A Preliminary Investigation of the Effects of Communication Quality and Use of Communication Platforms on Students' Perception of Virtual Team Performance

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Abstract. *The central topic of this research paper is virtual team performance in an academic context in which students use communication platforms to perform their tasks. The Task-Technology Fit model and various aspects of communication quality and usability of communication tools were used as a theoretical framework as they are considered to be important for the virtual team performance, but still understudied in that context. This paper presents a preliminary evaluation of a measurement instrument that was used to analyse processes in virtual teams in a university setting. Participants were university graduates in software engineering (N=64) who collaborated in virtual teams and extensively used various communication applications for their task related activities. The results confirmed the reliability and validity of the scales of our measurement instrument and revealed that communication quality was the most influential and statistically significant predictor of perceived performance in virtual teams.*

Keywords. virtual teams, task-technology fit theory, communication quality, communication tools, usability, team performance, instrument validation.

1 Introduction

A recent extensive review of literature on virtual teams (Garro et al., 2020) revealed that in the last 25 years most of the publications have been related to the topics (studied constructs) of *performance and communication* in virtual teams, including *communication technology* (equipment) that was used. A newer study (Muszyńska, 2021) focused on publications on virtual teams over the last two decades and found that the most frequent topic of the research papers was related to the *methods and tools for communication* in virtual teams. According to this study, other frequent topics were associated with the factors influencing team communication, effect of communication on team performance, as well as communication challenges, practices and patterns.

After the onset of the COVID-19 pandemic there was an increased pressure in organizations to shift into virtual teamwork, with a possible effect of gradual improvement of team action processes and better adaptation of teams to virtual work over time (Klonek et al., 2022). The adaptation of team work to the virtual environment and online collaboration technology during the COVID-19 pandemic can be analysed regarding *task* interactions, *process* interactions, and *relationship* interactions. However, those interaction domains are almost always reliant on the use of appropriate digital tools for synchronous and asynchronous communication (as reported in: Whillans, 2021). In addition, it is important to identify various human and organizational factors that affect the productivity of software teams during the COVID-19 pandemic like communication, collaboration, organization of teams, motivation and work environment (see for instance: Bezerra et al., 2020). In fact, abundant advice is offered in literature for the rapid deployment of virtual teams when lockdown and social distancing are used as a countermeasure for the waves of COVID-19 pandemic (for example see: Kilcullen et al., 2021).

2 Shift in communication in higher education

The COVID-19 pandemic imposed numerous challenges on teachers and students, including keeping the course related communication effective. A notable breakthrough in teaching and learning practice was achieved by an intensified use of web conferencing systems, for example, *BigBlueButton* (Čižmešija & Bubaš, 2020), as well as communication platforms like *Telegram* to support effective educational interactions

(Aladsani, 2021). On the other hand, the practices of using communication platforms among students for collaboration in teams for performing tasks, projects, and other academic activities were unquestionably influenced by the pandemic. Consequently, over the past two years, a significant shift has been made from the students' use of classic instant messaging tools, whose main purpose is the exchange of messages and photos, to more advanced collaboration tools. A recent study (Gonçalves, Sousa, & Pereira, 2020) revealed that students favoured communication platforms (e.g., Zoom or Google Hangouts) over e-mails, smartphone chat, or e-learning platforms as means of communication, with a preference for richer communication channels for facilitating the learning processes and group work.

One review of scientific literature on *virtual teams in higher education* (Jony & Serradell-López, 2019) indicated that some of the popular topics in related research papers are denoted by keywords like *team performance, success, effectiveness* and *satisfaction*. However, only several research papers were found that used the Task-Technology Fit (TTF) model to investigate virtual teamwork in higher education. For instance, a representative paper by Fuller & Dennis (2009) included students as participants in a study of TTF variables with a focus on prediction of team performance. Another study (Aiken et al., 2013) investigated how the task-technology fit mediates between knowledge sharing and team satisfaction with the use of technology in form of the WebCT learning management system.

In literature, perceived communication quality is the construct that comprehensively maps different interactions and actions in the academic context in which students working in virtual teams use communication platforms to perform various tasks. Common sub-dimensions of communication quality include information elaboration, knowledge sharing, openness of communication and general information sharing (Marlow et al., 2018). Since communication quality has a greater influence on perceived virtual team performance than communication frequency, and given that its sub-dimensions are connected to various aspects of interactions among students collaborating in virtual teams, the authors of this research paper found it worthwhile to explore its role in the academic context in conjunction with the TTF model.

3 Theoretical framework

One approach to investigating virtual team performance both theoretically and empirically is to use the Task-Technology Fit (TTF) model (see: Goodhue & Thompson, 1995; Goodhue, 1998). This model assumes that information systems (ISs) can be instrumentally used for a task or a collection of tasks and that the correspondence between task requirements and technology/IS functionalities ("task-technology fit") influences performance. In other words, the characteristics of tasks "moderate" the association between characteristics of ISs and how the users evaluate them. Information technology can thus have a positive impact on performance if it is utilized and if its features are in correspondence with the requirements of the tasks. According to a recent review of literature on TTF (Spies et al., 2020), the last decade and a half has seen a growing interest in the ways to apply this model in practice, from the use of various technologies (mobile, ISs, software, communication etc.) to its application in diverse fields (from healthcare, education and finance, to software support and other areas). A newer literature review (Hidayat et al., 2021) on the research application of TTF confirmed its use in diverse domains (education, social media, business and management, finance and banking etc.), while also evidencing continued interest of researchers for TTF over the past several years. Another relevant finding of this literature review was that the most frequent antecedent variables in TTF related scientific research were *Task Characteristics* and *Technology Characteristics*, while the most numerous dependent variables were *Perception of Usefulness* of technology, *Performance*, *Satisfaction* and *Perception of Ease of Use*. Still, it must be noted that virtual teamwork has both advantages and potential problems, as documented in a comprehensive review paper by Morrison-Smith and Ruiz (2020).

In our paper the constructs of the Task-Technology Fit model are used for the evaluation and improvement of existing assessment scales developed by other authors for the measurement of TTF related variables, as well as for the construction of new scales for this purpose. This is performed in the empirical context of university students' virtual teams and their use of communication and collaboration technologies (e.g. *WhatsApp, Discord, Facebook Messenger, MS Teams, Slack, Zoom*). After evaluation of the scales that were designed to measure the TTF related variables in the context of virtual teams, the intercorrelation of those variables was investigated, as well as the predictors of the variable *Perceived Team Performance*.

4 Research problems and goals

The *first and main* goal of our research and pilot study was to evaluate the assessment scales for the measurement of task-technology fit (TTF) constructs in the context of students' virtual teams. The *second goal* was to examine the relationships between the following variables: (a) quality of communication, (b) characteristics of communication platforms, (c) perception of the task-technology fit and acceptance of technology in the context of virtual team tasks, as well as (d) perceived performance in a virtual team. The *third goal* was to examine the students' usage of communication platforms in the context of performing virtual team tasks. In other words, the aims of our study

were to investigate the potential influence of the aforementioned variables on the perceived students' performance in virtual teams and also to test the measurement instrument that was designed for that purpose, including testing of its reliability and usefulness so that it could be applied in further research of virtual teams in other contexts.

According to the goals of our study and the *Task-Technology-Fit* theoretical model, the following research questions were defined:

RQ1: Which platforms for communication are most frequently used by the respondents (virtual teams) in our study?

RQ2: What is the reliability of the assessment scales that measure the corresponding constructs of the *Task-Technology Fit* theoretical model?

RQ3: What are the predictors of the TTF dependent variable *Perceived Performance* in the context of virtual teams?

5 Methodology

5.1 Data collection instruments

Possible effects of communication quality, characteristics of communication platforms, task-technology fit and evaluations of virtual team tasks on students' performance in virtual teams have not yet been investigated in scientific literature. Therefore, the first step in our research was to develop a measurement instrument with assessment scales designed for the specific purpose of measuring variables associated with the TTF model as a theoretical background. The first part of our survey included demographic questions regarding age, gender and year of study. The remaining sections of our survey included assessment scales specially designed to measure the constructs related to the TTF model and to collect students' responses regarding their frequency of use of various communication platforms in virtual teams. For the responses to the items of the assessment scales a five-point Likert-type scale in the range from *"1 – Totally inaccurate"* to *"5 – Absolutely accurate"* was used.

As was mentioned earlier, the main research constructs in our study were taken from the *Task-Technology-Fit model* (Goodhue & Thompson, 1995), which was used as a starting point for the operationalization of variables. It is important to note that the items used for the measurement of the construct-related variables were adapted to the context of students' virtual teams and the academic environment in which the research was conducted. Furthermore, some of the items were adapted from the assessment scales used in related research by other authors. Each of the variables (constructs) in our study is explained in more detail in the continuation of this section of our paper and sample items for their measurement are provided for illustration purpose.

Communication Quality is the level at which the content of communication is distributed and shared in a virtual team (Daim et al., 2012). This variable was measured using the following three relevant dimensions of communication quality identified in literature: (1) openness of communication, (2) knowledge sharing, and (3) information elaboration (see: Marlow et al., 2018). *Communication openness* refers to the level at which individuals in a team receive ideas, values, opinions, and emotions from others and share them with each other (Carlson, Carlson, Hunter, Vaughn, & George, 2013). An example of an item for the measurement of communication openness in our study is: *"Virtual team members were able to easily ask for advice from any other team member".* In the context of communication quality in a virtual team, *knowledge sharing* refers to virtual team members' willingness to share their functional experience or knowledge acquired through education to others within a team. Accordingly, the statement *"Members of my virtual team shared their previous experiences and examples of good practice within the team in performing related tasks"* is an illustration of a questionnaire item for the sub-dimension knowledge sharing. *Information elaboration* is associated with the complexity and assimilation of information to process the team/individual ideas comprehensively. This is a representative item for its measurement in our study: *"While working on a task or project in my virtual team, members sought to gather and use all available information."*

Communication Application Characteristics are related to the features of tools that individuals use to execute their tasks (Cane & McCarthy, 2009). In our study this multi-faceted construct was measured by the following subscales: *teamwork efficiency, perceived ease of use* and *reliability of communication platforms*. An example item used for measuring the reliability of communication applications is *"During the work of my virtual team with communication technologies, technical difficulties and technology-related downtimes were very rare."*

The ***Task-Technology Fit & Acceptance*** construct can be described as actions that team members accomplish and how these actions rely on specific functionalities of information technology (Hauder, Fiedler, Matthes, & Wüst, 2013).*"For all important activities and tasks in my virtual team, we were able to find and use a suitable functionality in the selected communication platforms"* and *"Generally speaking, members of my virtual team accepted the selected communication platforms well in relation to our mutual activities and tasks"* were two of the items used in the assessment scale for the measurement of the correspondence of tasks with technology choice and acceptance of selected technology for the tasks. It should be noted that three items that refer to *acceptance of technology for tasks at hand* were included in this assessment scale.

The *dependent variable* in our study was ***Perceived Performance*** in a virtual team. In the TTF model, an individual's (e.g. student's) performance refers to the accomplishment of a portfolio of tasks by an individual (Goodhue & Thompson, 1995). Two examples of sample items in our study that were formulated according to the measures of team effectiveness identified by Hertel et al. (2004) were: *"The members of my virtual team were effective in achieving team goals."* and *"In my virtual team, members typically completed work tasks within agreed deadlines."*

5.2 Respondents and data collection

The initial convenience sample of respondents in our study were 70 graduate IT students at a higher education institution in Croatia. The survey was anonymous and administered in an online format with the *Google Forms* online questionnaire tool. The students' participation in the online survey was on a *voluntary* basis. Consequently, only 70 of the 113 students who were enrolled in the course filled out the online survey.

To check the respondents' overall determination and honesty, at the end of the survey the following item was included: *"How committed, focused, and honest were you in answering the questions in this survey?"*. In case of answers to this question which indicated an unserious approach to the survey, the respondents' data was excluded from further analysis. Also, the responses to survey items which indicated the *general frequency of communication platform use*, as well as *how much these platforms were used on a daily and weekly basis*, were carefully reviewed. Students who responded to the related questions with "*Never/I don't use it"* or *"Very rarely"* were omitted from the data set before statistical analyses because our study was focused on the evaluations and perceptions of students who had sufficient experience with interacting with team members using communication platforms like Facebook Messenger, WhatsApp, MS Teams, Slack, Zoom, Jira, Skype, and Google Hangouts while performing their tasks in virtual teams.

After data cleaning and removal of records with responses that were not found to be suitable to be included in statistical analysis, *the final convenience sample consisted of 64 respondents* (41 male and 23 female). Most of the subjects, 53.1% of them, were aged between 21-22 years, followed by 42.2% of them aged between 23-24, and the rest, who were 25 or more years old. Also, 60 subjects were in their first year of graduate study, and 4 subjects were in the second (final) year of their graduate education.

It must be noted that before the data collection for our study the approval of the *Ethical Committee* was obtained.

5.3 Respondents' virtual team activities

The subjects in our study were students enrolled in a course on *technologically mediated communication* in the winter semester of the 2021/2022 academic year and the study was conducted during January 2022, after the students had finished almost all course activities. Due to the COVID-19 related epidemiological measures at the time when the teaching in this course was performed, the students in the course were attending fully synchronous online video lectures from the beginning until the end of the semester, as well as laboratory exercises in various formats: (a) synchronous online sessions, (b) asynchronous online sessions, (c) mixed on-site sessions in the computer lab and simultaneously streamed online via a videoconferencing tool, as well as (d) fully on-site sessions in the computer laboratory. The use of the previously mentioned formats of laboratory exercises depended on the epidemiological situation during the semester. Because of the anti-COVID measures, in most cases and for the majority of students the laboratory sessions were performed with a significant degree of the online component (either as fully online synchronous exercises or as on-site exercises combined with simultaneous live stream exercises). Students were also able to choose to attend one fully online study group of laboratory exercises.

A part of students' practical assignments in this course was to work on a team project that included a search of scientific literature on a specific topic, defining the topic/theme of their project, performing a survey on the topic of their project, and oral presentation of project results to other students with online presentation software like *Prezi* or *Emaze*, as well as the design of an asynchronous multimedia presentation of the project using the Mahara e-portfolio system. Four weeks after the beginning of the semester the students were organized in teams with 2-3 members who worked together on the project topic they selected.

During the period of more than 10 weeks, the members of students' teams used various communication platforms of their choice in order to perform diverse tasks that were assigned to them at different project stages. The context of the COVID-19 pandemic and mixed format of their laboratory exercises forced most of the students' teams to collaborate "virtually" in an online communication environment. The fact that project assignments were performed as an out-of-class learning activity, with most of the students being physically away from lecture halls, classrooms and laboratories at their college caused the dispersion of team members, who were forced to predominantly collaborate virtually via communication platforms to execute and complete the project assignment. Therefore, it can be considered that the project tasks that demanded considerable time and effort to complete were in fact performed by virtual student teams. In other words, the virtual teams consisted of groups of students that collaborated remotely on a joint task for the duration of this task (a

course project). The teams were assembled on a voluntary basis and spontaneously, without any direction of the instructor regarding specific team membership and composition.

6 Results

6.1 Reliability analysis

The verification of internal consistency or *Cronbach's alpha reliability* is an important phase in the development of an instrument that consists of self-assessment scales designed to measure various constructs or research variables. Cronbach's alpha is an indicator to which extent a proposed set of items of an assessment scale measure a single construct or variable (Ursachi, Horodnic, & Zait, 2015). In *Table 1*, values of Cronbach's alpha reliability coefficients for the assessment scales that were used in our study are displayed, as well as the number of items in each of the scales. The results of this analysis indicated that the original sets of items in almost all of the assessment scales that measured the corresponding constructs were of appropriate reliability because the Cronbach's alpha values were above the 0.7 (this is considered as acceptable in the educational research context; see: Taber, 2018). Only in the case of the assessment scale that measures the construct ***Task-Technology Fit & Acceptance*** one item was omitted to achieve a higher value of Cronbach's alpha coefficient.

Table 1. Cronbach's alpha values for constructs; labels for (total) scales are written in boldface and for their subscales in italics (N=64)

Variable name	Number of items in scale	Cronbach's alpha coefficient
Perceived Performance	**5**	**0.743**
Communication Quality	**15**	**0.851**
- Subscale *Openness of Communication*	6	0.748
- Subscale *Knowledge Sharing*	5	0.743
- Subscale *Information Elaboration*	4	0.712
Task-Technology Fit & Acceptance	**6**	**0.759**
Communication Application Characteristics	**9**	**0.778**
- Subscale *Teamwork Efficiency*	3	0.716
- Subscale *Perceived Ease of Use*	3	0.781
- Subscale *Reliability*	3	0.783

6.2 Students' use of communication platforms for virtual team activities

In the context of our study it was important to explore students' general usage of communication platforms for their activities in virtual teams. According to the analysed data, 29 participants in our study (45.3%) stated that they used communication platforms for virtual team activities *"very often"*, followed by 22 of them (34.4%) who responded with *"often"* and 13 (20.3%) who responded with *"neither often, nor rarely"*. To better understand the frequency of use of communication applications for team tasks by students, the responses related to the time that they spend daily on using them were also analyzed. In total, 62.6% of the subjects in our study reported that their use of communication applications that can be utilized for virtual team activities was approximately 2 or 3 hours per day, 20.3% of them reported that they allocated about 1 hour a day to such applications, and the remaining 17.1% reported using them 4 or 5 hours per day. Besides the frequency of usage, the use of specific communication applications by students was also investigated. Their most frequent choice was *WhatsApp* (43.75%), followed by *Discord* (31.25%). *Facebook Messenger* was the first option for 9.38% and Zoom for 4.69% of the students in our sample, while other communication tools were given as the preferred choice by 1.56% to 3.13% of respondents.

It is important to emphasize, however, that most of the students reported using at least three or four different tools for communication purposes. In further analysis of the multiple-choice answers regarding the use of communication platforms (checkboxes question type), it was found that 25 respondents (39.06%) stated that they also use *Jira*, which is a common communication tool in software engineering.

In their responses to an open-ended question regarding their *most common conversation topics* while using communication platforms for work in virtual teams, the students pointed out scheduling and planning activities and tasks for the virtual team, monitoring the workflow and progress of team members, coordination of activities and deadlines, discussing how to solve tasks and sending additional materials such as pictures (screenshots) and videos that were useful for learning that was needed for task accomplishment. Apart from using communication platforms for virtual team activities in our study, students also used communication tools for other assignments in different courses that were related to software development, like writing a project plan, or preparing seminar papers and presentations.

To explore whether the main constructs and corresponding survey questions in our study were related to their real-life academic activities in virtual teams that students performed to meet course requirements, in the last section of the survey the question *"How many questions in this survey concerned you and your virtual team?"* was included. This was done to check if students had adequate experience for working in a virtual team to properly respond to the content of the survey questions. For the majority of students from the research sample in our study, the questions in the survey reflected a lot of their virtual team experiences (47 respondents, or 73.44%)

or were at least partly related to what they experienced in virtual teamwork (16 respondents, or 25%).

6.3 Correlation and regression analysis

6.3.1 Correlation analysis

To examine the relationships between the variables in our study in the context of virtual team performance and the use of communication platforms for virtual teamwork, we calculated the Spearman's rank correlation coefficient (r_s) between the total scores of assessment scales used to measure different TTF constructs. The Spearman's rank correlation coefficient (Spearman's rho) is suitable for nonparametric data distribution and measures the strength of the monotone association between two variables. This coefficient is not a measure of the linear relationship between two variables since the data are transformed into ranks before calculating the coefficient (Hauke & Kossowski, 2011). It can be interpreted as follows: a perfect negative or positive monotonic relationship between variables occurs in the case when $\rho = -1$ or $+1$. On the other hand, if $\rho = 0$, there is no association between variables.

In *Table 2* the values of Spearman's rho coefficients between the following variables are displayed: *Perceived Performance*, *Communication Quality*, *Task-Technology Fit & Acceptance,* and *Communication Application Characteristics*. It must be noted that for the purpose of correlation analysis the data collected with the *Communication Quality* scale was used as a summative score of its three subscales *Openness of Communication, Knowledge Sharing* and *Information Elaboration.*

Table 2. Spearman's rank correlation coefficient values for key TTF variables (N=64)

	Perceived Performance	Communication Quality	Task-Technology Fit & Acceptance
Communication Quality	.632**	-	-
Task-Technology Fit & Acceptance	.291**	.345**	-
Communication Application Characteristics	.421**	.364**	.605**

**Correlation is significant at the 0.01 level (2-tailed).

The results of the correlation analysis revealed that all of the key variables have positive intercorrelations that are statistically significant at the 0.01 level. The strongest correlations were identified in the case of the following variable pairs:

- There was a positive and strong correlation between *Perceived Performance* and *Communication Quality* ($r_s = .632$, $p < .001$).
- There was a positive and strong correlation between *Task-Technology Fit & Acceptance* and *Communication Application Characteristics* ($r_s = .605$, $p < .001$).
- There was a positive and moderate correlation between *Perceived Performance* and *Communication Application Characteristics* ($r_s = .421$, $p < .001$).

In the case of other variables, the correlations presented in *Table 2* can be qualified as positive and statistically significant but weak since their values were in the range between 0.20 and 0.39. The lowest positive (only weak) correlation was revealed between *Perceived Performance*, on the one side, and *Task-Technology Fit & Acceptance* ($r_s = .291$, $p < .001$).

6.3.2 Regression analysis

To determine which of the independent variables *Communication Quality, Task-Technology Fit & Acceptance* and *Communication Application Characteristics* had greatest association with the students' *Perceived Performance* in a virtual team, as a dependent variable, regression analysis was performed. The results of the regression analysis that are presented in *Table 3* reveal that the value of R^2=0.390 (coefficient of determination), i.e. that 39% of the variation in the *dependent variable* is shared or can be predicted from *independent variables* included in the regression analysis.

Table 3. Model summary of regression analysis – dependent variable *Perceived Performance* (N=64)

Model	R	R square	Adjusted R square	Std. error of the estimate
1	.625[a]	.390	.360	.391

a. Predictors: (Constant), *Communication Quality, Task-Technology Fit & Acceptance, Communication Applications Characteristics*

The next step in the regression analysis was to explore which of the included variables can be considered as the greatest statistically significant predictor of the criterion (dependent) variable *Perceived Performance*. According to the data displayed in *Table 4*, only in the case of variable *Communication Quality* the p-value was < 0.01. Therefore, *Communication Quality* could be taken into consideration as the most influential statistically significant independent predictor of *Perceived Performance* in a virtual team. For variables *Task-Technology Fit & Acceptance* and *Communication Application Characteristics,* the p-value was above 0.05, so they were not confirmed as statistically significant predictors in the regression model for the observed dependent variable *Perceived Performance* that is displayed in *Table 4*.

Table 4. Statistical significance of independent variables as predictors of *Perceived Performance* (N=64)

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.
	B	Std. error	Beta		
(Constant)	.551	.626		.881	.382
Communication Quality	**.674**	**.134**	**.551**	**5.022**	**.000**
Task-Technology Fit & Acceptance	-.087	.144	-.083	-.603	.549
Communication Applications Characteristics	.243	.153	.219	1.582	.119
a. Dependent variable: *Perceived performance*					

7 Discussion

The participants in our study relied on their interaction in virtual teams to perform the task that was assigned to them in form of a course project. Most of the subjects (79.7%) stated that they used communication platforms *"very often"* or *"often"*. Regarding the first research question (RQ1) in our study, it must be noted that their most frequent choices of a communications platform were *WhatsApp* (43.75%), *Discord* (31.25%), *Facebook Messenger* (9.38%), *Slack* (3.13%) and *MS Teams* (3.13%). Most of the students in our study use multiple communication tools for performing educational activities on daily basis, which is in the line with the results of research on using Slack (see: Menzies & Zarb, 2020). The mentioned research also established that Facebook Messenger, WhatsApp, Snapchat and Discord were the most popular applications for communication.

Having in mind the previously presented results of data analysis and considering the second research question in our study (RQ2), we confirmed the satisfactory internal consistency (measured by the Cronbach's alpha coefficient) of all scales and subscales that were designed or adapted for our study. As can be seen in *Table 1*, all of the Cronbach's alpha coefficients had value above .70, which can be considered as satisfactory for preliminary research.

The results of regression analysis in our study (see *Table 2*) revealed that *Communication Quality* was the most influential predictor of the criterion variable *Perceived Performance* in virtual teams. This answers the third research question (RQ3) and is in correspondence with the findings of Garro-Abarca et al. (2020), who also used regression analysis for prediction of *virtual team performance* (as a dependent variable) and found that its variance is mostly determined by the predictors labeled *"Trust"* and *"Virtual Team Communication"* in their study.

8 Conclusion

Our pilot study used the *Task-Technology Fit* (TTF) model as a theoretical framework to design a measurement instrument for assessing the performance of virtual teams in higher education. All of the measurement scales for TTF related variables in our pilot study had acceptable internal consistency. Our research also revealed that the two most frequently used communication tools for collaboration in students' virtual teams were *WhatsApp* and *Discord*, which is in line with research results of other authors. Furthermore, it was revealed that the quality of communication is a most influential and statistically significant predictor of the perceived performance in virtual teams. This finding is in line with the claim in literature that the quality of communication is more important than its frequency. It also highlights the importance of accurate and understandable communication among students' virtual team members. The implication for researchers of students' virtual teams would be to focus on evaluating the quality attributes of students' communication rather than the number of posts or messages they exchange or publish.

In the research presented in our paper the sample was rather small since it involved students from only one course. However, such research context was suitable for examining the students working in predominantly virtual teams on project tasks due to the COVID-19 situation. Therefore, in our future research we aim to further test the measurement instrument by including subjects from several other university courses. Next, the sample was rather homogeneous, which means that their prior knowledge of their field of study, common ways of communication and task completion routine may have influenced high values of Cronbach alpha.

In the future, we plan to investigate the relationship between the TTF constructs in a context outside higher education, especially in IT companies, where employees extensively use communication platforms for collaboration in virtual teams.

In addition to testing the measurement instruments in the real context of virtual teams, the instrument can also be tested in an international academic environment, for example in courses where students collaborate with colleagues from other universities on virtual team tasks. In the latter case, the impact of cultural factors on the performance perception of team members should also be investigated. On the other hand, in the research on virtual teams in a real working environment more detailed task characteristics and their possible influence on the perceived performance of virtual team members should be taken into account.

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