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STIMULATING QUESTIONING BEHAVIOUR IN VIDEO-MEDIATED DESIGN TEAMS

A study on learning and understanding

Abstract. In video communication, there seem to be no generally accepted habits that make questioning explicit, such as for instance explicit signals as hand raising or a time-out sign. Moreover, subtle signals often stay unnoticed. In the current work, we focus on improving people's natural questioning behaviour in video-mediated design teams. We performed a quasi-experimental study to investigate if either a questioning tool or a facilitator stimulated reflective behaviour and therefore stimulated learning and understanding. We compared twenty teams that performed a complex design task; ten of these teams had next to audio and video support a questioning tool available. Preliminary results showed that perceived shared understanding increased over time, and that teams with both a facilitator and the tool understood each other best, which was in line with our hypotheses. On the other hand, we found that teams with neither a facilitator and nor the questioning tool posed most questions.

INTRODUCTION

Increasingly, ad hoc expert teams are formed, within and across companies, to solve complex problems, such as design problems, for which multi-disciplinary views are necessary (Maitland, 2002). At the same time videoconferencing has attracted a great deal of new interest since 11 September 2001 (Automatiserings Gids, 2002). In the current work, we focus on ad hoc teams that rely on videoconferencing. In such teams, understanding each other is not easy, though crucial. Questioning is one of the most important means of facilitating learning and understanding, not only for the individual asking the question, but for the group as a whole. It can serve to keep the group focused, and prevent the group from getting bogged down. It can also help other group members by forcing them to present information and concepts more precisely (Queen's university, 1999). In face-to-face communication we see that people "can participate in the formulation of another speaker's utterance: They can ask questions, paraphrase, or seek clarification" (Krauss & Fussell, 1991). In addition, participants in face-to-face interaction routinely use a signalling system whose function it is to enable the interacting parties to coordinate with respect to meaning (Duncan & Fiske, 1977; Kraut & Lewis, 1984; Kraut, Lewis, & Swezey, 1982). In video-mediated communication this all is not so obvious. While observing an ad hoc design team during four months (Mulder, Swaak, & Kessels, 2002), we found that hardly any questions were raised and answered. Consequently, shared understanding was sub-optimal. *Why is questioning so difficult during videoconferencing?* In fact, questioning is natural. Take a look at children; they are very eager to ask questions. However, we influence their natural behaviour. They have to adopt our rules of interaction: as raise their hand when they have a question,

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and only when an adult mentions their name, they are allowed to pose their question. In other words, face-to-face interaction rules and habits for questioning have been adopted. For instance, people raise their hands (e.g., during presentations) or use a time-out sign (e.g., in sports) to indicate a necessary moment for questioning. As far as we know, in videoconferencing no such sign is internationally accepted or understood. Interestingly, in formal meetings next to hand raising "important people" are looked at in a subtle way, to notice whether they have questions or remarks and to check their agreement. This brings us to another difference between face-to-face and video-mediated communication. In videoconferencing, subtle signals or non-verbal behaviour frequently stay unnoticed. Interacting by means of videoconferencing systems is often referred to as less rich, less social and less personal than face-to-face communication (e.g., Short, Williams, & Christie, 1976; Kiesler, Siegel, & McGuire, 1984). Therefore, non-verbal behaviour and subtle signals have hardly any impact on questioning behaviour during videoconferencing. To circumvent these problems, video-mediated teams use for instance text chat to complement their communication (Mark, Grudin, & Poltrock, 1999). Moreover, due to the formal flavour of video meetings –no coffee breaks– and given the disturbing effect of whispering, video-mediated teams also lack informal chats during and in between meetings. Besides this deficiency of subtle signals, videoconferencing needs floor control to facilitate one person speaking at the time. In sum, we assume that next to sub-optimal technology support, there is no culture on questioning behaviour (yet) in video-mediated teaming. Therefore, we pay attention to stimulating questioning behaviour in video-mediated teams. We believe that the limited richness not only can be interpreted as a constraint, it can also be seen as a challenge. Implicit rules based on hierarchies and status are less visible and less evident, it also implies that undesired effects of hierarchies are not inhibited yet. The challenge here is to support questioning behaviour in such a way that we prevent adopting undesired communication patterns, and foster natural ways of interaction.

Stimulating questioning behaviour

Improving people's natural questioning behaviour can either be in a technological or in a social way. We are interested in both as long as it involves support that is natural and intuitive, has low thresholds, and makes the collaboration better, easier, and more fun. This is even more important for ad hoc teams as they need to be formed quickly, and consequently lack time for training and social bonding. We reviewed some technology (e.g., Malpani & Rowe, 1997; van Santvoord, 2001) that explicitly tried to support questioning during video communication. Our main conclusion was that we could not find any technology that is natural, intuitive and has low thresholds. We took an interaction design approach to find out how we can support people in asking questions best. In a workshop we started with what people actually do when raising a question and came up with valuable ideas for support (Mulder, Swaak, & Kessels, 2003). These technological ideas were evaluated in a user pilot, and resulted in the development of a tool that supports questioning behaviour (Q-tool). Though we used an interaction design perspective in developing the Q-tool, it still involves reasoning from a technology support point of view. However, we argue that the support can also be of social nature and looked at the role of a facilitator. Mark et al. (1999) studied technology use in video-mediated teams. They observed roles that seem to have value for virtual teams, namely what they called a "technology facilitator" that enhanced display information for remote participants by gesturing with the cursor and zooming, and a "meeting facilitator" that overcame interaction problems, and encouraged questioning behaviour. The main research decision to make was whether to give instructions or to observe spontaneous facilitating behaviour. We decided to focus on spontaneous facilitating behaviour; we can instruct someone to some extent to be a facilitator, however, some people are just natural leaders, whereas others prefer to keep in the background. As we believe stimulating questioning behaviour increases reflection, learning and understanding, we hypothesed that teams with the Q-tool learn and understand each other better than teams without a Q-tool, and that teams with a spontaneous facilitator perform better than teams without a facilitator. Finally, we expect that teams that have both a Q-tool and a spontaneous facilitator perform best.

A QUASI-EXPERIMENTAL STUDY

We investigated both the role of the Q-tool and the role of a facilitator. The experimental conditions were one condition with and the other without Q-tool. However, we also made a post-hoc distinction in teams with and without a facilitator; as we observed spontaneous facilitator behaviour, these teams were classified afterwards. We tried to make the experimental setting as realistic as possible: students were working on a complex design task, in two sub-teams, using collaborative technology. The unrealistic part was that teams were not really geographically dispersed, but were in two different rooms in the same building. *Subjects* of the current study were 20 teams of 4-7 students (N = 20; n = 110). Participants were recruited at three universities in the Netherlands. We tried to have comparable teams across conditions. To put it differently, students with differences in study background, nationality, age, and motivation for participation (voluntarily or part of the curriculum) were as far as possible equally distributed across teams with and without a Q-tool. The subjects had to perform a *collaborative design task* during one hour and a half. This task involves the creation of an added value service for a university portal. All teams had audio and video conferencing tools available. We selected technology that can be expected to be available for a large audience in the near future. We provided the teams with a laptop with desktop videoconferencing (Microsoft NetMeeting™), which included chat, shared whiteboard and application sharing functionality. We set up an internal connection between the two laptops, using a wireless LAN connection at 11Mb/sec. For the video two Philips ToUcam USB cameras were used. Ten teams had next to audio and video conferencing tools the Q-tool available (Figure 1); the other ten teams could only communicate by means of audio and videoconferencing. In order to avoid the audio to be a bottleneck we provided the teams with (two-way) half-duplex hands free telephones. Teams also had common visualisation tools at hand:

paper, pencils, flipchart, and whiteboard. Figure 2 shows the experimental setting as seen on both laptops during the teamwork.

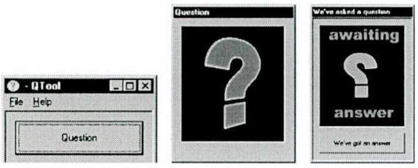

Figure 1. Q-tool. Both sub-teams have the button "question' next to the video screen. By clicking on this button one expresses the desire for questioning, and a red question mark (image on the middle) appears on the video screen of the remote team. Only the sub-team that presses the button can remove the question mark by ticking "we've got an answer".

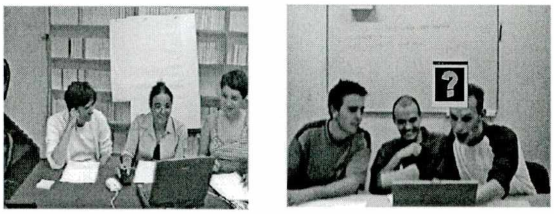

Figure 2. Experimental setting. Both sub-teams are working on their design task. The three male students just pressed the Q-button to get attention of their remote team members. Therefore, the three female students see a question mark on top of their video screen.

Data collection

We used several instruments to collect data to assess shared understanding and learning in the design teams. All instruments were validated in a pilot study (Mulder et al., 2003). All participants were assessed on their *prior knowledge and experience* on the domain of the design of services; they filled in a questionnaire at the start of the experiment. We used a self-scoring instrument to measure the *perception of shared understanding* (Mulder et al., 2002). With a 6-point scale we measured how team members perceived their understanding concerning content, procedure and relation aspects. Even number of points (6-points) forced students to choose either negative (1, 2, or 3) or positive (4, 5, or 6). After each half-hour team members rated their perceived understanding. Next to the perception of shared understanding (process), we also assessed the *perception of shared understanding of their final design* (product). Hereto, we asked each subject to describe *in their own words* the final design their team came up with. All descriptions were collected. Two experts judged these individual descriptions, using a 6-point scale (1 = not at all corresponding; 6 = completely corresponding) to indicate to what extent the descriptions of a whole team corresponded. In addition, just after participants finished their description, we randomly selected one description and read it aloud.

All team members indicated to what extent the description read aloud corresponded with their perception of the final design. They indicated on the same 6-point scale to what extent the description corresponded with their own description, and indicated on a second scale to what extent the description corresponded with their idea of the final result. Then, a second description was read aloud and one team member was asked to explain in his or her own words what (s)he thought the writer meant. Finally, the 'description writer' indicated on the same 6-point scale to what extent the explanation corresponded with his or her description. *Experts judged the quality of the final designs* using a 5-point scale (++, +, 0, -, --). Portals were awarded for the eight criteria mentioned in the task description. Plusses and minuses lead to sum scores, which were ranked. We *observed facilitating behaviour* during the team communication using an observation scheme. We focussed at who was initiating proposals and raising questions with respect to the content and procedure. Moreover, we were interested when a person was paying attention to other team members (social relation and team cohesion). We *recorded the team communication* on videotapes. In order to get more insight in learning and reflection in video-mediated design teams, and results that better allow comparison across the teams, we developed a coding scheme (Mulder & Graner, 2002). Several *participating students* (N= 13) reported their videoconferencing experience. Among others they reflected on the usage of collaboration tools, their expectations, and their collaboration process. Finally, log-files were generated by the Q-tool to monitor its usage (frequency), including which sub-team was pressing the Q-button, and at what time.

Data analysis

In order to get more insights from the observations and the videotapes, we developed a coding scheme for questioning behaviour, and analysed facilitating behaviour. Main aim of observing *facilitating behaviour* was to classify the twenty teams into teams with and without a facilitator. We labelled a team 'with facilitator' if someone in that team appeared to take more than 40% of the initiatives of the whole team. At the same time we checked if someone in a team was accounted for more than 50% of the content related or process related initiatives, and if this percentage corresponds with at least 75 utterances. The current *coding scheme* has been based on the one we used in the previous study (Mulder et al., 2002). Whereas the current goal has next to learning and understanding a specific focus on questioning behaviour we made some adjustments (Mulder & Graner, 2002). On the one hand we are interested in categories that can be counted (frequency), e.g., number of questions raised, on the other hand we are interested in categories that last a certain period (% of total time), e.g., sub-team communication.

RESULTS

Table 1 displays the experimental conditions with and without a Q-tool, and the number of teams that belong to one of the four resulting groups (with or without a Q-tool and with or without a facilitator).

Table 1. Experimental conditions and number of teams

	- **Facilitator**	+	
-	AV (N = 6)	AVF (N = 4)	Q-tool – (N = 10)
Q-tool			
+	AVQ (N= 8)	AVQF (N = 2)	Q-tool + (N = 10)
	Facilitator – (N = 14)	Facilitator + (N = 6)	Total (N = 20)

Perception of shared understanding

The numbers in Table 2 increase from T0 to T3; as expected the perception of shared understanding increased. Only the teams with a facilitator (AVF) seemed to have a slight dip on T2. According to our hypothesis we noticed that teams with the Q-tool had a better perception of shared understanding than teams without, and that teams with a facilitator had higher scores than teams without. Also teams with both a Q-tool and a facilitator had better perceived shared understanding than teams without. Averages in Table 2 do not show clear differences between teams with only a facilitator (AVF) and teams with only the Q-tool (AVQ).

Table 2. Perception of shared understanding at start (T0) and after each half hour (T1, T2, T3) (mean and sd per Q-tool (+ and -), Facilitator (+ and -), AVQF, AVF, AVQ, and AV)

	T0 - mean	*(sd)*	*T1 - mean*	*(sd)*	*T2 - mean*	*(sd)*	*T3 - mean*	*(sd)*
Q-tool + (N=10)	3.48	(0.52)	4.02	(0.33)	4.37	(0.34)	4.71	(0.36)
Q-tool – (N=10)	3.40	(0.59)	3.98	(0.48)	4.05	(0.42)	4.39	(0.40)
Facilitator + (N=6)	3.23	(0.72)	4.20	(0.39)	4.31	(0.39)	4.80	(0.35)
Facilitator – (N=14)	3.53	(0.48)	3.92	(0.42)	4.17	(0.39)	4.44	(0.39)
AVQF (N=2)	3.17	(0.65)	4.46	(0.49)	4.83	(0.41)	5.13	(0.41)
AVF (N=4)	3.26	(0.36)	4.07	(0.36)	4.04	(0.35)	4.63	(0.39)
AVQ (N=8)	3.56	(0.50)	3.91	(0.47)	4.25	(0.45)	4.61	(0.39)
AV (N=6)	3.49	(1.15)	3.92	(0.23)	4.05	(0.26)	4.22	(0.25)

We assumed shared understanding increased over time. A Friedman test pointed out that shared understanding significantly increased across the 20 teams (= 23.520; df = 3; $p < .001$). When looking at this increase across teams with a Q-tool, we found that shared understanding increased significantly (= 16.212; df = 3; $p = .001$). Also teams working without a Q-tool had significant increase in shared understanding (= 38.638; df = 3; $p < .001$). A Mann-Whitney test on the effect of the Q-tool obtained no significant differences on the increase of shared understanding across experimental conditions ($Z < 0$; $p > .10$). In order to correct for differences at the start of the experiment (T0), we performed also a Mann-Whitney test on the increase of shared understanding, which showed no significant differences across experimental conditions either ($Z < 0$; $p > .10$).

Perception of shared understanding of final design

We measured the perception of shared understanding of the final design using participants' descriptions by means of both expert rating and self-scores. Two experts rated independently all the individual descriptions. The correlation of the experts' scores was .74 ($p < .01$), which implies their ratings corresponded substantially. Also scores of *rater 1* and the *self-scores* on description correlated significantly ($p < .05$); *rater 2* and the *self-scores* on description did not correlate significantly ($p = .069$). Results either negative (1, 2, or 3) or positive (4, 5, or 6) are displayed in Table 3. Almost all scores are higher than 4. The two experts indicated low scores for the AVQF teams (2.83 respectively 3.03). Also the self-score on the description of AVQF teams was low (3.83). This was not in line with our expectations. The scores with respect to their idea of the final design show that teams with a Q-tool had higher perceived shared understanding than teams without, and that teams with a facilitator scored higher than teams without. In addition, AVQF teams had higher scores than AVF teams respectively AVQ teams. AV teams had lowest scores. These scores confirmed our hypotheses. A Mann-Whitney test on the measures of shared understanding of the final design showed no significant differences across experimental conditions for *your description*, *rater 1*, *your idea*, and *explanation other* ($Z < 0$, $p > .1$). Only *rater 2* appeared significant across conditions ($Z = -2.121$, $p = .035$), though this significance was contrary to our expectation that shared understanding was higher in teams with a Q-tool.

Table 3. Perception of shared understanding of final design (mean (sd))

	Description (Expert 1)	*Description (Expert 2)*	*Description (self-score)*	*Idea (self-score)*	*Explanation (other)*
Q-tool + (N=10)	4.05 (1.03)	3.84 (0.85)	4.47 (1.14)	4.97 (0.92)	5.30
Q-tool – (N=10)	4.68 (0.77)	4.50 (0.70)	4.71 (1.08)	4.92 (0.97)	5.50
Facilitator + (N=6)	4.25 (0.94)	4.22 (0.69)	4.60 (1.10)	5.14 (0.96)	5.67
Facilitator – (N=14)	4.28 (0.89)	4.06 (0.81)	4.59 (1.12)	4.85 (0.94)	5.23
AVQF (N=2)	2.83 (1.73)	3.03 (1.05)	3.83 (1.56)	5.17 (1.15)	5.50
AVF (N=4)	4.96 (0.54)	4.81 (0.50)	4.98 (0.87)	5.13 (0.87)	5.75
AVQ (N=8)	4.35 (0.86)	4.04 (0.80)	4.62 (1.04)	4.92 (0.86)	5.25
AV (N=6)	4.50 (0.93)	4.29 (0.83)	4.54 (1.17)	4.78 (1.03)	5.33

Team communication process

Results from our video analyses (Table 4) point out a lot of content proposals in all teams, and compared to that few process proposals. It seemed that communication was focussed on the content, and apparently involved much answers. In relation to the number of content proposals, few questions were raised. High scores on 'confirm' seemed to indicate that team members did listen to each other, though they seemed to reflect little according to the average frequencies. With respect to reflection it was remarkable that teams with neither the tool nor a facilitator reflected most. The averages indicate that there was few impasse in all teams, however in the AVQF teams no impasse took place. The amount of sub-team communication was more or less the same among teams. Interestingly, teams with facilitator communicated less in sub-teams. Another observation was that no collaborative reflection took place. Teams with Q-tool and AVQF teams talked hardly about irrelevant issues. Finally, AVQF and AVQ teams produced more tech talk. High standard deviations pointed out the differences among the teams. This might be one of the causes that the Mann-Whitney test did not obtain significant differences ($Z < 0$; $p > .10$) across experimental conditions.

Table 4. Frequency of moment codes and period codes in minutes (mean (sd))

	Q-tool+ (N=10)	*Q-tool- (N=10)*	*Facilitator + (N=6)*	*Facilitator - (N=14)*	*AVQF (N=2)*	*AVF (N=4)*	*AVQ (N=8)*	*AV (N=6)*
New question	65.60 (14.26)	78.70 (13.84)	71.83 (13.48)	72.29 (16.41)	66.00 (12.73)	74.75 (14.66)	65.50 (15.44)	81.33 (13.97)
More questions	30.30 (9.63)	36.20 (10.82)	30.17 (10.15)	34.57 (10.62)	29.50 (0.71)	30.50 (13.08)	30.50 (10.90)	40.00 (8.05)
Content proposal	106.50 (32,24)	119.80 (22.67)	118.67 (29.31)	110.79 (28.16)	114.50 (2.12)	120.75 (37.59)	104.50 (36.23)	119.17 (8.73)
Process proposal	28.10 (12.52)	31.70 (5.27)	33.67 (10.60)	28.29 (8.96)	34.00 (22.63)	33.50 (4.04)	26.63 (10.77)	30.50 (5.99)
(Dis-) confirm	206.20 (64.05)	194.30 (64.44)	197.83 (25.07)	201.29 (74.32)	222.00 (5.66)	185.75 (21.28)	202.25 (71.98)	200.00 (84.29)
Feedback	81.00 (20.29)	100.50 (45.10)	97.33 (55.91)	87.93 (24.66)	68.50 (6.36)	111.75 (66.07)	84.13 (21.62)	93.00 (29.54)
Reflection	3.60 (3.66)	5.80 (3.99)	3.83 (3.06)	5.07 (4.25)	1.00 (1.41)	5.25 (2.63)	4.25 (3.81)	6.17 (4.92)
Impasse	0.30 (0.67)	0.40 (0.70)	0.50 (0.84)	0.29 (0.61)	0.00 (0.00)	0.75 (0.96)	0.38 (0.74)	0.17 (0.41)
Sub-team comm.	12:46 (14:15)	07:15 (09:32)	06:58 (10:34)	11:18 (12:53)	14:53 (17:07)	03:00 (05:04)	12:14 (14:45)	10:05 (11:09)
Collabor. reflection	00:00 (00:00)	00:00 (00:00)	00:00 (00:00)	00:00 (00:00)	00:00 (00:00)	00:00 (00:00)	00:00 (00:00)	00:00 (00:00)
Off-topic comm.	00:22 (00:29)	03:40 (04:37)	01:25 (01:54)	02:16 (04:11)	00:41 (00:58)	01:47 (02:16)	00:17 (00:21)	04:55 (05:32)
Tech: talk	02:39 (05:07)	01:09 (00:55)	00:58 (01:36)	02:18 (04:15)	02:03 (02:54)	00:26 (00:31)	02:48 (05:42)	01:38 (00:49)

Quality of final design

Two experts on portal designs judged the final designs. Teams with both a facilitator and the Q-tool came up with low quality portals, and the portals of teams without a facilitator were the best, which is not confirming our hypotheses. On the other hand AV and AVQ teams design portals of low, medium and high quality. We performed a Mann-Whitney test to test for differences across experimental conditions in the quality of the final portal design. Teams with and without a Q-tool did not come up with final designs that have significant different quality ($Z < 0$; $p = 0.76$). So, it is not straightforward how to interpret the quality of the portal and how these product measurements relate with our assessments of learning and shared understanding.

Use of Q-tool

In AVQ teams (N=8) the average use of the tool is 28.75 times, in AVQF (N=2) teams 39.5 times. In the *participants experiences* the AVQ team that used the tool most (73 times) wrote that they experienced the Q-tool as a very nice way to get attention of their remote team members. A consequent use seemed to yield positive experiences. The AVQF team that used the tool 51 times indicated that they used the tool primarily for fun. To conclude, it is not straightforward how to interpret these frequencies.

CONCLUSIONS AND DISCUSSION

In the current study, we gained insight into learning and understanding in video-mediated teams by focussing on their questioning behaviour. We hypothesed that teams with the Q-tool learn and understand each other better than teams without, and that teams with a spontaneous facilitator perform better than teams without a facilitator. Moreover, we expected that teams that had both a Q-tool and a spontaneous facilitator performed best. Results of the assessment of the perception of shared understanding confirmed our hypotheses. Teams with either a Q-tool or a facilitator indicated a better perception of shared understanding that teams without a Q-tool respectively a facilitator. Also teams with both a Q-tool and a facilitator had better perceived shared understanding than teams without. Though, the perception of shared understanding increased during the teamwork, little (collaborative) reflection took place. One possible explanation is that such behaviour just did not occur. In that case it is a challenge to investigate which incentives can stimulate a team's reflective behaviour. Another explanation is that we were too rigid in coding (collaborative) reflection. A limitation of the experimental setup was that the teamwork only lasted one and a half hour, and that we did not pay attention to team development and diffusion of technology use. Rice, Majchrazak, King, Ba, and Malhotra (2000) performed a longitudinal study of a creative design team for 10 months. They concluded that it was clear "that a fair amount of "mutual expectations" and shared understandings had to be developed before the team could move into a period of focused design process (Krauss & Fussell, 1990; Schrage, 1990)" (Rice et al., 2000, p. 96). This may also be an argument for our finding that it proved to be difficult to assess an improvement in the final result when focussing on team processes. Results of the pre-questionnaire confirmed that all teams that came up with high quality portals did project work together before, and assumable they had their mutual expectations on forehand. Another explanation of the high assessments on shared understanding is that the participants were a bit too positive about their perceived shared understanding. Interestingly, teams' self-scores were more positive than those of external experts. This would also be better in line with the little reflective behaviour.

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Title: Stimulating questioning behaviour in video-mediated teams: A study on learning and understanding

Author: Mulder, I., Graner, M., Swaak, J., & Kessels, J.

Summary: In: Hoppe, U., Wasson, B., & Ludvigsen, S. (Eds.). *Computer Support for Collaborative Learning 2003 - Designing for Change in Networked Learning Environments*. Dordrecht, The Netherlands: Kluwer Academic Publishers. Paper to be presented at CSCL 2003, Bergen, Norway, June, 14-18.

Description: In video communication, there seem to be no generally accepted habits that make questioning explicit, such as for instance explicit signals as hand raising or a time-out sign. Moreover, subtle signals often stay unnoticed. In the current work, we focus on improving people's natural questioning behaviour in video-mediated design teams. We performed an experimental study to investigate if either a questioning tool or a facilitator stimulated reflective behaviour and therefore stimulated learning and understanding. We compared twenty teams that performed a complex design task; ten of these teams had next to audio and video support a questioning tool available. Preliminary results showed that perceived shared understanding increased over time, and that teams with both a facilitator and the tool understood each other best, which was in line with our hypotheses. On the other hand, we found that teams with neither a facilitator and nor the questioning tool posed most questions.

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