Participatory Videoconferencing for Groups

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Abstract

For decades after its introduction, videoconferencing remained a marginal communications medium, used primarily by corporate businesses. However in recent years videoconferencing has been taken up by a wide range of individuals, groups and communities. Videoconferencing occurs when people at geographically dispersed sites communicate with each other by transmitting audio and visual data through videoconferencing systems. Group videoconferencing – or multi-site videoconferencing – refers to linking individuals or groups of people in three or more sites using videoconference systems. This unique method of communicating face-to-face without being there in-person is currently being used for education and learning, health and medicine, meetings and conferences, personal communication and community-building. Group videoconferencing does not necessarily lead to participation and knowledge retention; for this to occur it must be used thoughtfully and strategically. Based on the work of researchers and practitioners in the field and an analysis of participatory videoconferencing literature, this paper suggests potential good practices for increasing participation during group videoconferences.

1. Introduction

The use of videoconferencing in the 21st century is increasing because videoconferencing is becoming more accessible. Videoconferencing is being used by a variety of organizations and individuals due to the relatively widespread availability of high speed internet and digital network access, inexpensive videoconferencing systems, and personal computers.

Videoconferencing allows people living in different places, often in different countries and time zones, to collaborate together in real time. To initiate a videoconference one participant contacts the other by transmitting audio and video through a videoconferencing system which then enables synchronous communication. Multi-site videoconferencing for groups occurs when groups of people are linked from multiple sites using videoconference systems.

Multi-site videoconferencing has several immediate and tangible benefits: it saves time and money participants would have otherwise spent traveling, it encourages people who otherwise could not get together to meet and it offers a "green" solution to meetings. Videoconferencing can also be an important tool for knowledge building, provide necessary services for people in rural or remote communities, and aid in community building and development.

Videoconferencing is currently being used for education and learning, health and medicine, meetings and conferences, personal communication and community-building. For example, videoconference use for patient care, education and administrative meetings at River Valley Health, the largest health region in New Brunswick, Canada, has almost doubled between the 2005-2006 and 2006-2007 fiscal years, jumping from 1,054 to 2,094 total hours [29].

The primary objective of participatory communication is empowerment achieved through democratic process and collective action [39]. Participation, or the active contribution by participants through dialogue, can be facilitated in many ways. Participation includes verbal communication and gestures that signal recognition, rapport or a connection with others, understanding, and openness to new ideas or information. Participation in group videoconferencing also includes the potential engagement of participants who interact with others before, during and after the videoconferencing to engage in learning, empowerment, the formation of identity or self definition, as well as individual or group action leading to individual, group, organization or community change.

Our analysis in previous work found that four variables can either enable or constrain participatory videoconferencing: the technical infrastructure, the interaction between users and the technology, group dynamics, and the organization of the content of the videoconference [21]. In this paper we explore two of these variables: the interaction between users and technology and group dynamics.

2. Methodology

Our analysis focused on understanding how the interaction between users and technology and group dynamics can be

improved to encourage participation among a group of people at multiple locations using multi-site videoconferencing. We used the following questions to guide our analysis:

- To what extent can people in multiple locations participate and engage with each other using multi-site videoconferencing?

- What group dynamics and technology interaction variables enable and constrain successful participation and engagement?

- How can the process of group dynamics and technology interaction be improved?

To address these questions we conducted a comprehensive review of the literature on user interactions with technology and group dynamics. We also solicited contributions from researchers, technicians, and experts in the field of group videoconferencing.

3. Analysis

Why is participation important? Researchers note that participation, or the ability to interact, is key to knowledge retention. Seeing, hearing and having the opportunity to interact can increase knowledge retention by as much as 90%, and videoconference experiences where members are not able to participate are not worthwhile [9] [26]. Therefore technology that enables interaction paired with a participatory atmosphere is a vital component for multi-site videoconferencing.

The technical infrastructure is crucial to multi-site videoconferencing. For a more detailed review of the technical infrastructure see Molyneaux et al. [21]. Clear audio and visual signals can increase participation by increasing the quality of the auditory and visual cues; however, the equipment itself does not insure successful communications. The interaction between participations and the technology and group dynamics are also critical variables that can either enable or constrain participatory group videoconferencing.

The interaction between the users and the technology encompasses access to technology, ease of use and the actual physical space – how the conference room is set up. The ease of use will determine how comfortable participants are with the technology and their willingness to participate. The physical space of the room and location of the equipment, lighting and microphones can either encourage or inhibit participation.

Group dynamics and social relations are also investigated in this analysis. Group dynamics include the task and level of group collaboration and participation needed; the experiences of different users and the effect on the group; social interactions with and between groups of users; group dynamic issues including trust, motivation, and participation; and representational models. Individuals who do not feel part of the group or do not trust others within the group may be less inclined to participate.

3.1. Interactions with technology: Using multi-site videoconferencing to encourage participatory behavior

Multi-site videoconferencing is a communication process requiring both technology and users. The design attributes of the technology and the behavior of the user and the group both determine the viability of the technology [5]. Studies on desktop videoconferencing systems conclude that the access to videoconference equipment alone was not sufficient to encourage interactivity - participants using videoconferencing interacted with the technology according to pre-established social norms that were critical in determining how the videoconferencing system was used [6]. Variables include access to and awareness of the technology, the ease of use and viewing of videoconferencing and the "real" and virtual spaces created by the interaction between the technology and the users.

3.1.1. Awareness. Videoconferencing offers many benefits for governments, businesses and communities. The technology for multi-point videoconferencing is widely available, but not everyone has equal access to the resources, services, equipment and expertise needed to acquire and operate the technology. More awareness of videoconferencing is required so that individuals and organizations are comfortable with this method of communication.

To increase awareness and encourage videoconference use, videoconference systems have to be easy to use. The way people view the technology will affect their use of the videoconferencing system [6]. The way people hear and see the remote locations, and see their own image, are potential enablers or hindrances to participation.

3.1.2 Technical support and training. Once the videoconference system and services are in place, dedicated professional technical support is needed for groups to use multi-site videoconferencing. Larger organizations may have on-site technical support while technical support in smaller organizations may be reached via telephone. Organizations providing bridge services need a proficient bridge operator who will be in charge of creating, scheduling and overseeing multi-site videoconferences. Certain types of videoconferencing will need to ensure Quality of Service (QoS), which will require a skilled network manager.

Training is also needed for participants to use the technology by themselves in efficient ways without having to rely on technical support staff. Once people are more comfortable with using videoconferencing, they will us it more

often, and a higher level of interaction and participation will be achieved. Ho's study of videoconference use in British Columbia's telehealth system found that the patients unfamiliar with the equipment were less receptive to treatment and more likely to distrust health professionals. Over time these patients learned to use the equipment and reported higher levels of satisfaction with videoconference consultations [12].

3.1.3. Multi-site videoconferencing audio.

For most videoconferencing situations, the audio is the most important feature of videoconferencing: engagement among participants cannot take place if the audio is poor. It is important that videoconference rooms have telephones in case the audio fails during the videoconference. If it is known in advance that a participant will join the multi-site videoconference by audio only, the audio connection should be made directly with the set-top or the videoconferencing bridge.

Microphones are necessary for videoconferencing but can create problems. Microphones can pick up the slightest noise – from coughing, sneezing, and background discussions, to clicking pens, shuffling papers and tapping the table. Multi-site videoconference participants need to be aware of how noise carries and restrict their actions accordingly.

Ideally videoconferencing rooms should have a ceiling mounted microphone to reduce unwanted background noise; however, tabletop microphones are commonly used in videoconference rooms. Tabletop microphones should be positioned on the table in front of the participants. In larger groups auxiliary microphones can be used; for example extra microphones on the table. However it is important to use as few microphones as possible during a multi-site videoconference because multiple microphones increase the likelihood that other sites will hear more background noises [27].

Lapel, lavaliere or hands-free microphones are used during lectures and presentations and are either clipped to clothing or worn around the neck. There are many drawbacks of the lapel microphones, including very poor spectrum reproduction, ancillary noise due to interaction with clothing during movement, and large variations in volume depending on the orientation of the wearer's head. A head-mounted microphone with a fixed mouthpiece is far superior to the lapel microphone.

The best way to eliminate background noise is to mute the microphone at sites when no-one is speaking. Most of the literature on videoconferencing best practices states that the microphone needs to be muted [36], [30]; however, muting the microphone could create barriers to trust formation and therefore have a negative affect on participation [20]. Participants not speaking and muted might feel unable to participate. Some researchers suggest that microphones should be left on during videoconferences and that, rather than muting microphones, participants should become more aware of the audio, and cover microphones when necessary [20], [34].

In smaller groups with only two or three participants communicating, having only one or two sites leaving the microphones on would be a good practice. However, in larger groups with more sites leaving the microphones on at all sites would greatly add to distracting background noise, and reduce the efficiency of both the audio and visual equipment. Multi-screen views are usually voice activated, therefore for multi-site videoconferences muting the microphone while not speaking is a critical factor for the initiation of the multi-screen view.

In large groups the use of automated equipment is a good practice. On the *Videoconference Cookbook* website the authors note that communication should be kept as "natural" as possible by hiding the equipment. Automated equipment would eliminate the necessity for participants to continuously mute and un-mute their microphones and zoom in and out on each other during the videoconference – actions that necessitate time and practice, and can ultimately distract participants from the task at hand [36].

3.1.4. Multi-site videoconferencing views.

Early studies on video suggest that while the addition of audio improves communication the addition of video to audio provides limited benefit [40]. However, newer research indicates there are conditions where adding visual cues or video is beneficial and even critical to virtual group work; for example, in group collaborations people benefit more from shared work spaces than from being able to see one another, especially when group tasks are visually complex [15].

In traditional one-on-one videoconferencing there is a local view and an off-site view. Participants may be self-conscious about seeing not only the remote site but also their own image on the screen or may be unaware of how their own image is being transmitted to the other site. However the transmission of a single site onto a screen is similar to a computer or television, and discomfort with the system can lessen over time.

Set-top videoconference systems can connect up to six sites independent of a MCU bridge, which can accommodate hundred of concurrent connections [21]. Multi-point videoconferencing is challenging for participants used to seeing just one image on the screen as they would on a television set. Participants have greater difficultly paying attention to and looking at multiple sites displayed on one screen [18]. For large group multi-site videoconferencing a larger screen is recommended. When the multi-site videoconferencing bridge is scheduling the call, the bridge operator will choose between showing one site at a time on the screen or multiple sites on the screen.

Multi-site videoconferencing generally uses voice-activated switching – a device that automatically switches the image on the screen so that only the site where the active speaker is located is shown at any given time [18]. This technique could enable higher levels of both viewer participation and engagement; however, voice activated switching could also

serve to alienate participants in multi-site videoconferences by rendering them invisible. The multi-site conference would have to be organized so that feedback and discussion occurs from all of the sites involved; thereby giving all sites representation during the multi-site videoconference.

3.1.5. Visual cues in multi-site videoconferencing.
The visual element of videoconferencing contains important cues to the viewer, including reactions of people onscreen and their body language. Longer explanations are needed when visual quality is low in the videoconference, because participants cannot read these visual cues [1]. This section focuses on good practices for camera operation during group videoconferences.

Researchers note that in large group videoconferencing, dynamic camera operation is needed so that all participants can see who is talking. A static camera could prove problematic when interactive and spontaneous discussions are required. The larger the group the more difficult it becomes to read facial expressions and see who is speaking. Focusing on the person speaking can enable participants to engage with the speaker but this requires constant camera operation, which could be distracting and even detract from the content of the videoconference [34]. Focusing on the speaker could serve to limit participation because those not shown on screen might feel excluded and be less inclined to ask questions or make comments.

In order to simplify the process of zooming in on the presenter and then back out during the discussion organizers can set remote control presets prior to the videoconference. Automated camera movements that zoom in on speakers and participants can increase participation in videoconferences because it can capture the dynamics of the presentation [11]. Camera presets programmed on the remote give participants the ability to zoom in on a particular point in their room automatically with the push of a single button.

3.2. Social infrastructure foundation: building relationships and good group dynamics within multi-site videoconferences

In order for organizations to encourage participation and engagement in multi-site videoconferencing the participants need to have access to the equipment, training and dedicated support. Videoconferencing systems also need to be set up so that the technology is easy to use. However, while interaction with technology is an important variable for participation, good group relationships are needed in order to maximize the participatory potential of multi-site videoconference. A good team will overcome technological problems; however, good technical support paired with poor team dynamics makes virtual teamwork very difficult [13].

3.2.1. Group Dynamics.
Group dynamics in videoconferences are different than in in-person meetings. Discussion during videoconferences is more task-orientated and less social; therefore interactions are more orderly and polite. Generally there are fewer interruptions and less conflict in videoconference meetings [37]. Researchers also found that members of virtual teams are judged more on performance than discriminatory or stereotypical cues [31].

However, multi-site videoconference technology can also have a negative affect on group dynamics, inhibiting participation by reducing group cohesiveness [37]. In order to create a participatory atmosphere that leads to positive group outcomes during multi-site videoconferencing, there are several variables pertaining to group dynamics that need to be addressed, including group task, issues within the group such as trust, critical mass, norms and size, group leadership, and the experiences of the individuals.

3.2.2. Task.
Using technology that fits the task means there must be compatibility between the task at hand and the technology used to do the task [38]. Multi-site videoconferencing is a very useful technology for brainstorming activities, negotiating and making decisions. When groups are cohesive multi-site videoconferencing can also be good for reporting status updates.

Videoconferencing is also good to use when resolving disputes. For example, if one member is dominating another, videoconferencing can be better than an in-person encounter because videoconferencing creates a less threatening environment than in-person meetings for conflict resolution [37].

3.2.3. Social Presence.
Social presence is the extent to which a technology used to facilitate a meeting can provide a social or personable feeling to the interaction. Videoconferencing also allows for a higher social presence than other computer-mediated communications and therefore is a better means of communicating when dealing with ambiguous tasks requiring the resolution of multiple views [42].

At the same time, the increased social presence offered by videoconferencing can serve to distract from task participation if participants are not comfortable with the technology [42]. Comfort levels are not static but generally rise with increased training and use of the equipment.

Videoconferencing may not be the best media to use when first forming a new team [37]; however, sometimes it is impossible for teams to meet in person, even for just the first session. If in-person communication is impossible for groups meeting for the first time it is best to meet via videoconferencing so that all members can see each other and associate names with faces.

The group dynamic also affects how users perceive and utilize technology. Group dynamics include the development of trust, the critical mass of users, and group norms and size.

3.2.4. Trust. Trust is one of the critical success factors for virtual teams working via videoconferencing cited in the literature on videoconferencing and virtual teams [19], [34], [37], [1], [20], [14], [32], [23]. Authors note that trust building develops more slowly in virtual groups than in person [22]. Also, researchers note that teams are more likely to report that their remote colleagues are less helpful compared to local team members [1].

Building trust in virtual teams is more difficult and time consuming for many reasons. In videoconferencing it is difficult to maintain eye contact, and eye contact is one way trust is developed. Body language and gestures are more difficult to interpret in videoconferences, especially when multiple participants are involved. In multi-site videoconferences gaining floor control to interject or ask questions can be challenging [37]. Large group multi-site meetings are also more time consuming than in-person because of the need for more verbal acceptance, and therefore there can be less time for relationship building [1], [14]. Trust can also be inhibited because individuals may not have worked together before and may not expect to work together again [14].

Trust building in virtual teams can be facilitated in several ways. Some researchers recommend that virtual groups are either created after members already personally know one another or that virtual team members should meet in-person at least once before continuing to meet via videoconferencing [32], [37].

Building trust can also be accomplished within groups that have never met in-person. In virtual group collaboration, trust is earned with the delivery of results, demonstrations that promises can be kept, and the finished product [22], [20]; therefore it is important that responsibilities are clearly set for each team member, members are striving towards objectives that are the right fit for them, and that these objectives are a part of the overall goals of the team. Conflicts must be resolved as quickly as possible, members of the team need to keep each other up to date on the work, and all team members need to seek and give feedback on the group's work [14], [28].

3.2.5. Critical mass for Adoption. Critical mass is determined by the number of users in the implementation stage of a technology; this number will indicate the success or failure of a new product [16]. If co-workers or friends lack access, or if there is a perceived lack of access, the technology will not become widely used and will not have the critical mass needed to become popular. As the number of users increase, the technology becomes used more often and subsequently becomes more useful [38]. The rate of use of multi-site videoconferencing is determined by the number of people using the technology.

Critical mass is also dependant upon *group norms* and *group size*. Three norms affect an individual's perception and use of new technology: culture, social influence, and group influence.

3.2.6. Group Norms. Researchers have found that culture influences group decision-making. Some cultures have a collectivist outlook with tight-knit social networks; these cultures are more willing to adhere to group norms than cultures that follow individualism, or the idea that individuals are responsible for themselves [8]. There can be problems in groups comprised of members of both cultures but these factors can be overcome with more tolerant perspectives [32].

Social influence also affects the attitudes, behaviors and perceptions of individuals vis-à-vis new technology. The theory of social influence is based on the idea that individuals want to conform to others' expectations, therefore leading to similar perceptions of new technology coupled with the willingness to conform to group norms [8].

Groups themselves can also develop their own norms which affect the norms of the individuals within the group. Over time groups develop norms about why and how they are using technology, how they should perceive it, and the best strategies to maximize technology use [8].

Groups that meet on a regular basis are more likely to develop their own group norms, and individuals in these groups are more like to view the technology used for meetings in the same way; however, it is important to note that norms are not static but change over time. Researchers note that ad-hoc groups or groups that are not likely to meet again have no future expectations, resulting in a negative effect upon the group dynamic [8].

3.2.7. Group Size. Opportunities for individuals to participate in videoconferences decline in larger groups meeting via multi-site because of fewer opportunities for interactivity and reciprocity [4], [31]. Participants in larger groups usually come from more divergent backgrounds than members of small groups, and therefore potential for knowledge discrepancies increases, which can also have a negative affect on participation [1]. Participants in large group multi-site videoconferences may also feel they have limited power and authority in group decision-making [33].

This does not mean that multi-site videoconferencing with large groups cannot be interactive, just that more time and effort is needed to facilitate the creation of a participatory environment. There are several ways to increase participation in large groups, including negotiation, getting feedback from participants, and recording videoconferences.

In large group collaborations decisions need to be based on negotiations between subgroups within the larger groups, making all participants take part in the outcome [33]. Soliciting comments and feedback from participants during and after the videoconference is also another important way to make participants feel part of the team, and that their opinions and ideas matter to the group [32], [14].

3.2.8. Leadership. Virtual teams, like in-person teams, require an organizer or leader. Researchers note the

importance of a system of rotating leadership in large group multi-site videoconference communication. When large groups meet on a regular basis, not everyone will be able to attend every meeting. When the leader is unable to attend, the meeting has to be cancelled or postponed. Rotating leadership responsibilities will increase the possible number of group meetings, encourage leadership within the group, help participants develop meeting facilitation skills, and foster greater interaction between facilitators and presenters and equalize influence and participation, thereby leading to higher levels of participation, more productive meetings and successful collaborations [34], [10], [35].

3.2.9. Individual experiences. Experiences of users differ according to culture, community membership and gender. Groups with common cultural backgrounds exhibit fewer problems when collaborating. There can be more challenges to collaboration with group members from different cultural backgrounds exhibiting differing behaviours or showing different degrees of openness toward technologies but, as researchers Rutowski et al. [30] note, these factors can be overcome with time and greater exposure to the collaborative technologies.

Differences in perspective are related not only to cultural differences but also community membership. For example, videoconference communication between researchers with public funding and industry-funded researchers can be challenging because the researchers are coming from two very distinct community backgrounds. However, interviewees in Munn-Venn's [22] study on collaboration reported that they saw the different perspectives of other researchers as a benefit rather than a threat or an impediment to participation.

Few studies have investigated the effects of gender on group dynamics using communication technologies, and researchers note that studies examining gender are sometimes contradictory or inconclusive [41]. Becker and Goodwin, in their evaluation of virtual learning, state that women prefer collaborative environments while men react more favorably to individual learning. In this study women had higher rates of participation in a virtual collaborative environment, leading Becker and Goodwin to the conclusion that women may prefer a virtual pedagogy [3]. O'Donnell, et al. [24], in a study of First Nations' videoconference use, determined that women are using the technology more often and more actively than men. However, Wong et al [38] suggest that virtual groups may exhibit higher levels of satisfaction and social presence in mixed gendered groups. More research needs to be conducted on the effect of gender on participation in videoconferencing.

3.2.10. Motivation. Motivation is an important factor determining participation within groups using videoconferencing. Researchers Becker and Goodwin [3] note that motivation is crucial to promoting student interactivity because students who are motivated exhibit higher levels of satisfaction and use the technology to interact more with their peers and instructors [3]. When intrinsically motivated activities are employed in virtual teams, participants exhibit increased creativity, increased conceptual learning, positive emotional health and higher self-esteem [32].

3.2.11. Archiving. Archiving videoconferences for future viewing can also lead to an increase in participation. In large group videoconferences where regular meeting occur, recording the conference and making the archive available allows group members who miss a meeting to review the recording afterwards and process the information before the next meeting, giving them the ability to discuss the meeting with their colleagues. Archiving the videoconferences reduces or eliminates the need for summarizing the previous meeting and prevents confusion. Videoconference archives can be helpful for groups that meet on a regular basis and for large conferences where not everyone has the time to attend the sessions when they are scheduled [15].

4. How is successful participation measured, and how can it be achieved?

Success criteria for group videoconferencing differ according to who is defining "success." For example, technical support staff might consider a videoconference event successful if there are no technical glitches – they are not basing the success of the event on the level of interaction, collaboration or potential outcomes [2]. Problems related to technology and attendances are more likely to be recorded than barriers to participation that are more difficult to measure such as problems with group dynamics or motivational or trust issues. That is not to say that technical and human errors are not important – they do affect the quality and success of multi-point videoconferencing. However, multiple success factors are involved in participatory videoconferencing. Successful participatory multi-site videoconferencing also depends upon the interaction between users and the technology and the group dynamic.

Success criteria depend upon the outcomes of the videoconference on individual, group and organizational levels. Researchers can examine group success on an individual level by measuring the knowledge growth and well-being of group members as well as their satisfaction with the process and technology. On a group level the interactions of individuals within the group and the comfort and trust levels of the group can be recorded and analyzed, and on an organizational level the productivity outcomes of the meeting and the group's capacity for future work are some measures of success [13]. For conducting this research data can be gathered on an individual, group and organizational level.

To gather data on an individual level, organizers can gather or solicit feedback at the end of the videoconference verbally or by using a questionnaire that asks participants questions

related to access, involvement, participation and the technology. Organizers can also give participants an e-mail address or a link to a website where participants can give feedback after the videoconference.

Data about success on a group level can be gathered through feedback from individuals who note the success (or failure) of their interactions with others within the group. This type of information can be collected via a questionnaire. Group dynamics can also be observed during the videoconference by analyzing the visual and spoken interactions between participants – their body language, facial expression, tone and verbal contributions. Such observations can take place afterwards if the videoconference is recorded and archived.

Success at the organization level can be measured by asking participants questions about the organizational impact of the session, such as: Were decisions made during the meeting? Were the goals set out in the agenda reached?

Successful participatory multi-site videoconferencing depends upon individuals, group dynamics and organizational outcomes. Different groups meeting via multi-site videoconferencing have different needs, and good practice techniques need to be adjusted accordingly. Time is also a factor in good practices for multi-site videoconferencing. Success needs to be measured over time, and good practices need to be adjusted based on continued audience feedback and ongoing evaluation findings.

5. Acknowledgements

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