Linek, Stephanie B.; Scholz, Willi; Schmidt, Andrea

**Conference Paper — Published Version**

# Face-to-face versus digital meetings in science popularization initiatives: Usefulness, importance of pros and cons, and inhibitions to take part

*Suggested Citation:* Linek, Stephanie B.; Scholz, Willi; Schmidt, Andrea (2021) : Face-to-face versus digital meetings in science popularization initiatives: Usefulness, importance of pros and cons, and inhibitions to take part, In: Gómez Chova, L. López Martínez, A. Candel Torres, I. (Ed.): Proceedings of the 13th International Conference on Education and New Learning Technologies (EDULEARN 2021), 5th-6th of July, 2021, ISBN 978-84-09-31267-2, IATED Academy, Valencia, pp. 1800-1809, https://doi.org/10.21125/edulearn.2021.0419

This Version is available at:
http://hdl.handle.net/11108/492

# FACE-TO-FACE VERSUS DIGITAL MEETINGS IN SCIENCE POPULARIZATION INITIATIVES: USEFULNESS, IMPORTANCE OF PROS AND CONS, AND INHIBITIONS TO TAKE PART

**S.B. Linek, W. Scholz, A. Schmidt**

*ZBW - Leibniz Information Centre for Economics (GERMANY)*

## Abstract

Science popularization (i.e., science communication to the broad public) often uses the possibilities of digital communication to reach a broad audience. Nevertheless, face-to-face meetings remain important and many initiatives use both, digital as well as face-to-face communication. However, sometimes (like during the COVID-19 pandemic) face-to-face meetings are not possible and the communication has to be switched to a pure digital format. Beyond this background, it is important to understand how people perceive digital versus face-to-face communication during science popularization initiatives.

This paper presents an empirical study that aims at a better understanding of pupils' view of different communication formats of science popularization projects. The study was conducted in the context of the YES! project that is a science popularization initiative on economics with an annual competition for schoolchildren from grade 10. In face of the special situation of the COVID-19 pandemic in 2020, we interrogated the YES! participants by the help of an online survey on their subjective experiences with face-to-face versus digital meetings during the YES! 2020 competition.

Overall, the results indicate a high desire for at least some face-to-face meetings, even in pandemic times. For digital meetings, the participants estimated videoconferences with additional textual chat as the most useful digital tool. The subjective importance of the pros of face-to-face meetings was judged as very high. Similar, the cons of face-to-face meetings were perceived as rather unimportant. Also equivalent single pros and cons of face-to-face versus digital meetings (e.g., eye contact possible or not) reflected this pattern. This indicated context effects in the sense that the subjective importance of abstract facts (like eye contact) depends on the communication context with a preference for face-to-face. The participation in a group discussion was easiest for face-to-face meetings followed by textual chat. The lowest easiness was reported for telephone conferences. Interestingly, these findings did not match with the results on the usefulness of digital tools. The open comments showed that the findings on easiness traced partly back to privacy considerations and indicated a relatively high media competence of the participants.

The reported results provide helpful insights into the young peoples' view of different communication channels. These insights can serve as basis for future improvements and optimizations of science popularization initiatives.

Keywords: Science popularization, science communication, communication channel, digital meetings, face-to-face meetings, group discussions, inhibitions.

## 1 INTRODUCTION

Science popularization, that means, communicating science and scientific insights to the broad public, is nowadays conceptualized as a participative interaction between laypeople and scientists [1]. Thereby, the possibilities of digital communication are very helpful elements to reach a broad audience. Nevertheless, also direct face-to-face communication remains important. Especially, science popularization projects with young people appreciate the immediate exchange between scientists and the youth. Overall, many initiatives use both, digital communication as well as face-to-face communication, in dependence of the situational and contextual demands. That means, digital communication and face-to-face communication exists in symbiosis because both forms have their pros and cons (systematic review by [2]). For example, digital tools enable time- and place-independent communication with many different people and require a minimum of travelling time. On the other hand, face-to-face communication is immediate, more personal and has its own unique atmosphere. Prior research on the Media Richness Theory [3] and the Media Naturalness Theory [4]

showed several differences in relation to learning and social networking. The related empirical findings underline the necessity to use both forms of communication [5] [6].

However, sometimes face-to-face contacts are not possible and the communication has to be switched to a purely digital format. The COVID-19 pandemic is a striking example of how things change when learning and science communication must be digital and there is no choice to combine it with some real face-to-face interactions [7]. Beyond this background, it is important to understand how people perceive the pros and cons of face-to-face versus digital interactions during science popularization initiatives. Thereby, the subjective view of the youth is of special interest, not only because they are often in the focus of science popularization but also because they are usually very experienced with the digital world around them. They are often denoted as digital natives [8] or digital residents (in comparison to digital visitors [9]), but this does not necessarily mean that they prefer digital communication more than face-to-face. Rather, they have a clearer picture of the digital possibilities and can make a differentiated judgement about the pros and cons of face-to-face versus digital communication. Thus, the question arises, how they perceive the (subjective) importance of the single pros and cons. Many pros and cons of face-to-face versus digital communication mirror each other (e.g., eye contact possible or not, time-constraints and place-dependency), but is this also reflected in the subjective importance of the accordingly pros and cons? In this context it is also interesting to know if and how different forms of communication influence the easiness (i.e., low subjective inhibitions) to participate in a group discussion with other people and scientists.

This paper presents an empirical study that explores these questions. The study was conducted in the context of the annual YES! - Young Economic Summit (www.young-economic-summit.org) in 2020. The YES! project is a science popularization initiative with an annual and nationwide (Germany) science-based competition for pupils on our era's economic and social key challenges. During the YES! competition the young participants work in groups and develop their own ideas and solution on the key challenges. The school groups are accompanied by their teachers as educational mentors and receive support by researchers as scientific mentors. Thus, the developed solutions of the pupils are science-based. During this process, the pupils learn about science and scientific methods. After they have developed their own solutions, the school groups participate in the regional and national finals. At the finals, one or two pupils per group present the teams' solutions on stage in front of the other teams. The competition winners are elected by the participating pupils (not the scientists or other experts). During the national final, well-known representatives from politics, business, and science are additionally present. All teams have the chance to communicate the developed solution to a broader audience and to realize it in practice. (Further details are described in [1].)

Usually (before the COVID-19 pandemic), the YES! project used a kind of "hybrid" communication format for the meetings and group discussions. The communication in the "kick-off meeting" and "expert talk" with researchers and the YES! team was partly face-to-face and partly in a digital format due to balancing travelling costs and time for travelling. The regional and the national finals were in a face-to-face format. These events provided pupils the opportunity for travels, having the chance to experience real stage experience, and the feeling during a scientific conference including networking with each other and with the experts. Thereby, digital tools and face-to-face meetings were applied depending on situational constraints, actual possibilities (e.g., long travel times), and the participants' willingness.

For the YES! 2020, the COVID-19 pandemic changed the communication format of the annual competition. At the very beginning (before the pandemic reached Europe) YES! 2020 started as the usual hybrid format. In the face of the pandemic and the related lockdown, the later phases were purely digital using a wide variety of the available tools. The (regional and national) finals were also digital instead of the usual face-to-face format. Due to the digital format, the regional finals were divided in smaller entities. That means, instead of a big one-day meeting of all groups and the accordingly presentation of all team solutions, there were several half-day meetings of only a part of the teams. Thus, the participants could only see the solutions of a part of the other groups (and not all groups). Due to this very special situation, the participants experienced not only the hybrid format and at least some face-to-face interactions with scientists at the very beginning of the YES! 2020, but they also recognized the necessity for a purely digital format that provides a safe space during the pandemic. Therefore, the participants of the YES! 2020 were highly sensitized towards the pros and cons of face-to-face versus digital communication. For this reason, we extended the usual evaluation survey (with questions on the YES! project for further improvement) and included several questions on face-to-face versus digital communication that built the basis for the presented empirical study. The aim was a better understanding of the young pupils' view of face-to-face versus digital communication.

In particular, we address the following research questions:

- RQ1: Which communication channel is estimated as the most useful for a science popularization project like the YES! project?
- RQ2: How estimate pupils the subjective importance of different pros and cons of face-to-face communication versus digital meetings?
- RQ3: Is the subjective importance of the pros and cons of face-to-face versus digital on an equal level if they refer to the same fact (e.g., eye contact) and mirror each other?
- RQ4: If and how does the form of communication influence the easiness (i.e., low or high inhibitions) to participate in a group discussion?

# 2 METHODOLOGY

## 2.1 Methodological Procedure and Participants

The research questions were addressed by the help of an online survey as part of the usual annual post-survey that had to be completed at the end of the YES! competition. The first part of this survey included the usual questions that were presented every year and served mainly qualitative insights for the continuous improvements. These questions related to the general format and organization of the YES! project. For example, people were asked for their highlight of the national final, feedback on the social activities, their experiences with the YES! project and general recommendations for improvements. The answers served internal purposes and will not be presented here. In addition, we also included several questions on face-to-face versus digital communication. These additional questions were placed in the second half of the survey (after the general questions on the YES!) and built the basis for the presented empirical study. The survey was presented during the national final after the school groups had presented their own work and had made their voting for the best idea. The participation was voluntary and without any reward for participation.

## 2.2 Variables

The dependent variables of this study were:

- Perceived usefulness of different digital tools and face-to-face-communication for the group work in a science popularization initiative like the YES! project
- Subjective importance of the pros and cons of face-to-face communication
- Subjective importance of the pros and cons of digital communication
- Subjective easiness (i.e., low subjective inhibitions) to participate in a group discussion in dependence of different communication channels (face-to-face and different digital tools)

Control variables were age, gender, digital experience and a short self-rating of personal attributes (experienced with the digital world, sociable, communicative, quiet, open to new experiences), everyday communication behaviour, preference for group work versus working alone, and subjective activity-level during group work. None of these control variables changed the patterns of findings on the dependent variables.

## 2.3 Description of the Online Survey and the Participants

The online-survey started with socio demographic variables including age and gender and the (mainly open) questions for improvements and recommendations of the YES! project (for internal purposes). Subsequently, the questions on face-to-face versus digital communication were presented.

First, the participants had to rate the perceived usefulness of different digital tools and face-to-face communication for the group work in a project like the YES! competition. The participants should give their rating beyond the background that they would be in a similar situation like during the COVID19 pandemic. The participants had to rate the following communication channels on a 7-point Likert scale (from 1 = “not useful at all” to 7 = “very useful”): videoconferences (audio & video), telephone conferences (audio only), pure textual chat, additional textual chat during videoconferences, online-platform/repository for sharing materials, mailing-lists, (additional) exchange via social media, and face-to-face meetings (at least some, no matter how and where, also outdoors if this was the only

allowed option). Afterwards the participants received a list of the pros and cons of face-to-face and digital meetings. The list of the pros and cons was mainly based on the experiences of the YES! team in prior annual YES! competitions. The list contained the well-known general pros and cons of digital versus face-to-face and also some specific aspects of the national final and the pupils' presentation in front of a big audience. For each of the pros and cons the participants should rate on a 7-point Likert scale (from 1 = "very unimportant" to 7 = "very important") how important this aspect was from their subjective point of view. (The complete list of the pros and cons can be found in the chapter on results in table 2 and table 3.) In the next section of the survey, we asked the participants (as control variables) how often they used the different communication channels in their everyday life and if their meetings with others were more frequently face-to-face or in a digital matter. Additionally, they should indicate if they prefer group work or working alone. Furthermore, they should rate how active they are usually during group discussions. Afterwards the participants should indicate how easily they take part in a group discussion in dependency of the used communication channel. In particular, they should indicate how high or low are their inhibitions to join a group discussion in the following situations: face-to-face, videoconference, telephone conference, pure textual chat. They should rate their inhibitions on a 7-point Likert scale ranging from 1 "very hard for me / high inhibitions" to 7 = "very easy for me / low inhibitions". At the very end of the survey, the participant should indicate (as control variable) how true the following personal attributes were for themselves: experienced with the digital world, sociable, communicative, quiet, open to new experiences. The survey closed with a thankfully farewell for the participants and the possibility of leaving additional comments and contacting the YES! team via email. The participants received no reward for their participation.

Overall, 78 pupils (43 males and 32 females) completed the survey. There were no forced answers in the survey. Thus, the number of valid cases was partly lower. The majority was between 17 and 18 years old and from high school.

# 3 RESULTS

## 3.1 Usefulness of Different Communication Channels

The rating of the usefulness of different digital tools and the additional option of (having at least sometimes) face-to-face meetings showed that videoconferences and additional chat during videoconferences were estimated as highly useful. Additionally, also in pandemic times, the option of (having at least sometimes) face-to-face-meetings was rated as highly useful. The descriptive statistics are listed in table 1.

*Table 1. Usefulness of different digital tools and face-to-face meetings: means (M), standard deviations (SD), and number of valid cases (n).*

| | *M* | *SD* | *n* |
|---|---|---|---|
| Videoconferences | 6.33 | 1.41 | 70 |
| Telephone conferences | 3.02 | 2.27 | 64 |
| Pure textual chat | 2.03 | 1.76 | 67 |
| Additional textual chat during videoconferences | 6.39 | 1.02 | 66 |
| Secure online platform / repository | 4.83 | 2.00 | 63 |
| Email-List | 4.97 | 1.83 | 63 |
| Social media (for additional exchange) | 4.76 | 1.93 | 62 |
| Face-to-face meetings (at least sometimes) | 5.99 | 1.74 | 69 |

In relation to RQ1 on the most useful digital tool for science popularization projects, there was clear preference for videoconferences with additional textual chat. Additionally, also during pandemic times, the pupils reported a high need for at least some face-to-face meetings.

## 3.2 Subjective Importance of the Pros and Cons of Digital versus Face-to-face Meetings

The descriptive statistics on all rated pros and cons of face-to-face meetings and digital meetings are listed in table 2 and table 3.

Nearly all pros of face-to-face meetings were rated as rather highly important (means around 6 on the 7-point Likert Scale) and all cons of face-to-face meetings were rather as medium to low important (around 3). In contrast, the pros and cons of digital meetings were estimated within a broader range.

*Table 2. Subjective importance of the single pros and cons of face-to-face meetings: means (M), standard deviations (SD), and number of valid cases (n).*

| ***Pros face-to-face*** | ***M*** | ***SD*** | ***n*** |
|---|---|---|---|
| Direct eye contact | 6.21 | 1.30 | 68 |
| Mimic and gesture visible | 6.15 | 1.51 | 65 |
| Vivid atmosphere | 6.35 | 1.36 | 69 |
| No technical barrier | 5.57 | 1.88 | 69 |
| Direct personal exchange | 6.34 | 1.39 | 68 |
| Going out and having new experience | 5.93 | 1.83 | 69 |
| (Social) networking | 6.04 | 1.53 | 67 |
| Stage experience with large audience | 6.03 | 1.56 | 68 |
| Free catering | 6.03 | 1.50 | 64 |
| Group fotos possible | 5.18 | 1.95 | 68 |
| Conference feeling | 5.67 | 1.66 | 67 |
| Every team sees every solution | 6.15 | 1.48 | 66 |
| ***Cons face-to-face*** | | | |
| Delayed arrival or departure possible | 3.42 | 1.85 | 64 |
| One person acts alone on stage | 3.88 | 1.86 | 58 |
| Majority of the team is passive | 3.52 | 1.86 | 60 |
| Time-intensive travels | 3.11 | 1.98 | 61 |
| Unknown surroundings | 2.71 | 2.02 | 59 |
| Big crowd is intimidating | 3.10 | 2.16 | 62 |
| Long uncomfortable sitting | 3.52 | 2.08 | 60 |

*Table 3. Subjective importance of the single pros and cons of digital meetings: means (M), standard deviations (SD), and number of valid cases (n).*

| ***Pros digital*** | ***M*** | ***SD*** | ***n*** |
|---|---|---|---|
| Easy exchange of links and info | 5.53 | 1.60 | 59 |
| Team-members can support | 5.64 | 1.50 | 58 |
| Scientists and other stakeholders participate more likely | 5.86 | 1.65 | 57 |
| Digital going in and out is possible | 4.60 | 1.98 | 57 |
| Half-day meeting is less exhaustive | 4.26 | 2.28 | 58 |
| Little unnoticed breaks are possible | 5.21 | 1.67 | 57 |
| No time-demanding travels | 3.53 | 2.25 | 57 |

| *Cons digital* | | | |
|---|---|---|---|
| No personal social exchange | 5.90 | 1.87 | 61 |
| Networking effects are lost | 5.52 | 1.82 | 56 |
| Reactions of the others are hard to perceive | 5.50 | 1.73 | 58 |
| Feeling of talking with oneself | 3.76 | 2.06 | 59 |
| Reserved participants are not recognized | 4.83 | 2.00 | 58 |
| Strange feeling when someone switches of the camera | 4.29 | 1.97 | 58 |
| Unclear who looks at oneself | 4.54 | 2.26 | 59 |
| Camera irritates | 2.73 | 1.85 | 59 |
| Not visible how the audience acts | 4.91 | 2.02 | 55 |
| Technical challenges / problems | 4.73 | 1.93 | 59 |
| Lower conformity with formalities | 3.98 | 1.92 | 58 |
| Limitation on smaller regional finals | 5.31 | 1.99 | 54 |

We calculated average scores (means) for all items of the pros of face-to-face, the cons of face-to-face, the pros of digital, and the cons of digital meetings. Fig. 1 shows the average scores.

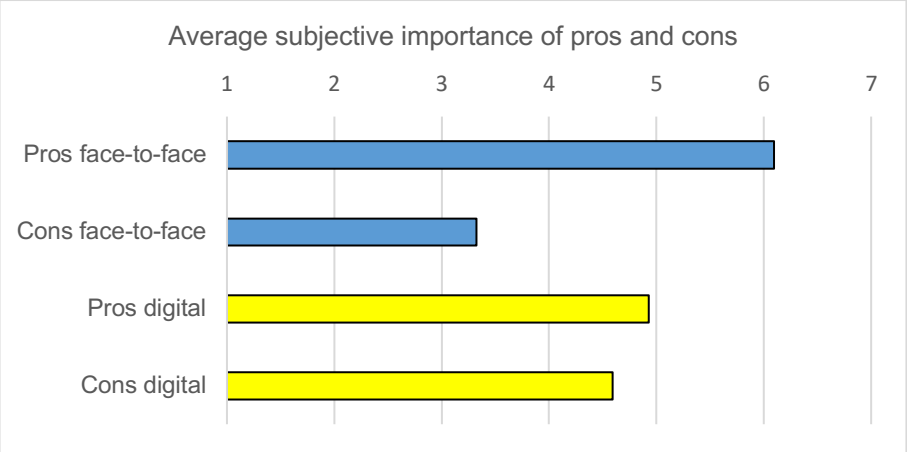


*Figure 1. Average importance (means) of the pros and cons of face-to-face versus digital meetings.*

In relation to RQ2 for the pros and cons of face-to-face and digital meetings, we found that the pros of face-to-face meetings were rated as highly important and the cons of face-to-face meetings were estimated as rather unimportant. The pros and cons of digital meetings were both rated of medium importance.

## 3.3 Comparison of the Pros and Cons of Digital versus Face-to-face Meetings

For the comparison of the mirrored pros of face-to-face meetings versus cons of digital meeting and the comparison of the mirrored cons of face-to-face-meeting versus pros of digital meetings, we calculated for each mirrored pair an ANOVA with repeated measurements. Table 4 shows the tested mirrored pairs and the statistical indices of significance.

*Table 4. Pairwise comparisons of the mirrored items: statistical indices of the ANOVAs with repeated measurements.*

| ***Pro face-to-face*** | | ***Con digital*** | ***F*** | ***p*** | ***Partial Eta²*** |
|---|---|---|---|---|---|
| Direct eye contact | > | Unclear who looks at oneself | 29.571 | <.001 | 0.342 |
| Mimic and gesture visible | ≥ | Reactions of the others are hard to perceive | 3.482 | .068 | 0.062 |
| Mimic and gesture visible | > | Not visible how the audience acts | 15.520 | <.001 | 0.237 |
| No technical barrier | > | Technical challenges / problems | 6.824 | .011 | 0.105 |
| Direct personal exchange | ≥ | No personal social exchange | 3.762 | .057 | 0.060 |
| (Social) networking | = | Networking effects are lost | 2.382 | .129 | 0.043 |
| Conference feeling | > | Lower conformity with formalities | 32.599 | <.001 | 0.372 |
| Every team sees every solution | > | Limitation on smaller regional finals | 12.139 | .001 | 0.195 |
| ***Con face-to-face*** | | ***Pro digital*** | | | |
| Majority of the team is passive | < | Team-members can support | 32.179 | <.001 | 0.378 |
| One person acts alone on stage | < | Team-members can support | 33.129 | <.001 | 0.389 |
| Time-intensive travels | = | No time-demanding travels | 0.734 | .395 | 0.014 |
| Delayed arrival or departure possible | = | No time-demanding travels | 0.267 | .607 | 0.005 |
| Long uncomfortable sitting | < | Digital going in and out is possible | 12.493 | .001 | 0.188 |
| Long uncomfortable sitting | ≤ | Half-day meeting is less exhaustive | 3.393 | .071 | 0.059 |
| Long uncomfortable sitting | < | Little unnoticed breaks are possible | 26.531 | <.001 | 0.334 |

We made analogous statistical pairwise comparisons for the average scores of all pros and cons. To test for significant differences between the average importance of the pros and cons of face-to-face versus digital meetings we made pairwise comparisons of the four groups by one-way ANOVA for repeated measurements. The statistics are listed in table 5.

The pairwise comparisons of the average importance showed the same pattern: The average importance of the pros of face-to-face were rated significantly higher than the cons of face-to-face, the pros of digital, and the cons of digital meeting. Vice versa, at average the cons of face-to-face were perceived as significantly less important than the pros of and cons of digital meetings. The average importance of the pros and the cons of digital meetings were rated as equally important.

*Table 5. Pairwise comparisons of the average importance: statistical indices of the ANOVAs with repeated measurements.*

| ***Pairwise comparisons*** | | | ***F*** | ***p*** | ***Partial Eta²*** |
|---|---|---|---|---|---|
| Pros face-to-face | > | Cons face-to-face | 85.761 | <.001 | 0.651 |
| Pros face-to face | > | Pros digital | 44.497 | <.001 | 0.509 |
| Pros face-to face | > | Cons digital | 49.972 | <.001 | 0.562 |
| Cons face-to-face | < | Cons digital | 19.591 | <.001 | 0.323 |
| Cons face-to-face | < | Pros digital | 55.258 | <.001 | 0.557 |
| Pros digital | = | Cons digital | 0.377 | .543 | 0.009 |

In relation to RQ3, the pattern of findings revealed that pupils estimated the pros of face-to-face as more important than the corresponding cons of digital meeting. Vice-versa, the cons of face-to-face meetings were perceived as less important than the corresponding pros of digital meetings. Analogously, also in regard to the average subjective importance the pros of face-to-face meetings were highly appreciated whereas the cons of face-to-face meetings were perceived as rather unimportant.

## 3.4 Easiness to Participate in a Group Discussion

The descriptive statistics for the easiness to participate in a group discussion are listed in Table 6.

*Table 6. Descriptive statistics on easiness to take part in a group discussion for different communication channels: means (M), standard deviations (SD) and number of valid cases (n).*

| Communication channel | M | SD | n |
|---|---|---|---|
| Face-to-face | 5.87 | 1.40 | 60 |
| Videoconferences | 5.09 | 1.38 | 58 |
| Telephone conferences | 4.31 | 1.83 | 58 |
| Textual chat | 5.50 | 1.71 | 60 |

The findings showed that it was most easy to participate in a group discussion for a face-to-face situation, followed by textual chat and videoconferences. For telephone conferences, the participants reported the highest inhibitions (lowest easiness). Please note: there was no significant correlation with the everyday usage frequency (control variable) of these communication channels.

The pairwise comparisons of the different communication channels were done by ANOVA for repeated measurements. The statistical indices are listed in table 7.

The pairwise comparisons showed that the easiness for face-to-face was significantly higher than the easiness of all other communication channels, except textual chat (which was on an equal level).

In their short justification of their easiness-rating the participants often stated that they are very talkative. Additionally, they also gave specific comments on the digital tools and face-to-face meetings: Some disliked videoconferences because they were afraid that someone might make picture and videos secretly. Partly, they mentioned also some technical problems, especially time delays in the video and voice transfer. Some people also reported that they like textual chats because they had enough time to think about what to communicate. Some explicitly also referred to the naturalness and immediateness of face-to-face.

*Table 7. Pairwise comparisons of the easiness to participate in a group discussion dependence of the communication channel: statistical indices of the ANOVAs with repeated measurements.*

| Pairwise comparisons | | | F | p | Partial Eta² |
|---|---|---|---|---|---|
| Face-to-face | > | Videoconferences | 13.202 | .001 | 0.188 |
| Face-to-face | > | Telephone conferences | 33.465 | <.001 | 0.374 |
| Face-to-face | = | Textual chat | 1.683 | .200 | 0.028 |
| Videoconferences | > | Telephone conferences | 14.822 | <.001 | 0.212 |
| Videoconferences | = | Textual chat | 2.382 | .128 | 0.040 |
| Textual chat | > | Telephone conferences | 24.395 | <.001 | 0.300 |

In relation to RQ4, the results showed that the easiness to participate in a group discussion was highest in a face-to-face situation while the inhibitions for most of digital tools were higher. The open comments indicated that the higher inhibitions for digital tools traced back partly to the higher naturalness of face-to-face meetings and partly to shortfalls and privacy problems of digital tools.

# 4 DISCUSSION AND CONCLUSION

To sum up our findings, we found a clear preference for face-to-face meetings. At least some face-to-face meetings are desired even in pandemic times. If face-to-face-meetings are not possible, then videoconferences with additional textual chat are the preferred digital tool for science popularization and the related group discussions and meetings.

The findings on the pros and cons of face-to-face versus digital communication provide a very interesting picture. The pros and cons of digital communication were both estimated of medium

importance. However, when it comes to face-to-face communication, the school pupils estimated the subjective importance of the pros as very high, but the subjective importance of the cons as rather low. This pattern was also found in most of the single comparisons between the mirrored pros and cons of face-to-face versus digital meetings. The same abstract fact (like travelling or no travelling) is perceived differently depending on the communication context that means, if it is perceived as a con of face-to-face or as a pro of digital meetings. This indicates clear context effects for the subjective importance of the pros and cons of face-to-face versus digital meetings. Overall, the pros of face-to-face were rated as more important than the cons of face-to-face and as more important than the pros of digital communication. These results indicate that also the digital experienced youth appreciate the advantages of face-to-face communication more than the possibilities of digital tools. They see the pros and cons of both forms, but the pros of face-to-face are (from their personal view) more important to them than the other aspects. One reason for these differences might be the special situation of the COVID-19 pandemic when children are often forced to communicate digitally and are "deprived" of the immediate and personal atmosphere of face-to-face communication.

For the inhibitions to take part in a group discussion, the findings were mixed. Overall, the data indicate that digital communication does not generally provide an easier entrance to group discussions. Interestingly, the inhibitions for participating in a group discussion are lowest for face-to-face and pure textual chat. This is remarkable because these two communication forms can be seen as two extremes of immediateness and naturalness. The highest inhibitions were reported for telephone followed by videoconferences. Interestingly, the results on inhibitions do not match the findings of the usefulness of these communication channels. Rather, the open comments indicate that there are two different kinds of influences on the easiness to take part in a group discussion. On the one hand, the higher immediateness and naturalness for face-to-face communication; this reason is very well in line with the predictions of the Media Naturalness Theory [4]. On the other hand, the pitfalls and privacy problems of digital tools; these practical reservations indicate a high media competence of the pupils.

To conclude, the main insight of our findings are:

- Videoconferences with additional textual chat are the most useful digital tool for meetings in science popularization initiatives.
- Even in pandemic times, there is a high desire for face-to-face meetings during science popularizations initiatives.
- The average subjective importance of the pros and cons of face-to-face versus digital meetings indicate that face-to-face is still preferred and highly appreciated by young digital experienced pupils.
- The subjective importance of the single pros and cons is different from the abstract fact (e.g., travelling, time constraints) and depends on the context (face-to-face versus digital).
- Digital communication does not lower the inhibitions to participate in a group discussion. Rather, face-to-face meetings provide the easiest entrance for pupils to take part in a group discussion during science popularization initiatives.

Overall, the presented results provide helpful insights into the young pupils' subjective view of different communication channels. This can provide the basis for future improvements and optimizations of science popularization initiatives.

Improvements that mitigate the drawbacks of digital meetings could address the privacy concerns and the less personal atmosphere. Privacy issues should be communicated more directly by giving the young people concrete examples of what is allowed and what is not allowed (e.g., video recordings secretly). Thereby it could be helpful to establish a netiquette for the online meetings, including the rule that it is very impolite to switch off the own camera while watching the others during the discussion. For providing a more personal atmosphere, it could be helpful to provide a user profile that also includes space for (voluntary given) personal information. Including extra time at the beginning of a meeting with icebreaking communication activities could also help to encourage the participants to talk (e.g., a quiz). To reduce technical discomfort, it could help to introduce gamification elements for technical skills during the session (e.g., turning the microphone or camera on and off). Also, voluntary social online events with facilitation methods might be advantageously to establish a more personal relationship between the participants. Examples are a chat room during virtual coffee breaks, a voluntary online party with live music or a multiplayer online activity game (e.g., online soccer or

karaoke). In addition, materials sent by postal service and integrated into the programme can create a sense of community (e.g. everyone drinking fair-trade coffee together during the break).

Such activities could make it easier to build personal connections and enable personal social exchange across the school teams. Based on such improvements, digital meetings might become more vivid and thus provide a real inspiring atmosphere during digital science popularization initiatives.

## ACKNOWLEDGEMENTS

We want to thank all YES! participants for their patience and their dedicated time to fill in the online survey. Additionally, we thank the whole YES! team at the ZBW (www.zbw.eu) and at the JHS - Joachim Herz Stiftung (www.joachim-herz-stiftung.de) for their support of the YES! project.

## REFERENCES

[1] S. B. Linek and W. Scholz, “Public engagement in science: new ways of participative science communication and the practical use case of the YES!-project,” Proceedings of the 12th International Conference on Education and New Learning Technologies (EDULEARN 2020), pp. 4612–4621, 6th- 7th of July, 2020.

[2] E. V. Frolova, O. V. Rogach, and T. M. Ryabova, “Digitalization of education in modern scientific discourse: new trends and risk analysis,” European Journal of Contemporary Education, vol. 9, no. 2, pp. 331–336, 2020.

[3] R. L. Daft and R. H. Lengel, “Information richness: a new approach to managerial behavior and organization design,” in Research in Organizational Behavior, vol. 6, (B. M. Staw and L. L. Cummings, eds), pp. 191–233, JAI, Greenwich, CT, 1984.

[4] N. Kock, “Media richness or media naturalness? The evolution of our biological communication apparatus and its influence on our behavior toward e-communication tools,” IEEE Transactions on Professional Communication, vol. 48, no. 2, pp. 117–130, 2005.

[5] I. Blau, O. Weiser, and Y. Eshet-Alkalai, Y, “How do medium naturalness and personality traits shape academic achievement and perceived learning? An experimental study of face-to-face and synchronous e-learning,” Research in Learning Technology, vol. 25, 2017. http://dx.doi.org/10.25304/rlt.v25.1974

[6] C. M. Fiol and E. J. O’Connor, “Identification in face-to-face, hybrid, and pure virtual teams: untangling the contradictions,” Organization Science, vol. 16, no. 1, January–February 2005, pp. 19–32, 2005.

[7] C. Romero-Ivanova, M. Shaughnessy, L. Otto, E. Taylor, and E. Watson, “Digital practices & applications in a Covid-19 culture,” Higher Education Studies, vol. 10, no. 3, pp. 80–87, 2020.

[8] M. Prensky, “Computer games and learning: digital game-based learning,” in Handbook of computer game studies (J. Raessens and J. Goldstein, eds.), pp. 97–122, MIT Press Cambidge, Massachusetts London, England, 2005.

[9] D. S. White and A. Le Cornu, “Visitors and residents: a new typology for online engagement,” First Monday, vol. 16, no. 9, 2011. Retrieved from http://www.uic.edu/htbin/cgiwrap/bin/ojs/index.php/fm/article/viewArticle/3171/3049