is important (a matter of value) and *how* participant will actually perform the step. This is where space comes in: the leader has to determine *how* participants will *interact in space* so that both cognitive and social presence will be suitably

supported and the work will be accomplished effectively and efficiently. This includes determining, for instance, arrangements of space (which rooms, which board and which panels positioned where on the walls or in the room), which movements in the rooms would be useful and when to undertake them, how to distribute the "boundary objects" of the interaction, etc.

5. The QUBE system

QUBE is a commercially available example of a 3D system that is suitable for supporting collaboration events, which are consistent with our presence model of knowledge sharing. The QUBE system is composed of three basic elements: learning, doing and technology. Accordingly, there are three basic design principles of QUBE. First the *learning* element has to be designed as a collaborative activity with people interacting in space; secondly the *doing* element consists of real work scenarios as goals towards which the collaboration has to be oriented; and finally the virtual environment (the *technology* element) must provide spatial functionalities which enable both the learning and the doing. It is essential to take seriously the fact that here "system" refers to the unity of the three constitutive elements of learning, doing and technology. With software alone, without the other two elements, the system is empty and useless: like a violin when you do not know how to play it.

A typical session on QUBE, for instance a meeting, begins with session facilitators welcoming the participants as they arrive in the space. Each person in QUBE is represented by an individual avatar, a simple box figure (like LEGO mini figures, but gender-neutral) which provides enough of a human form to foster the needed identification. Using your avatar, you are able to communicate with other people just as you would in the real world. You can move around in the rooms of a building, physically interact and work shoulder to shoulder, literally brainstorming with many other people by means of whiteboards and sticky notes. The facilitators welcome each one individually and make sure that they are ready to start. Then the avatars can visit the collaboration space room until the meeting starts. The room has been carefully prepared in advance. Boards, tables and chairs needed during the meeting are available on the walls and on the floor. Tools called PETs (Performance Enhancing Tools) are guidelines or procedures about how to accomplish a task and can easily be replicated on a whiteboard or panel when needed; each PET is linked with a specific documentation which describes "what is it?", "why do I need it?", "when do I use it?" and "how do I use it?".

Regularly scheduled problem-solving and decision meetings with a project team are the most important requirement for collaboration effectiveness and efficiency (Gordon 1977). On QUBE these meetings, called "drumbeats", eventually receive the high consideration that they deserve. A drumbeat starts with a previously appointed coordinator welcoming the team members as they arrive in the project space on QUBE and gather at the central meeting place, called "home" (leadership presence, social presence). When the group is complete, they walk together to a panel that displays the PET "Hopes & Fears", where the coordinator asks: "what are your expectations and what are you afraid of in relation to this meeting?" Each participant writes his/her contributions on cards and places them on the hopes or fears area of the panel (see Fig. 3). A team member will then order the cards in clusters and clarify their meaning with the help of the group. Together then the team needs to discuss what could remove the Fears (social presence) before creating an agenda for making the Hopes a reality (cognitive presence).

Then the team starts working on the task defined in the agenda. PETs like "FIX IT NOW" or "5 Ps" help to clarify the problem in the beginning. The PET called "FIX IT NOW" is a way of avoiding risks for real and PET "5 Ps" is a way of making sure that messages which you have tried to convey are received and acted upon. Some specific questions will arise and provide opportunities for starting work in smaller groups.

Small groups can move to an area in the same room provided with chairs and round tables and sit down here when they want to discuss something, for example how to proceed when dealing with the specific question they have selected to work on (cognitive presence, leading presence). Once they have decided this, they can move to another area of the space and gather in front of a huge whiteboard, with sections separated by panels. At tables and within panels, the group members will only hear each other talking, without noise from other groups (a feature that is quite impossible in a real room). Shortly before the time assigned for the work in small groups has elapsed, a signal (flashing room light) lets the groups know that soon they will have to return to the plenary assembly, usually gathering in a circle in the middle of the room. Here the group performs a so-called spin-casting (social presence): each team member in turn has the opportunity to give brief feedback about the work carried out in the small groups (insight, remarks, questions, learnings, etc.). This sequence of interactions in

three steps (plenary with a PET, work in small groups with various PETs, plenary feedback by gathering in a circle) can also be applied during any phase of the collaboration. At the end of the meeting, a PET called RAPID will help the whole team to define the next steps and related tasks and plan when and who will accomplish them after the meeting (leading presence, social presence).

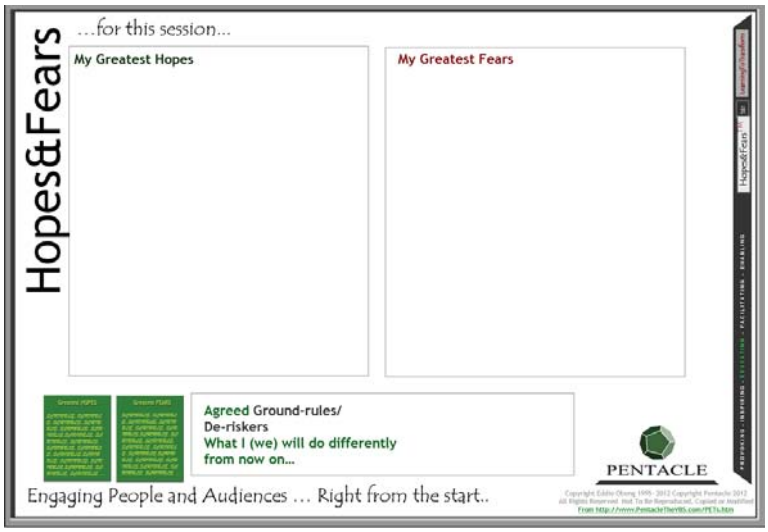

Figure 3: Hopes & Fears PET by Pentacle (http://www.pentacle.co.uk/)

Figure 4: Groups at tables on QUBE (http://www.pentacle.co.uk/)

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6. Conclusion

Since little research exists about 3D virtual environments as workplaces, it is not surprising that covering theory about the role of space in making these platforms powerful collaboration tools is lacking. The presence model of knowledge sharing presented in this paper is a first attempt to fill this important gap and contributes to clarify how to conceive and design such environments for serious distributed collaborations. In collaboration, all participants work on the same, single task that remains a unit instead of being split into pieces, like in cooperation. Thus the knowledge required for accomplishing the task must also become a unit and for this, participants need to mutually engage in a conscious, continuous effort to construct and maintain a shared knowledge structure suitable for the task. This is not easy to do, especially for tacit knowledge, among other things, because of the essential role that presence plays in collaboration as we have defined it. According to our presence model of knowledge sharing, the integration of three essential elements is required: cognitive presence, social presence and leading presence. In each of these types of presence, space has a great influence: it is contained in any knowledge item (cognitive presence), is essential as a medium enabling social presence and needs to be taken into consideration when designing how participants will interact (leading presence). As a consequence, in online situations where people need to interact (learning, working), we could make collaboration more efficient and effective by supporting it with a system which provides spatial functionalities and interaction methods which are consistent with our presence model of knowledge sharing. The system that we have presented, QUBE by Pentacle (UK), fulfils these requirements thanks to an appropriate design of its three basic elements: learning, doing and 3D technology.

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