INFORMÁCIÓS TÁRSADALOM

Can team communication obscure severe usability problems?

Communication analysis of teams using shared visual workspaces

Team communication is a significant topic of study in the psychological literature, but it is a less researched area in relation to software usability. In this article, as part of a larger research project, we investigated team communication to explore the relationship between usability problems and team communication patterns. The research question was examined in two laboratory experiments as part of a collaborative software evaluation process. For sequential analysis of team communication transcripts, we created a custom code system based on previous literature. The results confirm that teams that experience special types of usability problem show different communicational patterns from teams that experience no such problems. The results also show high reliability of the new code system. Further research is needed to explore the relationship between usability problems and team communication patterns in different settings.

Keywords: *Human–computer interaction, collaborative software, communication analysis, lag-sequential analysis, team usability testing*

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How to cite this article:

Geszten, Dalma, and Balázs Péter Hámornik. “Can team communication obscure severe usability problems?”. *Információs Társadalom* XXIII, no. 2 (2023): 48–66.
https://dx.doi.org/10.22503/inftars.XXIII.2023.2.3

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1. Introduction

How users use different technology in their everyday lives is a key topic in the human-computer interaction research field (Tófalvy 2019; Fehér 2017; Vajda 2020; Szűts and Yoo 2018; Hámornik et al. 2014; Hercegfi et al. 2015). Among several types of software, this paper focuses on collaborative software, the goal of which is to support teamwork. The first collaborative software emerged in the 1950s and became widespread from the 1990s as a consequence of the appearance of the World Wide Web and due to the popularity of teamwork as a research topic (Schmidt and Bannon 2013). Therefore, collaborative software has quickly become an integral part of everyday work, making usability a key issue.

The study presented in this article is related to the investigation of team communication in a collaborative software usability context, as part of a larger research project. Although the goal of the research project is to develop a new method for the usability evaluation of collaborative software, here the focus is on the communication analysis of teams, as it is an element of the new method, called Team Usability Testing (Geszten, Hámornik and Hercegfi 2021).

First, we present the theoretical background of the topic and the broader research context. Then we describe the steps of the code system design and the results of analysing the communication of teams while using shared online visual workspaces.

2. Related literature

2.1. Teamwork: definition of team and virtual team

Teamwork is a major research topic in work psychology, as people work more effectively in a team than individually. There are many definitions related to team, the different elements of which are: being a system of interdependent individuals in which members have different roles (Hackman 1987); being characterised by the fact that its members see themselves as a social unit (Cohen and Bailey 1997); and having cooperation as a common goal (Salas, Burke and Cannon-Bowers 2000).

Globalisation, the explosion of the Internet, the development of technology, the resulting demand for rapid product development and the competitive market responses to this have all been key drivers for the widespread adoption of virtual teams (Aldag and Kuzuhara 2015). This was also facilitated by the rapid spread of collaborative software, which took place in the decade following the appearance of the World Wide Web in 1989 (i.e., 1989–99) (Schmidt and Bannon 2013).

In defining virtual teams, the continuum theories seek not to distinguish strictly between virtual and non-virtual teams but rather to view virtuality as a continuum, a characteristic of the team (Hertel, Geister and Konradt 2005; Mesmer-Magnus et al. 2011).

Virtuality refers to whether team members prefer to be face-to-face, hybrid (with some members face-to-face and others virtual) or fully virtual when working together.

Virtual teamwork has several benefits at both individual and organisational level, as well as a number of challenges, as Table 1 describes.

	Benefits	Challenges
At individual level	Flexibility (in time and space) Higher motivation Increased responsibility and authority of members	Loneliness Reduction in personal relationships Role conflicts Conflicts of interest
At organisational level	Can form teams based on expertise, not location (can gather experts on a single topic or different topics) Work can be continuous, because of different time zones Flexibility and responsiveness to changing market needs Reduced travel and office-related costs	Difficult to monitor performance Can have high cost for the right technology Data security Additional development costs Designing efficient workflows Reduced motivation among members Maintaining trust and team spirit

Table 1. Benefits and challenges of virtual teamwork (Hertel, Geister and Konradt 2005; Krumm et al. 2016)

2.2. Team communication analysis

Achieving performance beyond individual effort is one of the key goals of teamwork, and several methods have been developed to investigate the factors that influence the performance and the characteristics of a successful team (Aldag and Kuzuhara 2015; Levi and Askay 2020). Team communication analysis is one of these methods.

The characteristics of a team can be divided into three main groups:

1. cognitive (cohesion, how well they know each other)
2. affective (group mood)
3. behavioural characteristics (coordination, cooperation, communication).

Cognitive and affective factors are not clearly manifested in behaviour and are therefore more difficult to measure than behavioural characteristics. One of the most dominant behavioural characteristics of a team is communication. Communication analysis is relevant because when a team performs a cognitive task (not a physical task), communication reveals the team-level cognitive processing of the task (Cooke et al. 2012).

One definition of team communication is the exchange of information among team members (Adams 2007); indeed, in teamwork sharing information is the most important function of communication among team members. In addition, communication is an opportunity to increase motivation towards a common goal and to provide control over tasks and responsibilities. It also has an emotional function, allowing members to express emotions and thereby reducing frustration (Aldag and Kuzuhara 2015).

Depending on how it is operationalised, team communication can mean many things, referring to the frequency, quality, duration or content of communication (Marlow, Lacerenza and Salas 2017). Team research most often investigates the frequency or the quality of communication. While frequency refers to the extent of communication, quality refers to the accuracy and clarity of communication among team members. In this study, team communication patterns are coded using our newly developed coding system and then examined with sequence analysis.

2.3. Technology as a key element of virtual team performance

As emphasised throughout the theoretical introduction, technology is a key determinant of virtual team performance. A prominent element in the various definitions of virtual teams is technology, especially the frequency and the mode of technology in use (Martins, Gilson and Maynard 2004; Kirkman and Mathieu 2005). Throughout the life cycle of virtual teams, the selection of appropriate technology is emphasised at the preparatory stage, as supported by the input-process-output model, which mentions ‘technology‘ as an important input factor among the work environment factors (Saunders 2000). In addition, it highlights the task–technology relationship as a team process that also influences team performance.

Having adequate technological support for virtual teams is therefore crucial. However, providing a high enough level of technological support for a virtual team to work effectively can be very expensive, so it is essential to choose the right tools and software.

2.4. Collaborative software and its usability

2.4.1. Collaborative software

In the broadest sense, collaborative software is computer technology that helps a team collaborate using digital media (Khoshafian and Buckiewicz 1995; Yen et al. 1999). Another definition is that ‘groupware systems support collaborative work of users that share common objectives‘ (Salomón et al. 2019, 11).

Collaborative systems (not just software) can be grouped in many ways. One of the most common approaches is based on where and when the interaction among participants takes place (Bafoutsou and Mentzas 2002). In terms of the temporal dimension, the interaction can take place at the same time (synchronous) or at different times (asynchronous), and in terms of the spatial dimension, it can take place in the same place (co-located/face-to-face) or in different places (remote) (Bafoutsou and Mentzas 2002).

The Team Usability Testing that is the subject of the broader research (detailed in Section 2.5.) aims to investigate the usability of collaborative software used at the same time, that is, synchronously.

A typical example of this type of collaborative software is any multi-user shared visual workspace, such as an online whiteboard. In this context, collaborative actions involve several users working together at the same time in a shared online space (e.g., editing or organising some content together).

2.4.2. Understanding the usability of collaborative software

Collaborative software usability is defined as the extent to which collaborative software enables teamwork to be carried out – efficiently, effectively and satisfactorily – for a given team's particular joint activity (Pinelle, Gutwin and Greenberg 2003). Problems with collaborative software can be divided into two groups:

- contextual problems caused by organisational and social factors
- problems resulting from inadequate support of collaboration mechanics (Steves et al. 2001).

Use of collaborative software involves two different types of work:

1. taskwork – single-user actions required to complete a task, without involving other team members;
2. teamwork – group actions required to complete a task, performed by working together (Pinelle and Gutwin 2002; Pinelle, Gutwin and Greenberg 2003).

It is important to distinguish between these two different types of work because, while individual software evaluation methods focus only on task-related work, collaborative software usability evaluation methods need to assess support for both task- and team-related work.

2.5. The broader context of our study

In the broader context of our research, we focus on developing a new usability testing method that aims to investigate the usability of collaborative software used synchronously, that is, at the same time. The new Team Usability Testing differs from previous methods in that it is an empirical method for evaluating synchronous (real-time) collaborative software, involving real or potential users to explore usability problems. In addition to individual usability problems, team usability problems must also be considered for collaborative software. Single-user usability methods are not suitable for investigating team usability problems because these problems can only be observed in a collaborative situation. Team Usability Testing can also be used to test teams working together in the same (face-to-face) or different (remote) locations.

Team Usability Testing consists of questionnaires, screenshots and interviews. Data analysis is based on the theory of team processes and the mechanics of collaboration and consists of the analysis of communication transcripts, interviews and questionnaire data (Marks, Mathieu and Zaccaro 2001; Pinelle, Gutwin and Greenberg 2003).

As team communication analysis is an element of Team Usability Testing, we performed a sequence analysis on the communication transcripts of the first and second lab studies using a self-developed code system. Although this paper focuses on the team communication analysis results, the development process and the usability results of the Team Usability Testing method are discussed in detail in other papers (Geszten, Hámornik and Hercegfi 2018, 2019, 2021, 2023).

3. Methodology

3.1. Research questions of the first and second laboratory studies

We designed the first and second laboratory studies to investigate the feasibility of the Team Usability Testing under controlled laboratory conditions. The method aims to test the usability of a given collaborative software and to identify team usability issues related to the software, involving real/potential users.

The research question we are focusing on in this paper is: What is the relationship between usability problems and a team's communication patterns?

3.2. Participants

Ten teams participated in the first lab study: two teams in the pilot study and eight in the final study. We needed the two pilot teams to finalise the task instructions and the technical conditions. In the final study, we excluded one team from the data analysis, so the remainder of the description of participants refers to the seven teams that participated. During the final study, we assigned participants to one of two roles: collaborator or observer. Each team consisted of three collaborators; if there were four members in the team, one member became an observer. Therefore, not all teams had observers. The observers were there more for organisational reasons, to monitor the teamwork and to act as a kind of back-up, standing in for any absent collaborators, so that we could carry out the study even if not all collaborator participants came (as was the case many times).

The teams were randomly formed based on the dates of the research. Students were allowed to apply for different dates, and everyone was put in a team with the participants who applied for the same date. Participants in the collaborative role were undergraduates aged 21–28 (mean = 23.57) who knew each other. Most participants described themselves as more of a team player (on a scale of 1–7: 1 – I prefer to work alone; 7 – I prefer to work in a team) with a mean of 4.61 across teams, ranging from 3.67 to 5). Further, 9 out of 21 participants had previous experience with PREZI and all teams had at least one participant who had used it before.

Eleven teams took part in the second laboratory study. As in the first lab study, we assigned the participants one of two roles: collaborator or observer. Each team consisted of three collaborators and an observer. (In the second lab study, we invited four participants to each time slot, with the aim of making the study feasible if someone did not come. As in the first lab study, the participants drew their roles from an envelope. Since all four participants came on each occasion, there were observer participants in each case.)

In the second laboratory study, 10 men and 23 women, aged 18–22, participated in the collaborator role (mean: 19.42, standard deviation: 1.27). In the before-task questionnaire, we asked participants, 'Do you prefer working alone or in a team?' (on a scale of 1 to 7: 1 – mostly alone; 7 – mostly in a team). The combined mean for all teams was 4.00, with standard deviation 1.54. In the second lab study, none of the participants had previous experience with the Miro collaborative whiteboard software.

3.3. The evaluated software

The first lab study was related to PREZI, while the second lab study was related to the Miro shared visual online workspace. We chose these for two reasons. First, they were relatively new and popular in Hungary at the time of the research, but still had huge potential for development. Second, they did not require any special prior knowledge to use, even for a first-time user.

PREZI is an infinite canvas (in the words of its creators, a 'zoomable, canvas-based editor') that allows users to develop creative presentations in an online interface. In addition to individual work, PREZI also offers the possibility for teamwork, and can therefore be considered collaborative software (Laufer, Halácsy and Somlai-Fischer 2011).

Miro (miro.com) is a collaborative whiteboard software that provides a common visual workspace for collaborators, mainly to visualise different ideas and (work) processes.

Several users can edit the same content at the same time in a shared workspace in both PREZI and Miro. The collaborative features supported by them are related to collaborative editing: users are able to work in a shared workspace at the same time, while seeing what other users are doing and where they are in the interface.

3.4. The procedure of the test

Figure 1 shows the process of the first and second laboratory studies. More detail can be found in Geszten, Hámornik and Hercegfi (2021).

The three collaborator participants were tasked to prepare a joint PREZI presentation in 30 minutes. Their task was to organise a company team-building event and to create a presentation from their ideas. This type of task was chosen because it does not require any 'special' skills. In addition, the short time frame justified the low complexity of the task. To solve the task, participants had to use the collaborative software PREZI.

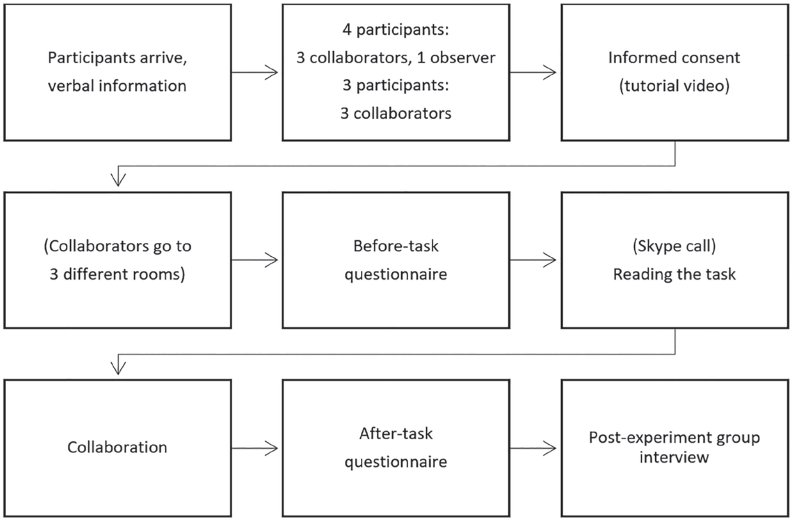

Figure 1. The procedure of the first and the second laboratory studies (in parentheses are the parts that occurred only in the first lab study due to the simulation of virtual collaboration) (created by the authors)

The procedure for the second lab study was the same as for the first lab study, the main difference being that the participants worked together face-to-face, using Miro.

3.5. Tools

The three collaborator participants worked on laptops during the task. The task was video and audio recorded using a free screen recording software OBS (Open Broadcast Software). The pre- and post- questionnaire was in Google Forms format. The group interview was recorded using a dictaphone and an audio recording application.

4. Results: analysis of the communication patterns of the teams of the first and second laboratory studies

Based on the results of the first and second lab study, we observed different usability problems in the teams that affected their collaboration. While some team usability problems occur in some teams, they do not occur in other teams (Geszten, Hámornik and Hercegfi 2021).

Among the factors affecting collaboration, we selected the most severe problem, overwriting, for further analysis. Overwriting means that one participant accidentally (due to inadequate support of collaborative functions) overwrites or deletes the work of another participant in the shared workspace. Therefore, we examined the nature of the differences in the communication patterns of the teams in which overwriting occurred, comparing to the teams in which it did not.

In the Team Usability Testing, the group interaction among team members, which in this study is the transcript of the communication, can be interpreted as a time series, that is, sequence data. 'Group interaction is a series of messages that influence subsequent group interaction and/or reflect underlying rules of interaction such as phases that sequentially structure group interaction' (Hewes, Poole and Hollingshead 2012, 358).

The basis of group interaction methods is that the interaction can be interpreted as a temporal pattern. This makes it possible to identify different patterns of interaction and to test hypotheses about the patterns (Hewes, Poole and Hollingshead 2012).

The two main method types are sequential contingency analysis and phasic analysis. Of the two methods of sequential contingency analysis (Markov models, lag-sequential analysis), we used lag-sequential analysis in this research. We performed the analysis using Brian O'Connor's freely available SPSS script (O'Connor 1999).

Lag-sequential analysis examines the pattern of sequential dependencies between encoded communication acts (currently a unit of communication) in terms of conditional probability. Its main question is the probability that an event is followed by another event. If this probability is less/greater than 50%, there is a sequential relationship between events (Hámornik 2013; Hewes, Poole and Hollingshead 2012).

4.1. Design of the code system

For the sequence analysis of team communication patterns, we created a new code system, as summarised in Table 2. To develop the code system, we combined two existing coding systems: team processes (Marks, Mathieu and Zaccaro 2001) and the mechanics of collaboration (Pinelle, Gutwin and Greenberg 2003). The main codes of the code system are based on team processes theory, which contains more general, higher-level codes. Under the main codes of team processes, the collaboration mechanics have been assigned as subcodes.

Based on the code system, one of the authors has coded the communication transcripts of the teams participating in the first and second lab studies. The first three transcripts were also coded by an expert independent of the research, who was trained by the authors. Based on the reliability analysis of the coding system (later we will write about it in detail), the reliability of the coding system is high ($kappa=0.819$; $p<0.001$). In this paper the phrases code, coding, code system and code reliability are related to social sciences. We assessed reliability by the value of the Cohen's kappa index (Keszei et al. 2019). When examining the codes one by one, each code is reliable. Of all the codes, only the MA (mission analysis) code has a low reliability value (below 0.5 is poor reliability).

Code name based on team processes theory (Marks, Mathieu, and Zaccaro 2001)	**Code explanation**	**Subcode name based on the mechanics of collaboration theory** (Pinelle, Gutwin and Greenberg 2003)	**Code abbreviation**
Mission analysis, formulation, planning	Evaluating and interpreting the team's purpose (when talking about the requirements of the task)		MA
Strategy formulation	Specific discussion about the details of the content of the task		SF
Monitoring progress towards goals	Monitoring tasks and the process and communicating progress to team members	**Explicit communication:** intentional information sharing among team members (task status – time, done)	MPEC
		Verbal shadowing (narration): when someone narrates what they are doing or what they are going to do	MPVS
System monitoring	Monitoring of events in the work area.	**Basic awareness (awareness:)** keeping an eye on who is present in the work area, what they are doing and where they are doing it – who sees what, who hears what	SMBA
		Consequential communication: information communicated by objects in **the workspace** – information communicated, noticed, received by objects or avatars: e.g., something happened to the text (it appeared, disappeared, is not visible) or changed its colour, location, etc.	SMCC
		Other: e.g., where a particular function is, feedback to the system, whether the system notifies about something, or whether someone has accidentally moved or deleted something	SMO

Team monitoring and back-up behaviour	Helping each other, on request or without request		TM
Coordination	Coordination of actions: what you or us should do (imperative mode)		C
Conflict management	Conflict management: apologising or joking away		CM
Motivation and confidence building	Building shared confidence (praising each other)		MB
Affect management	Regulation of members' emotions		AM
Confirmation	Confirmation		CO
Researcher	When the researcher speaks and how the participants react to it		R
No data	No data		ND

Table 2. The code system used for the analysis of communication transcripts (created by the authors)

Due to the marginal nature of MA, we merged it with another code, SF (strategy formulation). According to the Marks, Mathieu and Zaccaro (2001) framework, both codes (MA and SF) fall into the transition category and are therefore considered similar codes. On this basis, the change in the reliability of the code system is presented in Table 3 (kappa = 0.823; p<0.001). The kappa value increased minimally from 0.819 to 0.823.

Code abbreviation	**ICC value**	**p**	**Code reliability**
AM	0.920	p<0.001	excellent
MPEC	0.667	p<0.001	medium
MPVS	0.841	p<0.001	good
C	0.748	p<0.001	medium
CM	0.894	p<0.001	good
R	0.961	p<0.001	excellent
CO	0.837	p<0.001	good
MB	0.882	p<0.001	good

ND	1.000	p<0.001	excellent
SMBA	0.706	p<0.001	medium
SMO	0.807	p<0.001	good
SMCC	0.703	p<0.001	medium
BB	0.840	p<0.001	good
SF	0.799	p<0.001	good

Table 3. Reliability of the code system used for the analysis of the communication transcripts after merging the MA and SF codes (created by the authors)

As demonstrated in Table 3, we used a total of 14 codes for the sequence analysis. Based on the original 14-code coding scheme, no significant results were found in 2 out of 7 teams in the first lab study and in 6 out of 11 teams in the second lab study. This could indicate several things. On the one hand, it may not be surprising that there are no communication patterns since we cannot talk about structured work in the traditional sense. Communication patterns may be influenced by familiarity, task and instrument. However, the coding system also influences the results. With such a fine-tuned code system of 14 elements, significant communication patterns cannot be detected in 8 out of 18 teams. For this reason, we decided to transform the original code system of 14 codes into a code system of 10 codes, as described below. In the transformation, the frequency of each code, its reliability and whether it appeared in all teams were also taken into account.

Thus, a new 10-element code system was created (Table 4), which also has high reliability (kappa = 0.825; p<0.001).

Code abbreviation	Code name	ICC value	p	Code reliability
AM	Affect management	0.921	p<0.001	excellent
PM	Progress monitoring	0.804	p<0.001	good
C	Coordination	0.748	p<0.001	medium
R	Researcher	0.961	p<0.001	excellent
CO	Confirmation	0.837	p<0.001	good
MB	Motivation and confidence building	0.882	p<0.001	good
SMBA	System monitoring basic awareness	0.718	p<0.001	medium
SMO	System monitoring other	0.807	p<0.001	good
TM	Team monitoring and assistance	0.840	p<0.001	good
SF	Strategy formulation	0.799	p<0.001	good

Table 4. Code system used for sequence analysis (created by the authors)

4.2. Emergence of team communication patterns in teams participating in the first laboratory study

In the sequence analysis, our aim was to see if the communication patterns of the teams differ when certain types of usability problem arise. The main difference between teams is whether or not they experienced the overwriting problem. We consider overwriting to be the most serious team usability problem, so we divided the teams into two groups according to whether overwriting appeared during their work or not. Overwriting is also special because this type of problem appears only in the communication transcripts.

The results of the sequential analysis confirm our hypothesis, that the teams where overwriting occurred have different communication patterns.

We used the Yule Q value, 'which is the recommended method for statistically quantifying sequential associations between two events' (Lloyd, Kennedy and Yoder 2013, 480). The Yule Q value can take a value between -1 and 1, indicating the strength and direction of the relationship between the two codes. A -Q value indicates a negative relationship between the codes, while a +Q value indicates a positive relationship.

Overwriting was reported as a problem in Teams 1, 2, 3 and 5 in the first laboratory study (Table 5).

Based on their communication patterns, the teams that did not experience overwriting (Teams 4 and 6) are those in which:

- the SMBA (system monitoring basic awareness) code is followed in almost all cases (above 0.9, i.e., a very strong Yule Q value) by another SMBA code, meaning that if someone communicates or requests information about where they are or what they are doing in the workspace, their peers respond with this type of information, so there is a discourse among the participants about it, which alone is enough to avoid a conflict;
- the TM (help) and C (coordination) codes also play a significant role – overwriting can be avoided where the SMBA–SMBA value is strong (between 0.5 and 0.69), but not above 0.9, and the TM and C codes are combined (!).

	Team 1	**Team 2**	**Team 3**	**Team 4**	**Team 5**	**Team 6**	**Team 7**
Overwriting	✓	✓	✓		✓		
Significant patterns detected (p-value)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SMBA–SMBA	0.628	0.792	0.762	0.943	0.937		0.873
TM–TM	0.76		0.382	0.714	0.789	0.707	0.624
C–C							0.844

Table 5. Team communication patterns for each team – Yule Q values of the first lab study (created by the authors)

Team 5 is an exceptional team as overwriting occurred here despite its having an SMBA–SMBA above 0.9 and a high TM–TM. This can be explained by the fact that this team was the only one to have a synchronisation problem and a very pronounced problem with verbal communication (Skype was interrupted). For this reason, despite all efforts, overwriting appeared.

4.3. Emergence of team communication patterns in the teams participating in the second laboratory study

In the second laboratory study, Teams 1, 2, 4, 5, 6 and 7 experienced the overwriting problem, while Teams 3, 8, 9, 10 and 11 did not (Table 6). The result of the first lab study is thus strengthened: teams that did not experience the overwriting problem can be characterised by the same communication patterns, that is, there was a discourse about awareness, or team members helped each other effectively, or they organised and planned collaborative work closely.

	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**T11**
Overwriting	✓	✓		✓	✓	✓	✓				
Significant patterns detected (p-value)	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SMBA–SMBA	0.694	0.895	0.938		0.604	0.804	0.844	0.937	0.905	0.609	0.916
TM–TM	0.378		0.315			0.447			0.605	0.555	0.882
C–C		0.364								0.675 (C–CO)	

Table 6. Team communication patterns for each team – Yule Q values of the second lab study (created by the authors)

Sequence analysis can be used to better understand and investigate team usability problems. It can reveal the communication patterns behind the problems, thus providing relevant results about different teams and team usability problems. Sequence analysis is therefore considered an important part of Team Usability Testing.

5. Discussion

Although team communication is a significant topic of study in the psychological literature, it is a less researched area in relation to software usability. In this paper, we investigated team communication patterns in the context of software usability: we performed communication analysis of teams using shared online visual workspaces. We used sequence analysis to explore the communication patterns of the teams using PREZI or Miro.

An analysis of the communication patterns related to all of the usability problems is beyond the scope of this article, so we selected the overwriting problem. Our choice is justified by the fact that this is the most severe team usability problem; it occurs when one participant inadvertently (due to inadequate support of collaborative features) overwrites or deletes the work of another participant in the collaborative visual workspace. Overwriting was avoided by some teams but not by others, so we examined the nature of the communication patterns between the teams where overwriting occurred and the teams where it did not.

Our results show that for those teams where there is a discourse on situational awareness, the overwriting problem does not appear. So, if someone communicates or requests information about what is happening in the shared visual workspace, team members respond with this type of information. In addition, teams that are effective in helping each other (if a team member asks for help, s/he gets help) or have a tight organisation and planning of collaborative work (if a team member shares information about the organisation of collaborative work, s/he also receives this type of information in response) can avoid overwriting.

The results are in line with previous research results, which claim that by identifying communication patterns, we can reveal the communication dynamics of each group and thus identify difficulties, stagnations and problems (Juhász 2015; Hámornik 2013; Soós 2012).

The novelty of the results is that we have examined this in the context of software usability. Just as certain conflicts and problems occur in teams that communicate differently, this is also true for the usability testing situation: teams with certain communication patterns will experience different usability problems. It can also have an impact on the interpretation of the usability test results, as teams' communication strategies can obscure serious usability problems.

Team communication in the context of software usability is a poorly researched topic, so during the research we developed a suitable code system by combining team process theory and mechanics of collaboration theory (Marks, Mathieu and Zaccaro 2001; Pinelle, Gutwin and Greenberg 2003). By merging the two code systems, we developed our own code system, which is described in detail in the Results section. The reliability of the final code system is high (Cohen's kappa = 0.825; $p<0.001$) (Table 4), making it suitable for exploring communication patterns of teams in the context of software usability. In summary, the new code system can reliably identify team communication patterns in the context of usability and is therefore considered part of the Team Usability Testing method.

6. Limitations and further research

The type of software evaluated in our study may limit the scope of our conclusions. Thus, as a next step of our research, it would be important to expand the number and types of collaborative software evaluated. Examining multiple types of software would make it easier to distinguish between usability problems specific to the software under investigation and general problems common to similar types of collaborative software. At the same time, it would also be possible to investigate the coding system while evaluating other types of collaborative software, broadening the scope of applicability.

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