Perceived enablers of 3D virtual environments for virtual team learning and innovation

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Abstract

Virtual teams consist of geographically distributed employees working with a common goal using mostly technology for communication and collaboration. Virtual teams face a number of challenges, discussed in the literature in terms of communication through technology, difficulty in building trust, conveying social cues, and creating awareness, as well as cultural differences. These challenges impact collaboration, but also learning and innovation. This research focuses on how a social medium, the 3D virtual environment, is perceived to enable learning and innovation in virtual teams. We study this through a qualitative study based on interviews of distributed work managers’ perception of VEs. The major findings are that VEs are perceived to create collaborative learning atmospheres for virtual teams in terms of enabling engagement, a shared context awareness, and support in social network building. Another finding is that VEs are perceived to enable team learning, knowledge development, and collaboration through persistence of content, information sharing, learning through role-plays and simulations, and visualization. Furthermore, VEs enable the development of co-created content as well as new ways of working in virtual teams.

Keywords: 3D virtual environments for work, virtual teams, learning, knowledge development.

1 Introduction

In this article we are interested in how the technology of 3D virtual environments (VE) can enable collaboration and learning in virtual teams. Virtual teams are defined as groups of geographically dispersed employees who have the common goal to carry out interdependent tasks using mostly technology for communication and collaboration (Cramton, 2001; Martins et al., 2004; Maznevski & Chudoba, 2000). Literature on virtual teams has discussed the difficulties of communicating over distance for building trust (Jarvenpa, Knoll & Leidner, 1998; Zakaria, Amelinckx & Wilemon, 2004), difficulty of conveying social cues, or creating a shared awareness (Hinds & Kiesler, 2002; Jarvenpaa et al., 1998; Zakaria et al., 2004),
crossing organizational and national cultures (Martins, Gilson & Maynard, 2004; Zakaria et al., 2004). Other literature focuses on communication with the help of technology (Daft & Lengel, 1990; Griffith, Sawyer & Neale, 2003). Next to team collaboration, it is important for virtual teams to share and develop new knowledge between distributed team members. For communication of complex, non-routine, and new knowledge people prefer personal communication. Furthermore, the medium used to distribute new information and knowledge is of importance (Daft & Lengel, 1990). In the virtual team literature the use of technology for communication has been discussed extensively (Maznevski & Chudoba, 2000; Roberts, 2000), however, learning and knowledge development are often hindered by distance and a lack of face-to-face contact. From the literature we know that learning is often facilitated by transmitting information via multiple dimensions, i.e., visual cues, voice modulations, oral and written means using examples, metaphors, and storytelling (Zakaria, et al., 2004). These multiple dimensions needed for learning and knowledge development are more difficult in virtual teams that communicate via technology (Roberts, 2000).

Recent developments of Web 2.0 platforms support users to continuously modify content in a participatory and collaborative way (Kaplan & Haenlein, 2010). Web 2.0 can be perceived as the platform for the development of social media (Kaplan & Haenlein, 2010). Social media is defined as a group of internet-based applications built on the ideological and technical foundation of Web 2.0, which allow creation and exchange of user generated content (Kiesler & Cummings, 2002:61). Examples of social media are social network sites as well as virtual environments (VE) like Second Life. Social media, and in particular 3D virtual environments (VE) could enhance collaboration, innovation, and learning in virtual teams. VEs are communication systems in which multiple interactants share the same three-dimensional digital space despite occupying remote physical locations; in them, interactants can navigate, manipulate objects, and interact with one another, usually via avatars (Sallnäs, 2005; Sivunen & Hakonen, 2011). Avatars are flexible and easily transformed digital self-representations in a graphic 3D form (Yee & Bailenson, 2007). Although research on VEs is relatively new and hardly applied for distributed work environments, researchers argue that VEs are beneficial for learning and knowledge development (Bosch-Sijtsema & Sivunen, 2013; Prasolova-Forland, 2008). Most research on VEs focuses on either experiments, the design of the environment or game environments, while research on the use of VE in work settings is very limited (Sivunen & Hakonen, 2011). In our study we are interested in how VEs are perceived to enable collaboration, learning and knowledge development in virtual teams. Enablers in this sense are defined as providing the means, knowledge, or opportunity to support learning and innovation in distributed settings.

The structure of the paper is as follows: In the next section we discuss some literature on distributed work and VEs. Thereafter we discuss our methods of how we performed our qualitative study. In Section 3 we present our findings and relate these to literature in Section 4, and finally we conclude the paper.

1.1 Distributed work

Distributed work is defined by people who collaborate remotely with their colleagues, either while traveling, at home, at another office, or at a customer site. Distributed work is often studied in terms of virtual teams. The common characteristics of virtual teams, like the distance, either spatial or temporal (different time zones), and the use of technology for communication have an impact on how virtual teams collaborate, but also how they learn or innovate. Studies on virtual teams suggest that the lack of face-to-face communication might
lead to feelings of isolation, increased chances of misunderstandings and hence conflicts among individual team members (Martins et al., 2004). In distributed work it is more difficult to build relationships and correct misunderstandings. Chances for informal and coincidental discussions are infrequent and possibilities to receive immediate and non-verbal feedback are scarce. Research shows that members of virtual teams often fail to acquire information on the context and distribute information evenly among team members (Cramton, 2001). Therefore retaining a shared understanding of tasks and processes can be difficult. Literature on collocated work (Kiesler & Cummings, 2002) and face-to-face communication in collocated settings (Nardi & Whittaker, 2002) states that face-to-face contact engenders social bonding and improves social interaction, informal conversations, and sharing experiences in a common space. By sharing a common space and context, connections can be established or strengthened and a shared space provides an ideal context for informal conversations (Nowak & Biocca, 2003). Furthermore, sensory information, feelings, intuition, and context are largely neglected in computer-mediated communication (CMC). The lack of proximity, and the use of CMC hamper the ability of virtual teams to create new, tacit knowledge through interaction (Griffith et al., 2003).

### 1.2 Virtual Environments

Researchers (Davis et al., 2009) have specified technology capabilities of VEs that should enable distributed teamwork. VEs allow for rich communication by supporting a multiplicity of cues and channels as well as feedback. The VEs offer opportunities to personalize avatar appearance, participate in modifying the content of rich virtual environment, create objects, move around in a VE, and utilize team working-tools. These capabilities are perceived as beneficial for virtual team coordination, creation of trust, and shared understanding (Davis et al., 2009).

Research has shown that VEs and the interaction with the help of avatars is different from more traditional collaboration media in ways that might benefit virtual teams’ collaboration as well as learning and innovation. Research discusses a number of characteristics of VEs that are perceived as beneficial for learning and collaboration. (1) **Social presence** (Van der Land, Schouten, Van der Hooff & Feldberg, 2011). VEs are capable of producing a sense of presence, which is defined as the user’s feeling of “being there” in a mediated environment (Zhao, 2003). The possibility to interact as an avatar with other avatars and understanding the realism of distributed team members being represented by avatars increases co-presence, the mode and sense of being with others (Davis et al., 2009; Zhao, 2003). Studies have shown that presence or a sense of being with other avatars in VEs has effects on avatar behavior, similar to the effects of presence of others on the behavior and performance of people outside of VEs (Davis et al., 2009; Hoyt, Blascovich & Swinth, 2003; Yee & Bailenson, 2007).

Presence and the social interaction in VEs can foster a sense of shared space among the members of distributed teams, an experience that often is missing in distributed work and which can influence group performance. (2) **Engagement**. Engagement is defined as intense absorption to the task (Helms, Giovacchini, Teigland & Kohler, 2010; Nowak & Biocca, 2003) and studies mention that engagement is higher in VEs than with other media. Others discuss immersion, as the feeling of being inside the media. (3) **Interactivity**. The ability to move and navigate through a virtual space and the ability to interact and control the environment are perceived as interactivity (Van der Land et al., 2011). Based on these characteristics researchers claim that VEs are suitable for learning and training in VEs in terms of situated learning, offering a space where people can create and receive training, or mirror the real-life world (Li, D’Souza & Yunfei, 2011). Research states that avatar-based
interaction is perceived as useful in cross-cultural learning (Diehl & Prins, 2008). Other research focuses on applying VEs in training medical skills of acute-care medical teams (Heinrichs, Youngblood, Harter & Dev, 2008), education (Bronack, et al., 2008; Prasolova-Förland, 2008) or company training (Li et al., 2011; Pollit, 2007).

Many of the VEs that are discussed in the literature are social or game-based VEs. Few of the studied worlds are especially designed for work environments. However, recently a number of VEs have come onto the markets that particularly focus on supporting work. Many of these work related VEs offer the opportunity to load, edit, share, and store content individually or collaboratively, and record, share, and store sessions. Unfortunately, few studies discuss how these VEs support teamwork in terms of collaboration, learning, and innovation.

2 Methods

2.1 Design

For this study we applied a grounded theory analysis approach (Locke, 2001) in order to gain insight in how managers who work with VEs, perceive the technology for collaboration and learning in distributed settings. In order to collect this data we used semi-structured interviews as well as several observations (seven) of the VEs used for work. The interviews were structured according to the following topics: (1) general questions on the interviewees’ work and VE experience in virtual teams; (2) enablers and challenges of VEs for work and virtual teams; (3) technology aspects like type of VE, technological features, and interoperability; (4) innovativeness and learning took up questions on how VEs can support innovation and learning, and (5) social processes focused primarily on the use of, appearance of, and identification with avatars. Furthermore, we received secondary data in the form of white papers, conference and journal articles of in-company studies. The interview guideline was developed, checked, and tested iteratively in a larger and multi-disciplinary research group of five people.

2.2 Participants

The interviews were either one-on-one interviews in person or on the phone, or group interviews (with groups of maximum three people). In total we held 47 interviews. We held six interviews with vendors of well-known VEs used for work contexts. In these interviews we gained an insight in the current market of VEs and their possibilities. Furthermore, we held two interviews with experts who specialize in VE research and consulting. We held 39 interviews with managers of 12 different global (Fortune 100 and 500) as well as US- and EU-based companies who all had experience in using VEs in their company. The companies were mainly selected because they presented their VE experiences externally in articles, blogs, or on conference presentations, and some were selected based on vendor contacts. The interviews lasted between 1-2 hours, and were taped and transcribed. Next to the interviews we had seven observations of VEs used in work context. The companies worked in different industries like high-tech - 67% (i.e., computers, software, networks), energy industry -18%, pharmaceutical and medical industry - 8%, and associations or communities - 8%.

2.3 Data analysis procedure

Both researchers coded, labeled and categorized iteratively the data through systematic stages (Locke, 2001). We used a qualitative approach based on the methodology of grounded theory
that was influenced mainly by Lincoln and Guba (1985). Our data analysis was performed in a three-step process (Miles & Huberman, 1984). The first step was data reduction, in which we applied open coding of all the data to tease out dominant themes in our data. The main themes we found were (1) engagement and immersion, (2) shared context awareness, (3) socialization, (4) knowledge sharing and development, and (5) adoption challenges. The second step involved focused coding within these themes to extract passages related to these main themes. We categorized sub themes according to how often they were mentioned by interviewees: dominant themes were 80-100% mentioned, strong themes 50-80%, and weak themes 30-50%. The next phase was data display in which we made lists and tables of emerging themes and monitored the internal cohesion of the codes. The coding process was an iterative process between the two researchers in order to increase validation. Below we discuss the main findings of on perceived enablers of VEs of managers working in virtual teams.

3 Results

3.1 VE enables engagement

One of the strong themes (58% mentioned) we found was that managers felt more free and comfortable when using VEs for distributed work. Interviewees mentioned that having a conference remotely with a larger collocated group with traditional CMC makes it rather difficult to get your messages through. However, many interviewees felt that within a VE and being represented by an avatar helped to be more comfortable to talk in team discussions: “I’m not a shy person but I still would go and talk to people that I would not normally go talk to. It [virtual world] added a certain protection – I don’t know. It made me feel more protected, that I could just go up to a total stranger and say hi, how are you doing? How is this working for you? And if I were at a [traditional face-to-face] conference I wouldn’t necessarily do that.

Within the VE, people felt they became more equal, had less status and hierarchical differences or cultural differences. The feelings of being able to behave freely and feel protected are important factors that can support a learning atmosphere in distributed teams.

Another dominant theme mentioned by 81% of the interviewees is the feeling of engagement and immersion. Many interviewees compare the VE to other traditional CMC media used for distributed teamwork: “So what we do see is that people can actually stay engaged and focused on a topic longer in a virtual environment than with, say, audio conferencing and web conferencing.” Others mention: “It almost feels magical when 2 people are placed in a virtual room, they seem to lose all sense of everything around them”

The ability of being able to create your own environment in the VE is discussed as having an important impact on engagement and enjoyment of work. One manager discusses the following example: “there’s a group of engineers, they are one of the top-performing engineering groups as far as delivering things on time. ... They're constantly sitting in Second Life, .. in an oilrig that they've built that has all the oilrig sounds. ... That's pretty powerful and their efficiency has increased because of that... as far as the ability for them to have an environment that for an engineer can be something that's really cool, increases their enjoyment at work. It increases their type of engagement because they're at a refinery.”
Several interviewees mention that the engagement and increased focus has an impact on working in a VE, and supports an atmosphere for sharing and developing knowledge. The increased engagement has also lead to the delivery of better results in a shorter period of time and with fewer mistakes.

### 3.2 VE enables shared context awareness

One of the difficult aspects in virtual teams is that team members have difficulty in sharing their context or create an awareness of the team. The interviewees (53%) discussed that the VE supported their team and team identity by creating a shared awareness and shared context of the team members. Members felt that the VE can reveal a sense of presence when members as avatars share a similar place or room in the VE. This sense of presence was lacking during videoconferences or CMC. The sense of presence of the team and its members was important to feel part of the team. Some mentioned that especially having avatars present in the room made them more aware of the virtual team itself. For example: “They actually feel that they’re in a room with the other individuals, with seeing expressions that give them a sense that they are being listened to, that other people are listening as well”.

Interviewees also mentioned the importance of identity and cultural identity in order to help creating a shared awareness and context within a team of different cultural backgrounds. One global firm used the VE to develop a cultural awareness for employees who often worked in virtual teams crossing time zones and cultures. In the VE participants followed cultural intelligence training sessions in teams in which different nationalities were represented by avatars dressed in specific national outfits. The team members interviewed each other in sceneries from their own country. One interviewee mentioned: “when I communicate, sometimes you forget you have a set of standard values and cultures that is from where you are and you’re in the digital world. We get too comfortable in the digital world like in audio conference and on the instant messaging, you forget that. But I think in a 3D environment, you feel more – use the avatar … like that is representing a little bit of where you’re from and – I think in the 3D environment, you could gain more of your cultural diversity identity back.”

The VE was also used for building team identities in the sense of creating shared experiences within a group of distributed people. Teams were able to create shared experiences of how they could collaborate and interact in a VE, create awareness of their cultural and local contexts as well as an awareness on how other members interact and behave.

The importance of VE presence of other team members and creating shared experiences within the VE, as well as having the possibility to create a shared awareness of the different identities, behaviors, local and cultural contexts was perceived as beneficial in virtual teams.

### 3.3 Socialization and relationship building

In all interviews managers (100%) reported that they used the VE platform as a tool to build social networks and communities of professionals. One manager states that they build a VE to reach their global community because they felt a need for people to talk to each other globally, mentor, share information and connect as well as build social capital. Many interviewees used VEs for community building and developing social networks with the help of events and conferences in which people could meet each other either formally or informally and share ideas on particular topics.
Next to community and social network building, several interviewees stated that working with VEs enhances relationships. Interviewees discuss that the VE can support the water cooler effect of people bumping into each other and talking with each other informally - an example mentioned is that people can walk together or meet each other in a more informal space, e.g., a park or coffee corner.

The VE can also support people who are working in a globally distributed setting but who are isolated in that they either work from home or far from their teammates. One manager mentions that many of their employees are global workers who work from home and miss informal interactions with their colleagues. “People who are finding it most useful are the ones that are quite isolated. And so for them it’s a huge plus, they can’t travel, they’ve been isolated, and here they have an opportunity to interact with people without having to go through the travel situation.”

Socialization is important to learn to know new people and create social networks, which is important for gaining new ideas and information for learning and innovation. Social relationships can be enhanced through VEs, as it is easy to create chances for informal interactions that are important to getting to know team members personally and professionally, and to develop trust.

### 3.4 VE enables knowledge sharing and development

#### 3.4.1 Persistence

The feature of VEs of having a knowledge repository and persistence of data was often mentioned as an important enabler for virtual teams (53%). The knowledge repository supported virtual team members working in different time zones. Team members could enter the VE and find and replay meetings, seminars, and discussions as well as work with models, and data and contribute with their own content to the shared space. A manager mentions: “the virtual environment becomes a great content repository. So you have access to all the presentations, you can record sessions so people can go back and listen to them.”

Interviewees mentioned the repository of knowledge as a way how groups or teams in different time zones could work around the clock and see what other team members had done and continue working on those aspects. “In a digital environment, stuff can persist between sessions and no one comes in there and erases your white-board. So the room is exactly as you left it.”

Several managers worked with virtual team-rooms. These are a fixed location in the VE where teams can store and access content as well as collaborate with this content. The VE team-room was a feature offered by several VE providers. Team members working across spatial distance and time zones discussed that team-rooms helped to keep the team up to speed because of the persistence of content in the room: “So every team can have a project room that’s dedicated to only their work. You never have to share a conference room with anyone else and you can spread all your materials on the walls and every time you go in, it’s just your stuff and you never have to tidy it up -- every team can have their own place. And they find it a very powerful metaphor that when people get together because they’ve all been to these rooms before, everyone knows where things are. And we find that the 3D environment gives people a spatial navigation, that they can actually navigate through content because, oh, I know on this wall there’s stuff and on the blue wall there’s other stuff,”
Teams can meet in real time and collaborate, and teams can store, access, and edit content of their team members independent on location or time zone. The fact that VEs have a knowledge repository with persistence of data and information of discussions, chats and all developed material is perceived as beneficial for both collaboration and sharing knowledge in virtual teams. Many interviewees mentioned that working in such a way made teams more effective and fewer mistakes were made over time.

### 3.4.2 Sharing of information, expertise, and training

In the interviews many examples were presented on transferring information, expertise and stimulating learning within VEs (75%). Several interviewees stated that the VE supported knowledge sharing and sharing of expertise. One example illustrates how senior managers used the VE to brainstorm, discuss and store challenges they faced in distributed work settings. “So, they came in and they used the brainstorming board to document some of the challenges they were having. And then ... some of the more experienced people would talk about well, here’s how I handle that situation or here’s what I would do in that kind of situation. All that information was documented by the team as they were in this space, and then they were able to take that, and share that with people who didn’t have the benefit of being able to come to the meetings.” In this particular example the VE was build specifically to support brainstorm sessions in which people are represented by an avatar and the VE offers features like sticky notes people can put on a board with their ideas, options to see all the different ideas, voting polls, flip-overs, and other presentation possibilities.

The VE was often used for virtual teams to stimulate discussions, brainstorm sessions, mentorship, and training. In all these sessions trainees were represented as avatars and performed the training in a VE that was specifically developed for a particular task. The VE was often used for training sessions to gain experience and knowledge in particular fields. Interviewees used role-plays, simulations of real-environment situations like machines, and applied hands-on training within the VE to train and educate people. Managers mentioned that VEs were especially well suited for the kinds of training that are difficult to perform in the real world. Many scenarios and hands-on training sessions that are either dangerous or very expensive to execute in real life were possible to construct and enact in VEs. Some of the examples were that teams learned how to deal with and behave in dangerous situations - they mentioned VE training for oilrig explosions or medical emergencies. The VE was used for role-plays in order to practice different types of roles and rotate roles within a team, e.g., leadership training. The VE was also used to teach people to deal with different environments, different scenarios, for example one company used the VE to learn to understand how it is to live with a disability and they let the employees as avatars deal with common situations and locations. Several companies used the VE for mentorship in which people could quickly access experts and mentors within the VE either in speed mentor sessions, discussions with executives or by bringing in experts in the VE. Furthermore, the VE was used for brainstorming on strategies and new concepts and ideas within companies. The interviewees felt that the VE was very suitable for internal company training and learning in many different areas for sharing expertise and information, learning from mentors or training specific (technical) skills through role-plays, simulations and brainstorm sessions. The possibility and feature of many VEs to quickly input data, models and information, to store and extract this material from the VE was perceived as very useful for virtual teams.
3.4.3 Co-creation

One of the enablers that were perceived as a weak theme for VE, was the possibility of co-collaboration and co-creation (40%). In the VE distributed team members can build together, have the possibility to collaborate remotely and co-create simultaneously within the VE. “So teams create things, and they’ll often create things and leave them, and then expect them to be modified by the next team who’s going to come along and modify them and play with them and leave them. This is a new team practice of build, code, modify code, play with it and so on, and iterate on other people’s ideas. And it works particularly well across time zones. So, I can draw something in a space, and fully expect to wake up the next morning and see that about 15 people have played with it. Which is a teaming element that isn’t really always available.”

One example discussed by the interviewees was that virtual teams come into the environment and work simultaneously on a certain project, i.e., co-collaboration. For co-collaboration people can be in the same space and share the similar context: “Co-collaboration means I can be in the same space as you and point in context and say no, this is what I mean. Or I can pick up a beam, and another person picks up another beam and we can put it in place together. This notion of working together in a global team over a virtual space is something that’s new to the teaming environment as well.”

In addition to simultaneous co-creation and co-collaboration VEs enable working together across time zones. Several interviewees perceive the fact that VEs enable co-creation and co-collaboration with virtual teams as important in work contexts. The possibility of co-creation offers opportunities for new innovative team behavior, as well as possibilities to develop and design models and products in real-time in a distributed setting.

3.4.4 Visualization

Another dominant theme of the VE (100%) is the visualization of data in 3D. The visualization was perceived to support learning and knowledge sharing in virtual teams and was often related to other CMC that could not visualize 3D content: “You can exchange these sort of complex ideas more quickly than on email or IM [Instant messaging] and somehow your visualization of it is a more thorough communication. You know, a picture tells a thousand words.”

Visualization was perceived as important for data interpretation and decision-making. One example on visualization that was mentioned refers to the oil industry: “... you have a lot of data, they do geophysical, seismic, and all the exploring to get data, tons of data coming up and they’re trying to figure out where’s the oil and where’s the reservoir and what does the reservoir look like and where should we drill? When they drill, that’s a multimillion-dollar decision. And so you have this 3D object, this pool of oil down in the ground and you have to decide and it’s a very complex kind of a thing. So the data comes up and first of all, oil companies have these very expensive people. These are really top-notch people to interpret data where to drill ...they’re experts all over the world. So an oil company might have some in Indonesia, some in the North Sea, some in Nigeria and so on. You can’t fly them in for a meeting just to say, where do we drill because this is a new field ... If you can meet virtually, you pipe the data in and you visualize it. ... You create this 3D representation of the data and then you walk around and then you have the team of experts, their avatars and then they walk around the 3D image...”
Others mention that being able to visualize ideas and data helps sharing ideas and creativity for example in brainstorm sessions. “I think it’s an important element of helping to foster the creativity and extend the brainstorming. Because often times what may happen is that your colleague might write something down that you see on the board that gets you thinking about something else that you haven’t thought about. So, now you’re scribbling a new idea, you put that up. And somebody else sees that and it takes them in a slightly different direction. So that concurrent activity allows people to feed off of each other. And that’s really where the productivity—or the creativity in a brainstorming session comes from.”

An important feature of a VE is the visualization of a space, but also visualization of information, data, models and designs. This visualization was perceived as very important for learning, innovation, development of concepts and products, and collaboration in virtual teams.

3.5 Adoption challenges of professional VEs

Although VEs are perceived by the interviewees to enable collaboration and learning, the technology is still in an early development stage for firms. Many interviewees discussed adoption challenges (55%) of the technology in their firm. Adoption challenges were discussed in terms of becoming familiar with the technology, creating standards to work with the technology, and acquiring a willingness to work with VEs. Interviewees discussed that they had to justify working with VEs to their colleagues since many feel that the VE is not a serious tool, but mainly used for gaming. Furthermore, interviewees mentioned that it was important to have some experience in using the VEs, mostly in terms of navigation and avatar use. “I see a lot of managers not being ready to spend time prepping the avatar to run around from scenery to scenery and then fall in the water ... And it is true that the more flying hours you have in virtual worlds, the better you become... so that you can actually concentrate on the content.”

Several managers reported that their firm had connected the internal yellow pages to their VEs, but more integration between all internal firm systems was necessary for VEs to be beneficial in work contexts. Interoperability and integration with other firm systems is currently a challenge for many VE platforms. Technical issues were discussed by 72% of the interviewees. One of these technical issues was the difference in standards and bandwidth in different countries. Several global managers discussed that there were different standards and different levels of broadband and bandwidth; these issues had negative consequences for working with VEs in virtual teams.

In order to support collaboration, as well as learning and innovation, the adoption and maturity of the technology are important.

4 Discussion and conclusion

The empirical data we collected suggest that managers perceive VEs in work contexts as enablers of learning and knowledge development in virtual teams as well as creators of an atmosphere that fosters collaboration and learning for virtual teams.

A number of the perceived enablers of professional VEs can support virtual teams to create an atmosphere that fosters learning and knowledge development, i.e., immersion and engagement; socialization and personal relationships; and the shared context and awareness.
Literature discusses that virtual teams have more difficulty in socializing, building relationships and trust. Furthermore, decision making and conflict resolution take longer time (Hinds & Kiesler, 2002; Martins, et al., 2004). A large number of technologies have been developed to support virtual teams to create more local awareness, and to support communication and document sharing over distance. However, traditional CMC makes it difficult to share sensory information or local contexts (Cramton, 2001). Literature furthermore states that the creation of trust, a shared understanding, and awareness of contextual information can create an environment for virtual teams supporting knowledge sharing (Zakaria et al., 2004). The VE in this respect can enable a shared awareness of local conditions, the team’s work progress and team member’s context.

The possibility to be represented as avatars in a 3D space enables looking for cues in others’ behavior – e.g., in terms of proximity, outfits and looks - and in the environment - e.g., in terms of design, lay-out and scenery - similarly to the real world. The fact that distributed team members feel more free to act and speak within the VE can support socialization, network building and informal interactions, which all support creating an open atmosphere in which team members can share knowledge. In addition, virtual teams gain access to new knowledge through employees’ social networks or ties by bridging otherwise disconnected sub units and remote site offices to one another (Boh, Ren, Kiesler & Bussjaeger, 2007). These possibilities can in turn help distributed collaboration, building social relationships, team identity and trust. Our findings confirm literature on VEs in that social presence, engagement, and interactivity (Bosch-Sijtsema & Sivunen, 2013; Davis et al., 2009; Van der Land et al., 2011; Li et al., 2011; Zhao, 2003) support virtual teams in creating an atmosphere in which they can collaborate, share and develop knowledge together.

From our study virtual teams perceived a number of enablers that support the sharing and development of knowledge within the team or between teams, i.e., persistence; sharing of information, expertise and training; co-creation possibilities and visualization. These perceived enablers were especially relevant in virtual teams. The VE has been studied from an educational and pedagogical perspective in which the VE is perceived as beneficial for information sharing and learning (cf. Pollit, 2007; Prasolova-Forland, 2008). Others discuss the lack of empirical studies on how VEs in work contexts (Sivunen & Hakonen, 2011) or VEs support in team innovation and learning (Li et al., 2011). Our findings confirm the benefits of VEs for learning and developing new knowledge in virtual teams. The VEs support learning of (a) know who; the VE enables social network building (b) know what - with help of persistence of content, information can be stored and accessed (c) know how - the VE supports learning-by doing in training sessions, simulations, role-plays, and scenarios. Furthermore, the ability to visualize models, ideas and scenarios, and to interact with visualizations in a 3D collaborative space can enhance collaboration and innovation of virtual teams. The possibilities of co-creation in VEs where team members jointly can create new content enable the development of new knowledge.

In conclusion, the perceived enablers of VEs in work context can support virtual teams in terms of collaboration, learning and knowledge development. The VE supports learning by presenting opportunities to store, access, and share data and information and in creating an atmosphere in which virtual teams feel engaged, comfortable, create shared context awareness, and are able to build social networks and relationships. Our findings confirm studies on VEs used for education, company learning, or socializing and give an additional insight in how managers perceive enablers of VEs for learning and knowledge development in virtual teams. The VE’s as social media enable various possibilities that benefit virtual
teams in terms of learning and different types of innovation. Through VEs teams can co-create content, but also develop new ways of collaborating and working.

Admittedly, the study results generalizability is limited in that the study is primarily based on qualitative interviews on the perceptions of managers on enablers of VE. We are aware that managers might perceive VEs enablers differently then virtual team participants. Therefore, in future research multiple methods like team observation, and team member interviews could give us more insight in how these VEs can contribute to virtual team learning and innovation. Furthermore, future research can look into different VE designs that support either particular tasks, innovation, or learning in work contexts.

5 References


