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Market research and survey report

DANTE PROJECT GUIDELINES

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1 Aim of the IO1

This part of the project focusses on two subjects: (i) general strong and weak points of distant learning to recognise the most frequent strong and weak points and (ii) experience and satisfaction with distant learning during the COVID pandemic compared to the situation before and after the pandemic situation (or at least when restrictions were relaxed). The idea was to ask all stakeholder groups at universities about their opinions on the past development of working in the online regime, as well as its current state. This will help to achieve the following three goals:

- To describe the current situation from the perspective of diverse interested groups (students, teachers, management, students' affairs departments, IT staff) at the participating institutions. The knowledge of differences between the institutions (cultural, social, technical) and between attitudes of different groups can be the source for further improvements and harmonization of the systems.
- To understand the preferences of the stakeholders regarding distance teaching and its future state or perspective (i.e., which parts of teaching process might remain online, and which should be realised in a face-to-face way). The opinions of stakeholders help to identify the strengths and weaknesses of the current state as well as the threats and opportunities for the future.
- To evaluate the available tools for distance teaching and assess their suitability for the participating institutions. This knowledge sets the barriers for further work.

The rest of this report is organised as follows. First, a proper state-of-the-art analysis is introduced in Sec. 2. This analysis is focused on (a) mapping of the satisfaction with blended learning at universities, and (b) methodology used to assess this satisfaction. This analysis gave rise to a need of the novel methodology which is carefully described and justified in Sec. 3. Sec. 4 is devoted to the data collection. That is, the questionnaire designed within the project and the survey realisation are presented there. The core sections of this report are Sec. 5 and Sec. 6 since the results are introduced there. The former presents the results obtained by the new proposed methodology, and the latter shows the results from 'classical' statistical analysis. The report is briefly summarised in the Conclusions section.

2 State of the art analysis

2.1 Evaluation of blended and distance learning

A sudden switch to lockdown during the COVID-19 pandemic forced many millions of teachers and students to go online to teach and learn. According to Marinoni et al. (2020), more than two-thirds of universities worldwide went online during the pandemic. The UNESCO study (2020) claims that the nationwide closures impacted more than 91% of the world student population. This unprecedented change brought many problems and opportunities. It is natural that immediately after this enforced change occurred, a big wave of research focused on distance learning and the corresponding issues raised. Most of the studies conducted are supported by surveys among students, teachers (or even parents¹). They focus on various levels of education (from basic schools to universities), they differ in the geographical location where the survey was done, etc. It is worth noting that the COVID-19 lockdown affected the people surveyed not only by closing schools, but also in other areas of their lives. Therefore, it must be taken into account that if the online regime is applied during the 'regular' period (meant non-pandemic) period, the evaluation of distance learning could be slightly different. This applies also to the research performed within our project.

Many studies explored the impact of distance learning on the mental health of stakeholders during lockdown. Lack of direct social contacts, the need to adopt new skills in a short time, and crucial changes in time management are the most frequently mentioned reasons in the literature. The study presented by Akour et al. (2020) confirmed the negative psychological impact of distance teaching during the COVID-19 pandemic (the study has been implemented in Jordan). Hoofman and Secord (2021) showed that the necessary rapid adaptation of both students and teachers was uneasy and had some negative impacts. They also confirmed the negative impact of the situation on the mental

¹ The parents are surveyed, for example, by Duraku and Hoxha (2020). It is apparent that they are relevant mainly for elementary and secondary schools.

health of the students. The analysis was more focused on high schools, thus many evaluation criteria are not applicable in our study. However, an interesting conclusion is that computational knowledge suffered more during the lockdown than knowledge of language arts. Duraku and Hoxha (2020) explored the potential negative impacts of sudden change in teaching regime on teachers' mental health. Jakubowski and Sitko-Dominik (2021) focused purely on the mental health of teachers during the pandemic in Poland because they felt under high pressure, especially during the first part of the lockdown when the sudden switch to the virtual environment occurred. The study confirmed that the pandemic and related online teaching caused blurring of the frontiers between professional and private life of teachers. Kim et al. (2021) also explored the impact of closing and reopening schools on teachers' satisfaction and wellbeing. 24 teachers from UK basic and secondary schools were surveyed and the results showed that the school governments should support teachers to feel autonomous, competent, and connected with colleagues.

Closing the schools also brought about other troubles than mental ones. Goudeau et al. (2021) explored that distance learning during lockdown will probably increase the social class gaps in society.

Many studies are not focused on a particular consequence of distance learning, but rather on an evaluation of its quality and satisfaction of the stakeholders (like we do in the DANTE project). The conclusions of these studies often differ substantially. Mishra et al. (2020) concluded that it is necessary to develop multimodal approaches to achieve course content objectives for better learning outcomes to deal with the complexity of online education and emphasised the role of high-quality technical equipment. It is worth emphasising that the study of Mishra et al. (2020) has been applied in India, where the conditions are hardly comparable with Central and Western Europe. Despite that, many criteria for assessment there are the same as in the European environment. Duraku and Hoxha (2020) showed a crucial role for good communication between teachers, students, and parents. Furthermore, the satisfaction of the students and teachers is highly dependent (one cannot expect a highly satisfied student if teachers feel frustrated and vice versa), thus they propose that teachers should feel involved and motivated for



changes. Van der Graaf (2021) emphasised the necessity of improving the technological support provided by both HW and SW to provide efficient distance learning. According to Shim and Lee (2020), students and academics argue that distance learning is 'inferior' and not of the same quality as face-to-face lessons. Means and Neisler (2020) presented the study, which showed that student satisfaction and motivation decreased substantially during the pandemic (more than 50% of US students surveyed felt dissatisfaction after going online). Altbach and de Wit (2020) saw the main challenge of distance learning during the pandemic in keeping the motivation of students to work hard enough even without face-to-face contact.

On the other hand, there are also studies revealing a positive impact of distance learning during the pandemic. Almendingen et al. (2021) surveyed Norwegian university students. Their results showed that the students got used to distance learning quite quickly (a significant improvement was apparent in a couple of months) due to the high-quality support of online teaching materials and frequent communication with teachers using SW. Students tended to prefer written home exams to online ones. On the other hand, the students suffered from lack of social contact during lockdown. Khalil et al. (2020) conducted the qualitative study among medical students in Saudi Arabia. This study came with surprising results that the online modality was well received by students, online sessions were considered time saving by students, and that their performance improved during distance learning.

Some studies focused purely on the evaluation of the state of the pandemic, but some of them also looked into the future and asked questions such as 'What online tools should be preserved also for times after the pandemic' (or times without any crisis like this pandemic in general). It would be too simplifying to claim that if students and teachers felt highly satisfied with distance learning during COVID-19, then this way of learning should also be used in the future (and vice versa). UNESCO (2020) claims that despite all the troubles caused by a sudden change to the online environment, the situation in the last two years provided an unprecedented opportunity to increase the resilience of national education systems and transform them into equitable and inclusive systems. Rapanta et al. (2020) claim that online teaching is an essential part of professional

preparedness of universities anywhere in the world nowadays. Universities should invest in the professional development of teachers in their faculty to make them familiar with effective pedagogical methods, regardless of whether they use or do not use online technologies. An enthusiasm for maintaining at least some elements of distance learning in the future is also shared by some surveys. Pokhrel and Chhetri (2021) conducted a survey among teachers and students at different levels of education in Bhutan and discovered that both students and teachers should be focused on the use of different online educational tools and, after the normal classes are over, should be encouraged to continue using them. In the study of Khalil et al. (2020), medical university students in Saudi Arabia would mostly prefer online learning also for the future despite they confessed that they had to deal with several challenges during the lockdown period like technical troubles, problems at exams, etc.

The studies mentioned above helped us choose the set of evaluation criteria for our complex model (distinguishing didactical, technical, and social factors seems to be reasonable). Factors must be adapted to the fact that the survey will be conducted at universities in western and central Europe. We will also survey different groups of stakeholders. Teachers and students are straightforward considering our aim, but we want to make our model more complex. The group of parents used by Duraku and Hoxha (2020) is not so relevant for the university level. Instead of that, we will ask also other members of academic staff: IT staff (they play a crucial role during the online regime, they also provide troubleshooting); members of the study affairs department (as Duraku and Hoxha (2020) claim, the communication of/with is during the distance mode even more vital than in the face-to-face mode, and this department has to communicate with students quite often), university management (as a decision-making authority). The satisfaction with a school, in general, is a qualitative measure highly influenced by emotions. Therefore, it is highly reasonable to allow interviewees to reveal their feelings as accurately as possible by including the uncertainty in answers (classical linguistic evaluation scales such as from absolutely yes to absolutely no are not sufficient; see Zapletal et al. (2022)). To the best knowledge of the project team, no such study has been published so far (at least for the COVID-19 period). Another contribution of the study should lie in the aggregation of partial satisfaction of individuals through all considered

criteria and for all members of each stakeholder group together. The complexity of the proposed model should help to understand the distance learning process in a more systemic way than in past studies.

2.2 Methodology for satisfaction evaluation considering hesitance in answers by soft computing

Valuable information for decision making can be obtained by collecting and analysing opinions from diverse stakeholder or respondent groups, which usually have different backgrounds and are varyingly affected by the topics under survey. Satisfaction and experience come from subjective opinions of respondents, usually by surveys (Albert and Tullis, 2013).

For this to succeed, it is necessary to manage the uncertainty and hesitance of the opinions of the respondents, the different number of questionnaires completed between the groups, the different number of questions for each stakeholder group, and the relevance of subsets of the response groups.

The following issues appear and should be considered (Rakovská and Hudec, 2019; Švaňa et al., 2021):

- Groups of stakeholders with different levels of expertise and skills as well as their own preferences and goals (in education: teachers, students, technical staff, etc.)
- Different sizes and backgrounds of these groups. The former causes differences in the number of questionnaires filled in by each group, and therefore troubles with the aggregation. The latter can result in hesitation when providing (neighbouring) categorical answers. In addition, questionnaires should be tailored to each group to improve cooperation in surveys. However, such questionnaires require an adequate method for evaluating and reporting results.
- The evaluation should be performed at the individual level, as well as at the level of the groups of respondents and the relevancies of their subsets.
- Some respondents do not fill out the questionnaire carefully (e.g., the respondent selects the neighbouring value).

To solve these issues and evaluate the opinions collected through surveys, a suitable aggregation model is required. Generally, any survey to succeed should be



tailored to each respondent group (Snijkers et al., 2013; Torres van Grinsven, 2015). A shelf-bound solution cannot be used straightforwardly or could not cover all the aforementioned aspects. In our opinion, this may be an oversimplification. Thus, we have developed a methodology to deal with these aspects. Our goal was not limited to the surveys related to blended learning. It can be also used in other fields, where we cope with the same problems like in smart cities (citizens living in the considered parts, citizens commuting to the considered parts, traffic practitioners, ecological activists, and so on) where a task might be to find the most suitable part for e.g., building new tram line. In the next section, a novel methodology is explained theoretically, followed by the survey conducted in the participating universities.

3 A novel methodology for satisfaction evaluation by fuzzy logic

The proposed model utilises fuzzy sets as a tool to capture the hesitation / uncertainty of answers. Intervals can be viewed as a special case of a fuzzy set, and, in our opinion, the stochastic approach is not very suitable for capturing the uncertainty in individual opinions.

The approach using the Likert scale (Liker, 1932) is easy and fast to use, but does not allow recording the uncertainty and hesitance in answers. Therefore, we decided to develop a new method. A respondent would be able to express to what extent he or she hesitates when providing the answers.

The popularity of the Likert scale is supported by its many advantages. Johns (2010) mentions simplicity and versatility as its main advantages. Nemoto and Beglar (2014) provide a more extensive and detailed list of advantages: "(a) data can be gathered relatively quickly from a large number of respondents, (b) they can provide highly reliable person ability estimates, (c) the validity of the interpretations made from the data they provide can be established through a variety of means, and (d) the data they provide can be profitable compared, contrasted, and combined with qualitative data collection techniques, such as open-ended questions, participant observation, and interviews".

However, as pointed out by Li (2013), the Likert scale also suffers from several disadvantages. First, it is unclear whether the scale is ordinal or interval. Given the scale is viewed as an interval, the second problem arises: Is the scale equidistant, i.e., are the distances between neighbouring choices always equal? Third, the closed response format might mean that some respondents cannot accurately express their opinion. These issues lead to information loss and/or information distortion. The last disadvantage gives rise to the need for an alternative.

considering uncertainty in evaluation.

In our approach, when providing an individual answer, let us say *quite high*, the hesitance is also recorded (no, slight, significant). We express the answer as a triangular

fuzzy number *around quite high*. By fuzzy arithmetic (arithmetic of fuzzy numbers) we calculate the overall opinion for each respondent to all questions and the overall opinion for all respondents in a group considering particular question.

Due to the different number of questions and respondents, we created quantified aggregation adopted from (Rakovská and Hudec, 2019; Švaňa et al., 2012) to reveal the validity of summaries related to positive and negative opinion: *most of respondents have positive opinion* and *most of respondents have negative opinion*, respectively by the theory of fuzzy sets and fuzzy logic to formalize quantifier and sentences based on these quantifiers. More details about the quantified summaries are in, e.g. (Lesot et al., 2016). This computation handles uncertainties and hesitance. In the first step, the possibility that the hesitant answers A_1 , A_2 , and A_3 belong to the positive opinion *PO concept* is shown in Figure 1. Obviously, the possibility assigns value from the unit interval: the possibility that the hesitant answer A_1 belongs to *PO* is 0, the possibility that the hesitant answer A_2 belongs to *PO* is α , and the possibility that the hesitant answer A_3 belongs to *PO* is 1.

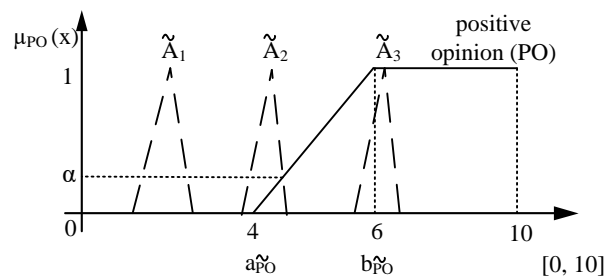


Figure 1. The possibility that the hesitant answers A_1 , A_2 and A_3 belong to the concept positive opinion *PO*

In the next step, the sums of all answers to the concept (in our case *PO*) are calculated and divided by total number of respondents in the group. Such proportion is applied in the quantifier *most of* formalized as an increasing function at the $[0, 1]$ domain (Kacprzyk, and Zadrozny, 2009; Kacprzyk and Zadrozny, 2005). Initially, we applied a usual definition from the literature of quantifier *most of* (Kacprzyk and Zadrozny, 2005) depicted in Figure 2.

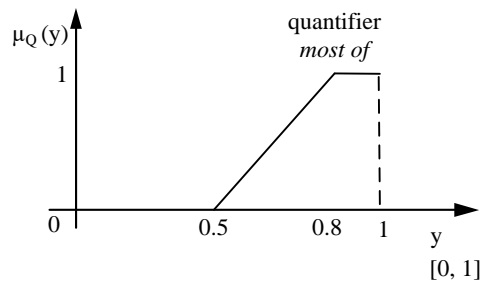


Figure 2. A usual interpretation of the quantifier “most of”

Due to unexpectedly high proportion of positive opinion among the participating universities, we decided to construct a strictly monotone increasing quantifier *most of* to record the differences among very positive, but not clearly positive opinions as is shown in Figure 3.

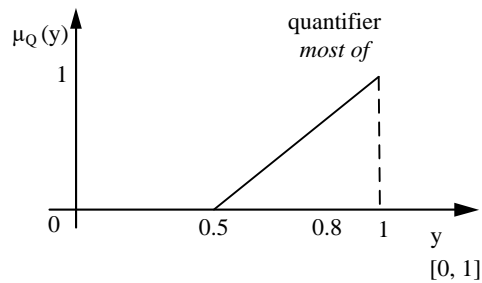


Figure 3. A strictly increasing quantifier “most of”

Theoretically, we can apply non-linear functions. It is, however, considered as an additional but unnecessary complexity, which requires formalizing slopes as an additional requirement (Hudec et al., 2018). Anyway, by linear and non-linear functions the differences in proportions of belonging to concept will remain.

4 Input data collection

As mentioned earlier, the survey by the questionnaire has been used to gather the required input data. This questionnaire and the related survey is described in this section.

4.1 Structure of the questionnaire

The questionnaire was built based on the interactive discussion and mutual agreement between the members of the project team from all participating universities. The questions were chosen to cover all important factors that influence the satisfaction of all university stakeholders (students, teachers, departments of student affairs, IT staff and management) with distant learning during the pandemic. The set of questions vary with the stakeholder groups because not the whole set of the questions is relevant for all groups. The following five groups have been considered:

- Teachers (T).
- Students (S).
- University management (M).
- Study affairs office (SA).
- IT staff (IT).

Regardless of the groups, all questions were to be evaluated using the Likert scale (value 1 corresponds to the lowest satisfaction with a factor (expressed by question); value 5 corresponds to the highest satisfaction with the given factor). To be able to assess the progress in time, the questions were tied with the three-time stages: Before the pandemic (and distant education regime, P0), at the beginning of the pandemic (P1), at the time of the completion of the survey (P2), that is, more, or less at the end of the pandemic, or at the time of a significant reduction in pandemic restrictions. The interviewees could then express their level of certainty in the answers provided. (0 = I'm absolutely sure with my answer, 1 = I feel a weak hesitance, 2 = I feel strong hesitance and my answer is driven mostly by my feelings). The very last factor evaluated was the weight of each evaluated criterion (1 = weak importance, 2 = medium importance, 3 = strong importance). The list of questions that evaluate satisfaction with past and current states can be found in Table 1.

Table 1. Questions of the questionnaire with distinguishing groups and time periods.

Question group	Question	Groups of respondents	Periods
Technical issues	Do you consider the internet quality sufficient?	S	P1, P2
	Do you consider your HW equipment sufficient?	S, T, IT	P1, P2
	Are you satisfied with the SW platform used at lessons?	S, T, IT	P1, P2
	Are you satisfied with the helpdesk support?	S, T, IT	P1, P2
Teaching issues	Do you find the lessons attractive?	S, T, M	P0, P1, P2
	Do you feel motivated to work hard?	T, S	P0, P1, P2
	Do you find the time demand of your duties adequate?	S, T, IT, SA, M	P0, P1, P2
	Do you think that tests are fair?	S, T, IT	P0, P1, P2
	Do you consider the course evaluation by students at the end of a semester beneficial?	S, T, SA, M	P0, P1, P2
	Do you consider the support by digital study materials sufficient?	S, T	P0, P1, P2
Communication issues	Are you satisfied with the quality of direct communication with students?	T, M, SA	P0, P1, P2
	Are you satisfied with the quality of indirect communication with students?	T, M, SA	P0, P1, P2
	Are you satisfied with the quality of direct communication with teachers?	S, M	P0, P1, P2
	Are you satisfied with the quality of indirect communication with teachers?	S, M	P0, P1, P2
	Are you satisfied with the quality of communication with non-teaching staff?	S, T, M	P0, P1, P2
	Are you satisfied with the communication of information by university management?	S, T, SA, IT, M	P0, P1, P2

4.2 Realization of the survey

The questionnaire has been implemented in Google Forms; see Fig. 4. Each university prepared its own language mutation (in Czech, Slovak, Polish, and Portuguese language). All respondents responded voluntarily. Regarding the students, we mainly asked the students with experience more than 2 years (to be able to assess the impact of the pandemic), ie, the third-grade bachelor and master students regardless of their field of study. The number of individuals surveyed at participating universities and with distinguished response groups can be found in Table 2.

Question 1/17: Do you feel motivated enough to work hard?

Part 1: Study affairs

Did/do you feel motivated enough to work hard? *

	Absolutely yes	Rather yes	Neither yes nor no	Rather no	Absolutely no	I have no opinion
Before the pandemic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
At the beginning of the distance learning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Now	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Do you feel any hesitance in your evaluation? *

	No, I'm completely sure with my evaluation.	Yes, I slightly hesitate.	Yes, I feel strong hesitance and my answers were driven by feelings.
Evaluation of the past situation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Evaluation of the current situation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How important is this issue for you? *

	1	2	3	
Lowest	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Highest

Do you see some proposals for improvement?

Your answer

Back Next Clear form

Figure 4. Print screen of a selected question of the questionnaire

Table 2. Numbers of interviewees

No. of respondents	CZ (Ostrava)	SK (Košice)	PL (Katowice)	PT (Santarem)
Students	294	221	333	153
Teachers	55	27	113	52
IT staff	9	2	6	6
Study affairs dept.	10	2	46	27
Management	4	6	12	8

The work on IO1 proceeded can be divided into the following eight phases.

Phase 1 (02/2021 - 05/2021)

In this initial phase, a thorough analysis of the current state was performed. This analysis focused on two fields. First, studies on distance learning (especially the novel ones conducted during the pandemic period) were explored. Second, available methodologies for satisfaction evaluation were mapped.

Phase 2 (04/2021 - 08/2021)

In this phase, the structure of the questionnaire has been built. First, the very first draft of the questionnaire was prepared based on the results of the state-of-the-art analysis (see Phase 1). At the regular meetings with the project partners, each part of the questionnaire (each question and sub-question) was carefully discussed to hit the desired idea. It was also necessary to consider the requirements of the colleagues responsible for other subsequent parts of the project to obtain the inputs they need.

Phase 3 (04/2021 - 09/2021)

This phase was managed in parallel with Phase 2. In this phase, it was necessary to choose the best possible setting for the evaluation model. In other words, we had to select how the data were to be processed and how the information obtained would be aggregated to obtain the required aggregated results. We partially adopted the evaluation model proposed by Zapletal et al. (2022) and made some necessary changes there retrieved from the state-of-the-art analysis.



Phase 4 (10/2021)

In this phase, we had to decide which platform we were going to use to disseminate the questionnaire. All project members agreed with Google forms, which are available for free and provide reasonable flexibility. First, the English mutation of the questionnaire was created. At that moment, we performed the alpha-test; see Phase 5. After completing Phase 5 of the test, project members from different partner universities were asked to translate the questionnaire into their native languages (i.e., Slovak, Polish, Portuguese and Czech).

Phase 5 (10/2021)

This phase contains the pilot survey, which was conducted to check if there are no problems such as technical problems, incomprehensibility of expressions, and also to get some idea of approximate time necessary to complete the questionnaire. Three teachers and eight students participated in this pilot phase. No greater problems were identified (except for a couple of typos).

Phase 6 (11/2021)

This phase of the research can be considered crucial. Namely, the questionnaire was disseminated among all considered stakeholder groups. The answers of the students were also collected during the lessons (where possible), but the vast majority of respondents were addressed by email, and they have one week to submit the completed form. Participation in the survey was purely voluntary for all participants.

Phase 7 (12/2021 - 01/2022)

In this phase, we put all the answers together and process them according to the developed methodology. First, we used Python environment to calculate the overall results (see the code in Appendix). Then, we also applied a statistical analysis of the results to understand some partial information and details.

Phase 8 (01/2022 - 03/2022)

This last phase aimed to interpret and understand the results. Similarly, with Phase 2, we organised several project meetings at which the conclusions were made, and the lessons learnt were analysed.

5 Overall results obtained using the novel methodology

Observing the proportion of positive and negative opinions in general, we recorded a decrease in the proportion of satisfied students at the beginning of online teaching. At the end of the fully distant teaching period, the proportion of respondents with a positive opinion increased. In many cases, it exceeded the proportion of positive opinion before the pandemic.

In the following sections we abbreviated findings from participating universities in the following way: VSB – Technical University of Ostrava (CZ), Kosice (SK) University of Economics in Katowice (PL) and Politechnico Santarem (PT).

This observation does not hold for the student affairs departments in SK and PT, the management in PT and CZ, and the IT department in PL. A deeper evaluation is advisable to reveal the main reasons. For instance, a coincidence with, e.g., the innovation in software might skewed these results.

In general, the proportion of students and teachers with a positive outlook was lower than in the student affairs departments at the beginning of the pandemic. It was observed in all countries. The reason might be that these departments already extensively communicated with students electronically, whereas online teaching was something new for teachers and students. The most significant decrease is recorded in PT. Presumably, in South Europe, people generally prefer direct contact and communication. After the pandemic, in the Student Affairs department, the proportion of positive opinions is highest in PL (0.97), while the proportion of positive responses among students was lowest in PT (0.72). The positive opinion at the end of the pandemic outperforms the positive opinion before the pandemic, while in few cases it reaches almost the same value or was slightly below (students in PT). The lowest positive opinion was in the IT department of SK at the beginning of the pandemic (0.46) and among students in PT (0.63). The maximum positive opinion was recorded in the student department affairs in SK and in the IT department in PT.

When one looks at a negative opinion, only in one case does the majority have a negative opinion. In the student affairs department, the proportion was highest 0.32 (CZ),

among teachers (PT), 0.39, in management 0.41 (PL), among students 0.47 (PT), which was the second recorded negative opinion, and in IT department 0.86 (SK), which was the highest negative opinion. These values are for the beginning of the pandemic.

We recorded similar behaviour among teachers and students. The highest positive opinion is recorded after the pandemic of 0.91 (SK), while the highest negative opinion was 0.32 (PL) at the beginning of a pandemic. Interestingly, students in SK and CZ evaluated the case after pandemic very similarly (a slightly better in CZ), even though in SK teaching was still partially online, whereas in CZ it moved to face-to-face teaching. Then the SK teachers were evaluated after the pandemic as much better than the CZ teachers, which is a surprising observation, as in SK teaching was still restricted. In SK this intensity was the highest and the lowest was in PT.

In student department affairs, the pattern that positive opinion is greater than before and at the beginning of pandemic is observed. It might reflect that a significant improvement is achieved in innovation in software, organisation of work, or even more flexible working hours and home office, which in some extent remained.

In the case of management, the pattern in SK, CZ and PT is continuously increasing. The most surprising is the rapid increase in CZ in each stage. The case of PL follows the usual pattern. In PL the decrease is recorded followed by an increase to the level of before the pandemic.

The most significant decrease at the beginning of the pandemic was recorded in PT among teachers and students. Their satisfaction was the lowest. However, it might have other reasons, such as the mentality and strong preferences of personal contacts. As a paradox, at the beginning of the pandemic, increased positive opinion is recorded in departments of student affairs. One option might be to avoid the queue of nervous students asking many questions. Management has kept positive opinion high constantly. In IT departments, SK recorded a significant decrease in positive opinion. In all countries, the positive opinion was higher after the pandemic situation or after the release of strong restrictions. presumably reflects the innovation and the lesson learnt. Fig. 5 shows the relative proportions of the positive opinions and Fig. 6 the relative proportions of the negative opinions.

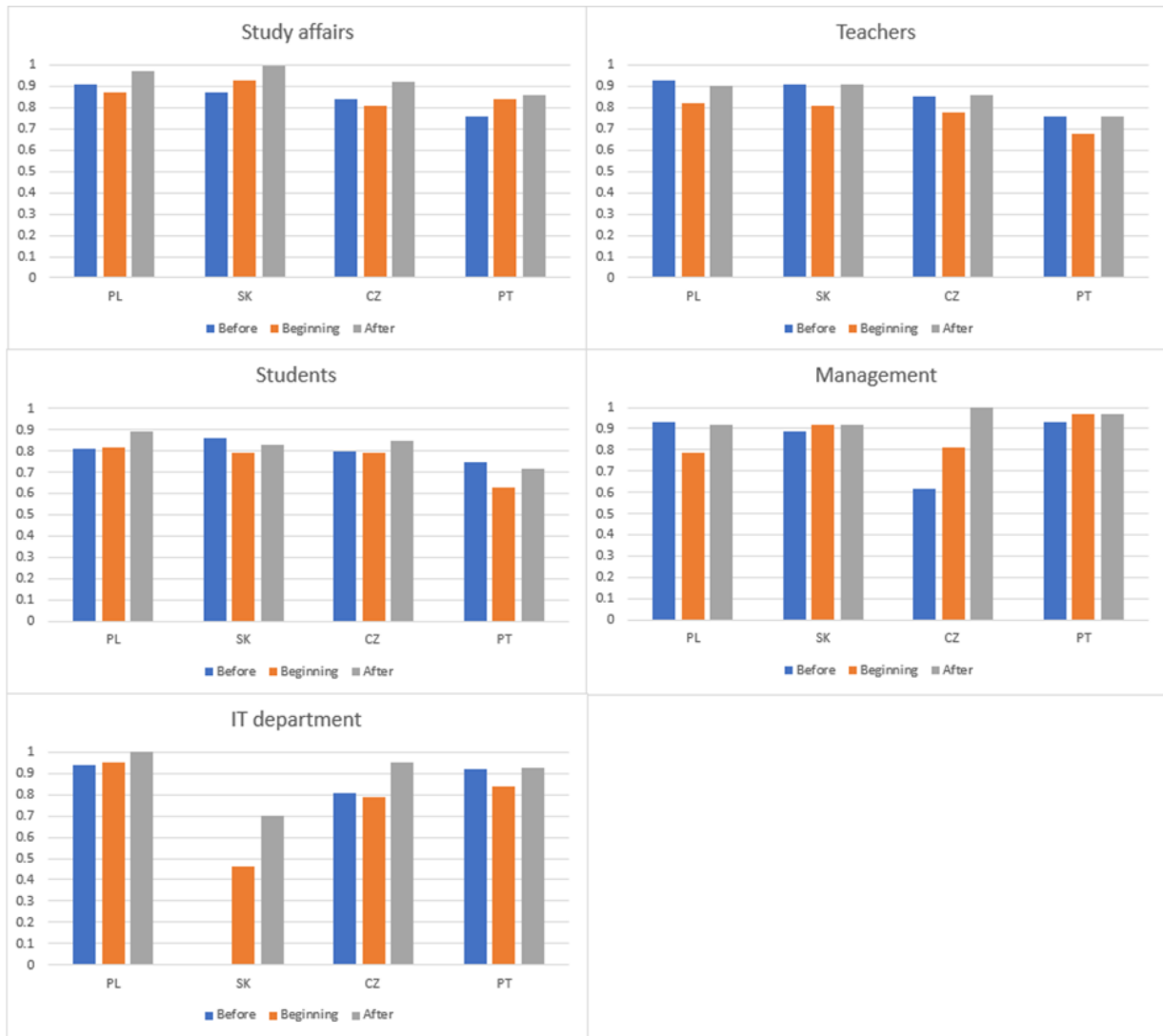


Figure 5. The overall result of survey among different stakeholders' groups

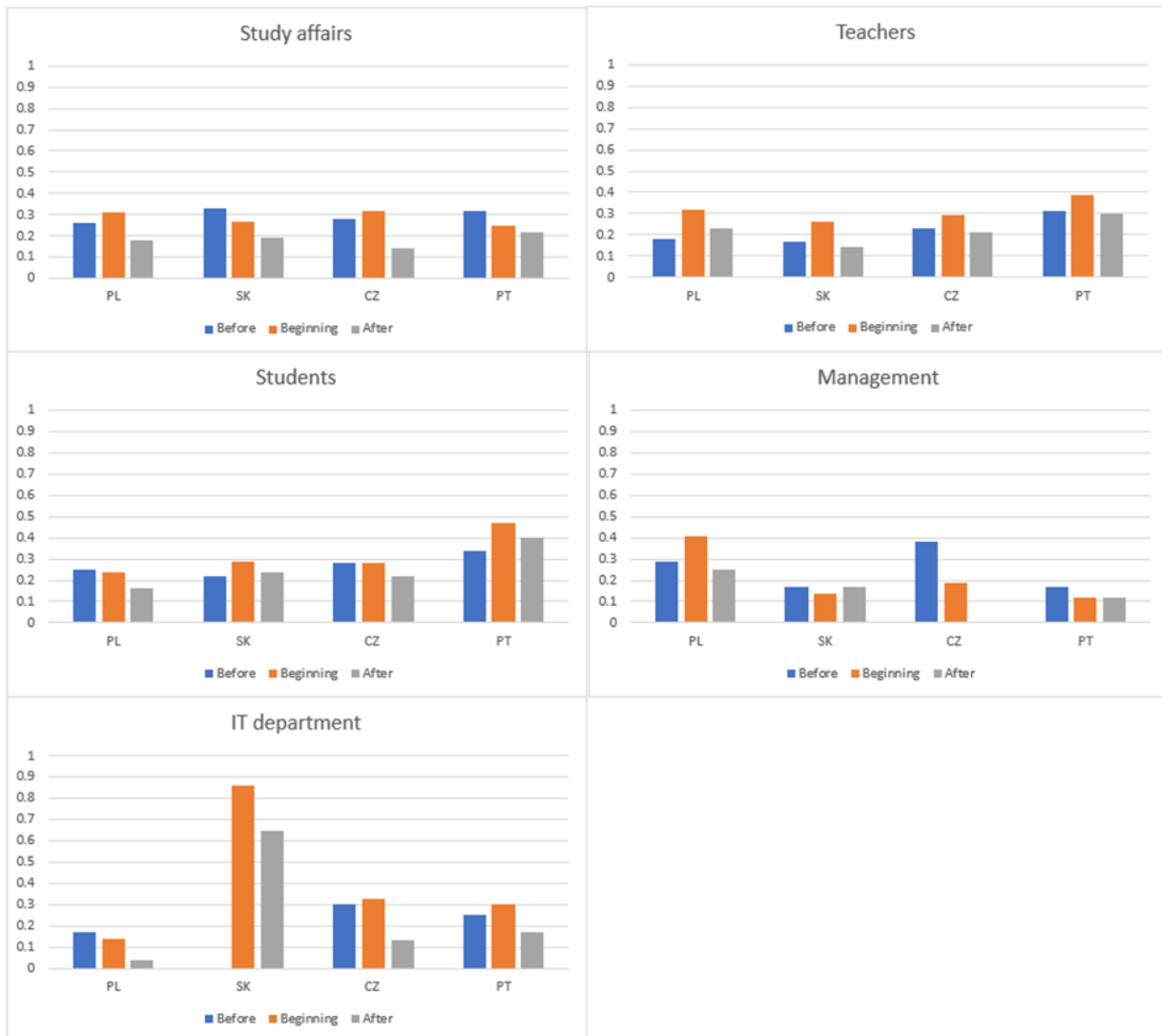


Figure 6. The overall result of survey among different stakeholders' groups

Figure 6 shows that the only group, who revealed mostly a negative opinion, is the IT department in Slovakia. One of the factors of such dissatisfaction was a) awareness of insufficient IT equipment at the university and b) (un)fairness of the tests online.

Possible further evaluations

If we want to get an overall overview for a university, considering all respondents' categories, we should consider the so-called coalitions. For example, in the evaluation of the content of (online) teaching, students and teacher are more relevant than technical staff and student affairs department. When evaluating technical support, the situation is the opposite.

Assigning weights to groups is a problematic and over-simplified solution because it does not consider weights of the aforementioned sets of groups. The answer could be



to apply the so-called capacities by fuzzy measures and aggregation by Choquet integral. The special cases of this integral are arithmetic and weighted arithmetic mean (in the case when all groups are equally important, or importance if different considering each group independently, respectively). Therefore, we will be able to cover both simplified and more complex requirements for evaluation among groups. Thus, this research inducted a topic for future research, which is an additional result of this project.

Software support

Since the established methodology is not supported by the existing software yet, Python code has been developed and applied on surveyed data, see the codes in the Appendix.

6 Deep analysis of the results through the processes

In this section, the three identified groups of processes (i.e., teaching processes, communication, and technical issues) related to the online teaching evaluation are analysed. The analysis is focused especially on the lessons learnt during the COVID period, the benefits and drawbacks, and their reasoning. In the end of this section, the opinions of each stakeholder groups on the use of an online environment in different fields of the teaching process are provided.

6.1 Teaching process

Motivation to work hard (Q1)

The online presence due to pandemics has decreased the motivation of students (S) and teachers (T) to work hard. After the end of the online mode, this measure increased again for students (the decline continues in Slovakia because there was still the online mode at the time of the survey). Teachers in general do not feel the improvement back to the prepandemic state.

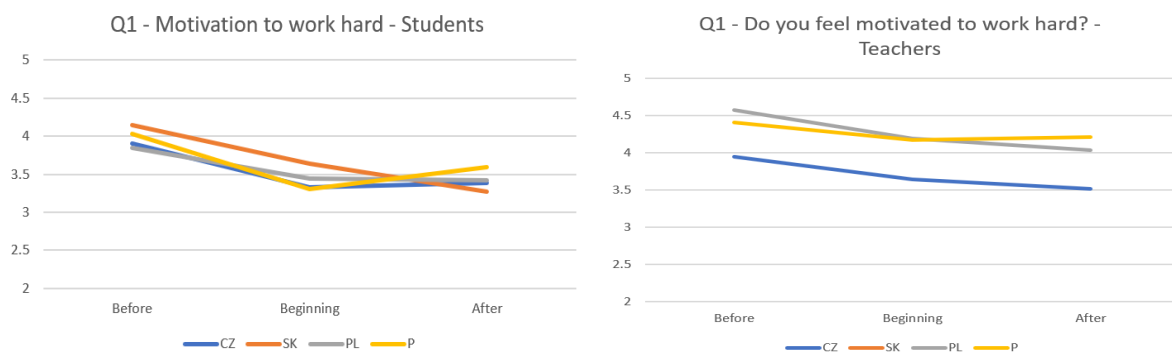


Figure 7. Results of the survey for students and teachers: Question on motivation to work hard; mean values of the answers (1= absolutely no, 5= absolutely yes)

Possible reasons: It took some time to get used to the new regime. Moreover, the online mode is also challenging in terms of lack of social contact, which cannot really be improved. We also recorded it in the general overview results, especially for a country known for very deep social contacts. The teachers' opinion can be explained by fatigue after a difficult pandemic period and the uncertainty of long-term development regarding COVID-19.

Attractivity of the lessons (Q2)

The online mode decreased the attractivity of the lessons for S and T in all participating countries. After switching back to the on-site mode, the perception of attractivity has returned back to its pre-pandemic values (the decline continues in Slovakia because there was still the online mode at the time of the survey).

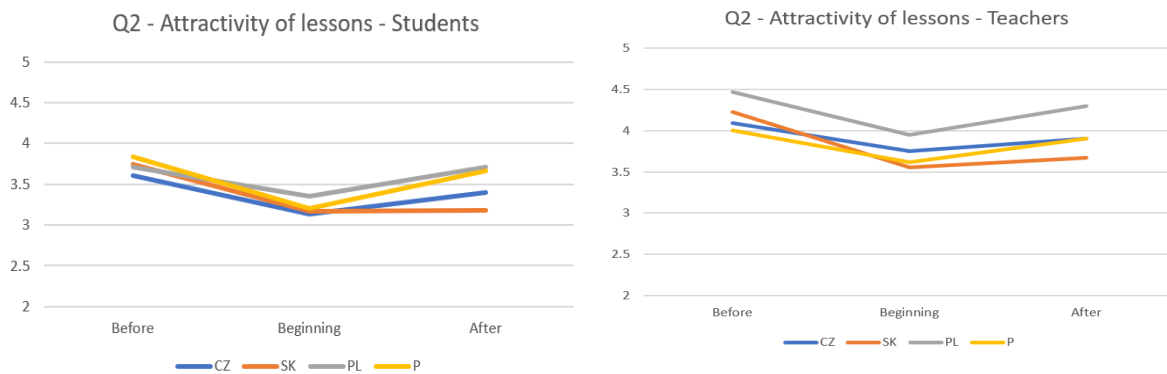


Figure 8. Results of the survey for students and teachers: Question on attractivity of lessons; mean values of the answers (1= absolutely no, 5= absolutely yes)

Possible reasons: The reasons are similar with those for motivation to work.

Time demands on study/teaching duties (Q3)

An opinion on time demands on study/teaching duties substantially differs for S and T. Students think that the time demands of study duties were almost unchanged all the time (CZ, PL), that is, the pandemic has not influenced it or even lower (SK, P). On the other hand, teachers in all participating countries felt a strong increase in time demands (and then fell again after switching to the on-site mode).

Possible reasons: Teachers felt under strong pressure when the online mode began. They spent much time learning how to use HW and SW to keep the attractivity of the lesson at some reasonable level.

Support by digital materials (Q4)

It turned out that the pandemics had a positive impact on the support by digital materials. All participating teachers and students (except for students from Portugal) confirmed this significant improvement. The Portuguese students expressed more or less the same satisfaction at all time periods (on the other hand, its initial level was above average in comparison with the other three countries).

Possible reasons: The reason is straightforward – to maintain teaching quality, it was necessary to provide high-quality support by materials to students. It is apparent that the students acknowledge this effort. The materials will be useful even for future students.

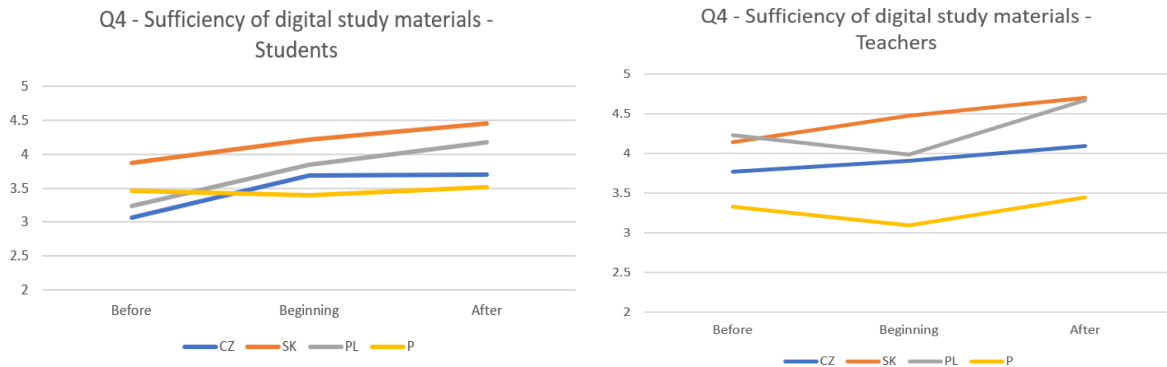


Figure 9. Results of the survey for students and teachers: Question on sufficiency of study materials; mean values of the answers (1= absolutely no, 5= absolutely yes)

Fairness of the tests (Q5)

Another issue in which consensus has been found among S and T in the countries is the fairness of the tests. Regardless of the initial (pre-pandemic) evaluation, the satisfaction with this indicator dropped dramatically. The situation returned to its original state after switching to the on-site mode.

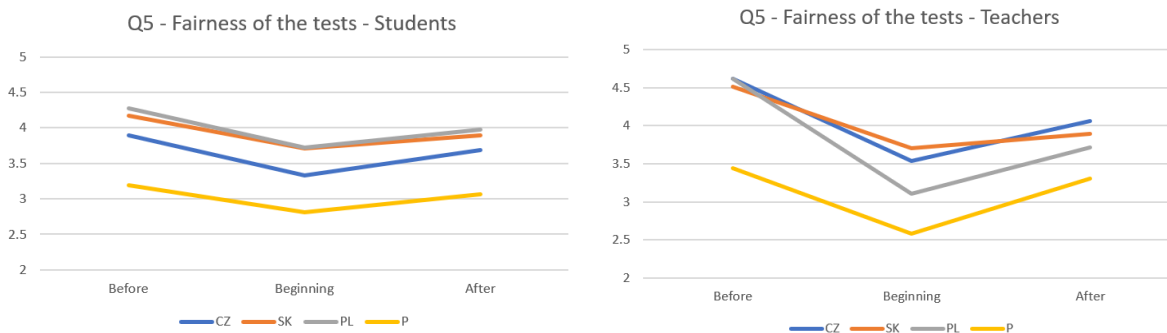


Figure 10. Results of the survey for students and teachers: Question on fairness of the tests; mean values of the answers (1= absolutely no, 5= absolutely yes)

Possible reasons: Technical equipment allows cheating more easily when examining online.

Evaluation of courses by students (Q6)

The evaluation of the courses by students after each semester is an important traditional tool to gather data from students. Students in all participating countries evaluated that the benefits of such evaluation have not been affected by the covid-19 / online mode at all. On the other hand, teachers in the four countries expressed that they felt that the benefits had been lower at the beginning of the pandemics. However, after switching back to the on-site mode, their perception returned almost to its pre-pandemic state (except for CZ, where the slight decline continues).

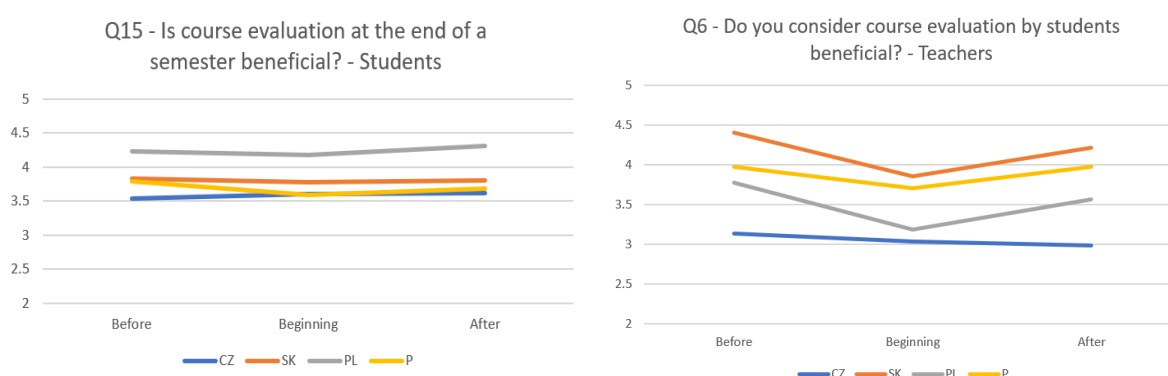


Figure 11. Results of the survey for students and teachers: Question on perception of the course evaluation; mean values of the answers (1= absolutely no, 5= absolutely yes)

Possible reasons: Teachers felt critically that their performance in lessons is far from the ideal state at the beginning of the pandemics, since they had become used to new procedures, HW and SW. Thus, it is possible that they were a bit scared to receive this feedback.

General overview for teaching activities and the lessons learned:

Table 3. Conclusions of the teaching activities' evaluation

		Q1	Q2	Q3	Q4	Q5	Q6
COVID-19	Students	Red	Red	Grey	Green	Red	Grey
	Teachers	Red	Red	Red	Green	Red	Red
FUTURE	Students	Grey	Grey	Grey	Grey	Red	Grey
	Teachers	Grey	Grey	Grey	Grey	Red	Grey

*red = negative impact; grey = neutral impact; green = positive impact

The concluding assessment of the factors for the COVID-19 period are in line with their detailed description above.

It would be ideal if the online mode would be of the same quality as the on-site mode, and it would be possible to switch between them without any negative impacts. In other words, all cells that indicate the impacts of online teaching in the future should be grey. Such an outlook is quite rational for almost all factors. All expected improvements (from red to grey) are supported by knowledge that both teachers and students have already learnt the basics and principles of the online mode and this advantage will persist for some time also in the future. Of course, it would be necessary to maintain it (or improve it), otherwise it can be lost. For this reason, it can be recommended to use the online mode even after the pandemics (at least for selected activities or special occasions). Despite the fact that the support by digital materials was the main benefit of last two years, it cannot be expected that the steep increase in satisfaction would continue if, for instance, all teaching activities are to be organised online forever. The gap has already been closed to some extent and the need for new materials is no longer so high. One must also be aware of the negative social impacts of online learning caused by the reduction of personal contacts at universities. There is hardly any way to deal with this problem. The only factor that can be expected to remain a thorny drawback of the online mode is the fairness of tests. Therefore, exams should definitely be kept on site in the future if possible.

6.2 Communication

Communication is the most important element of teaching. And communication between students and teachers is certainly basic, but not the only communication that exists in schools and universities. Therefore, both students and teachers were asked how I communicated with each other, for example, with the administration (a study department used by both parties), and with the administration (a study department that is used by both parties), and for example how they liked my communication from the school.

Direct communication

The online environment led to a change in direct communication, which was not face-to-face at first. Everyone was learning to use new technologies, and some time passed before video calls were adopted (it should be noted that even now people sometimes don't want/can't turn on the camera). However, based on Figure 12 (left), it can be concluded that students did not feel much difference in direct communication with teachers at the beginning of the pandemic. In the end, they were even more satisfied than before. That is, except for the case of Portugal, where it seems that student satisfaction with communication with teachers is more or less the same all the time. In contrast, it is interesting how the teachers perceive the given situation; at the beginning of the pandemic, felt a large decrease in communication, and even after the pandemic did not feel that the students wanted to continue to communicate directly that much. Perhaps the notable exception is Slovakia, where it now seems that students and teachers want to communicate much more personally, even more than before.

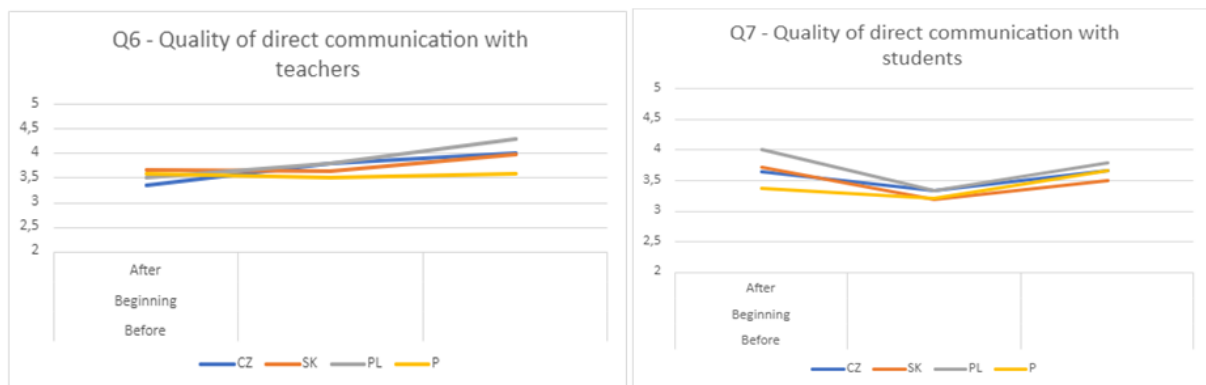


Figure 12. Results of the survey for students and teachers: Quality of direct communication with the second side

Possible reasons: It is obvious that at the beginning people were learning to work with new technologies, so it is clear that at the beginning a drop-in communication was to be expected. On the part of the students, it could have been exacerbated by the vision of short vacations and the fact that no one will be doing much, so they too can rest. However, it is surprising that the situation did not improve after the pandemic, as many people complained that they were unable to communicate directly. But this can be explained by fear, fear of talking to people directly or from contagion, and it can also be attributed to

convenience. Being at home or anywhere else and communicating indirectly is easier and more convenient. Call out if people already have these technologies and know them.

Indirect communication

The question of indirect communication was easy. Given that, at least in the beginning, people had to change the linear for the non-linear, it was necessary to assess whether there was an improvement here as well.

It should be noted that the increasing trend is again recorded by students in communication with teachers (Figure 13 – left). Therefore, it can be concluded that the teachers improved as time passed and the pandemic went on. In the case of students (Figure 12 – right), we can generally talk about an improvement in indirect communication (if we compare before and after the pandemic), but in all countries, we can always see a decrease in progress.

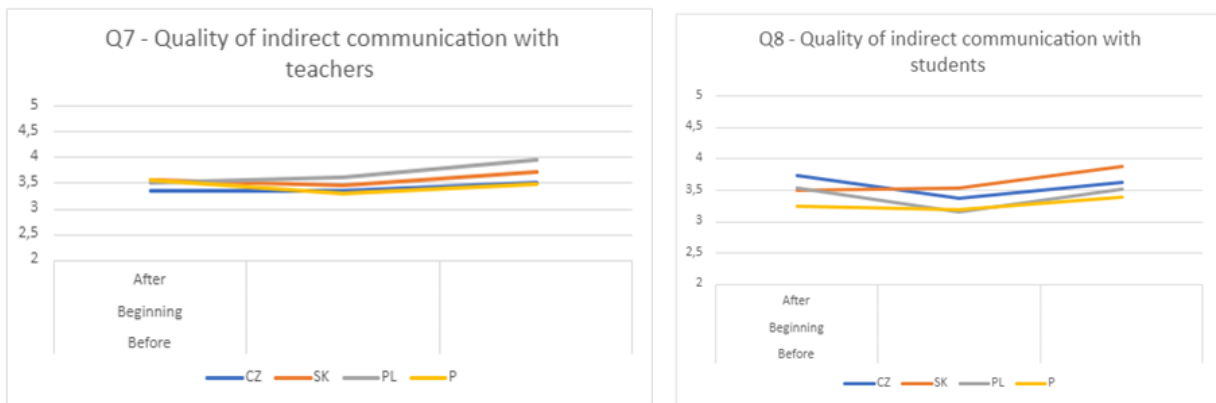


Figure 13. Results of the survey for students and teachers: Quality of indirect communication with the second side

Possible reasons: The reason why the quality of communication, at least in the communication between the teacher and the student, is in the shape of a "v" can be seen in the fact that the students were overwhelmed by communication at the beginning of the pandemic and thus "coughed up" it for some time, they were not used to it to deal with many emails, or they were simply not communicated with. However, in terms of quality satisfaction, this could be more likely attributed to both students and teachers learning to communicate effectively indirectly, unifying communication and the appropriate amount of information.

Communication with the administration office

Under the term administrative office, the study department is the study department, which provides support primarily to students with their studies, namely recognition of subjects, transfer of subjects to the next year, interruption of studies, etc. Pedagogues also turned to her more during the pandemic.

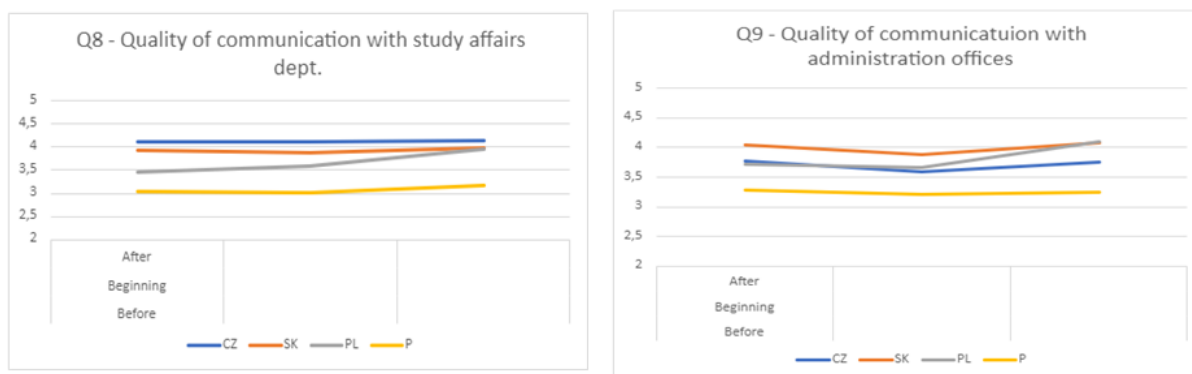


Figure 14. Results of the survey for students and teachers: Quality of communication with the study affairs with students and in the case of teachers with the administration office.

With the students, it can be seen that the quality of communication during the pandemic did not match how well/how well they communicated with her during or after the pandemic. Perhaps the only exception is Poland, where rapid improvement can be seen. In the case of teachers' communication with the given office, it can be seen that at the beginning there was a drop-in satisfaction in communication, but at the end of the pandemic, the level of satisfaction generally returned or even increased.

Possible reasons: The relationship between the administrative office and the students can be evaluated as constant, so it can be concluded that the students and the office staff always used the same communication flows and the pandemic did not affect them much. When it comes to communication between teachers and the given office, it can be assumed that the "v" shape in most countries is caused by the fact that before the pandemic, in general, teachers did not need this office - the administrative one solved the students' problems, so the pedagogue did not have to solve anything. Unfortunately, during the "unconscious" period, i.e. the beginning of the pandemic, no one knew anything, so even the pedagogues had to ask questions or were asked about several things regarding the study's administration that they could not answer. Then it is possible that they rated the quality of communication as bad. However, it can be seen that, apart from Portugal, there has been a general improvement in communication between

teachers and the office, perhaps it is also a matter of mutual recognition of the need for work and understanding.

Communication with the faculty/university management

This communication also proved to be crucial during the pandemic. Before the pandemic, many students and perhaps even some teaching staff had no idea who was in charge of the school or what the structure was (except for the study department), but thanks to the need (at least at the beginning) to find out what was going on, there was an improvement in the knowledge of who runs the school/u university and leads.



Figure 15. Results of the survey for students and teachers: Sufficiency of information dissemination from faculty/university management

Figure 15 shows that the students were more or less always satisfied with the information provided by the school management, and the drop at the beginning of the pandemic was very small (picture on the left). For teachers (picture on the right), it can be seen that satisfaction with management communication decreased at the beginning of the pandemic, but at the end it returned to its original state or worsened. That is, except for Portugal, where an overall improvement can be seen, even at the beginning of the pandemic.

Possible reasons: The constant satisfaction in communication between students and management is probably a consequence of the fact that the relationship between students and management is generally very small. The student perceives the teacher and the study office as the primary partner and if he receives information from these two sources, then there is no reason to deal with anything else or with anyone else. On the contrary, it can be understood that teacher satisfaction with management was lower at the beginning of the pandemic. Nobody knew anything, not even the management, so



they could not pass on information to the pedagogues, and they had to follow their conscience and consciousness and hope that then the management would support them. The positive thing is that it can be seen that the communication level eventually reached the same level or even improved. Portugal can be seen as a great positive, where the pandemic helped improve communication between teachers and management.

6.3 Technical issues

Technical equipment - software and hardware - were the other key things that were discussed a lot at the beginning of the pandemic. People did not have the necessary equipment, and there was a shortage of computers, cameras, microphones, etc. across industries.

Technical support

In the case of students and teachers, there is technical support from the IT department at the school, which can help with problems both online (mostly via the help desk) and directly at the school. Due to the closure of schools, no direct help could be provided. And due to the rapid growth of people who started working with IT, there were many problems and therefore also many questions for these departments.

From Figure 16, this trend can be seen - technical support grew throughout the monitored period. It is very positive that the departments in question were able to respond quickly and technically support all, both teachers and students. The slope of the bushes is diverse. It is generally less steep for students than for educators, but it is for both groups.

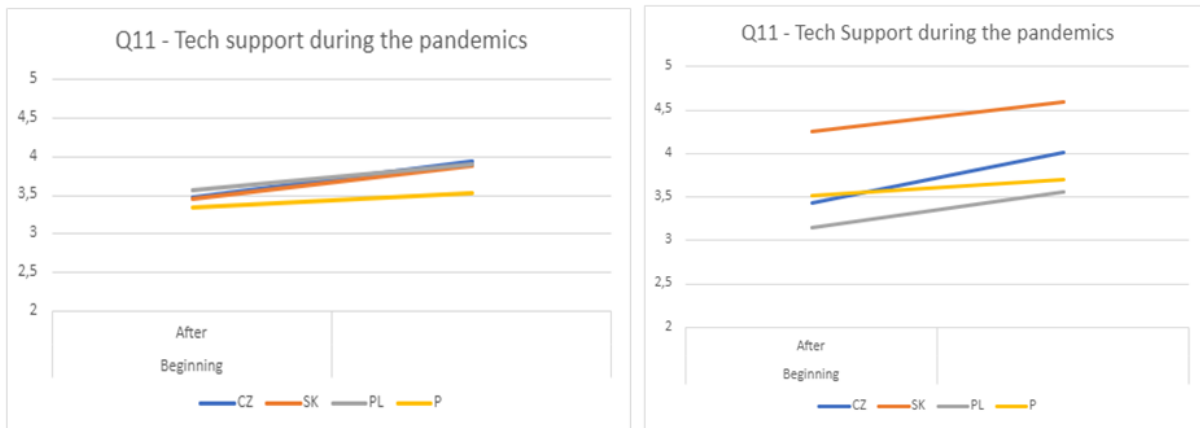


Figure 16. Results of the survey for students and teachers: Technical Support during the pandemics

Possible reasons: The different inclinations between the group of students and teachers can be attributed to several things. 1) it can probably be said that the students are generally young and thus probably also understand technology more and can help themselves or each other, 2) pedagogues are after all more used to support from the employer and solving technical matters is not part of their basic work, and 3) even the support for the teachers could have been greater in the first moments, because after all, they were the ones who needed to broadcast and produce more (that is, to be active), while the students only received.

Interestingly, Portugal always has the slowest trend in both groups. This may be due to a generally poorer technical background. The steepest growth in the Czech Republic is very surprising. It can be, for example, support from the faculty or the state for the quick purchase of new technology, which goes along with the technical support.

HW equipment

As already mentioned, there was a hardware (HW) problem at the beginning of the pandemic. Therefore, it is very positive that from Figure 17 it can be seen that both students and teachers were more satisfied and satisfied with HW. Both groups went with the flow of scarcity and tried to obtain better equipment to deal with the situation. In some countries, the HW was improved with the help of schools or the state.

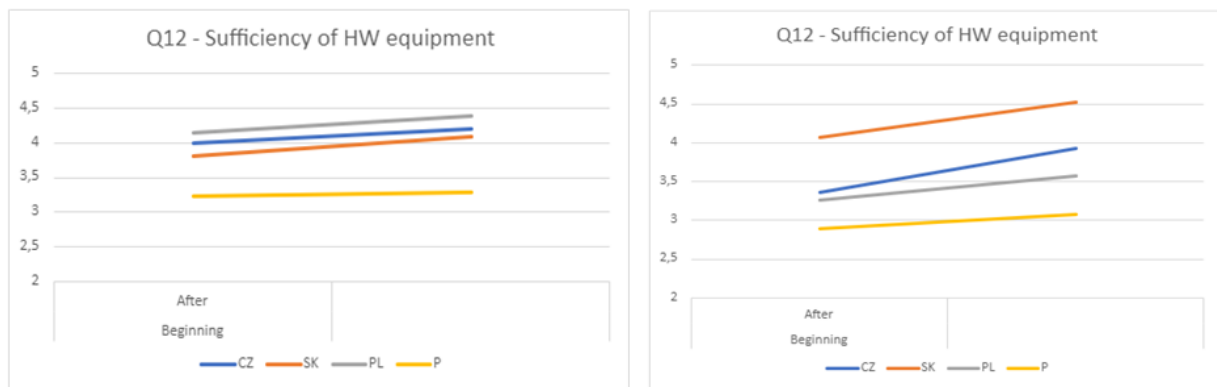


Figure 17. Results of the survey for students and teachers: Sufficiency of HW equipment.

In addition to this question, students were also asked a question about their satisfaction with the Internet connection. It should be noted that many students stated in their verbal responses that they had to increase their internet connection during the beginning of the pandemic. On the positive side, all countries except Portugal report that satisfaction with the connection for students increased slightly. Portugal was going against the tide and satisfaction was falling. However, considering the previous questions, it can be seen that the problem can be both in technical support and in HW, where Portugal was also among the less satisfied. It is true that in Portugal, students have a certain part of the internet connection for free (as a student benefit in the data plan), but this is a small amount of data and, therefore, the enthusiasm for internet teaching could lead to the given problems.

SW platforms for teaching

At first, probably only a small percentage of teachers and students knew about SW platforms for online learning. And so, when starting out, about 90% of people started from scratch. Therefore, it is obvious why satisfaction with these platforms grew across the group of students and teachers. See Figure 18.

However, it should also be said (also based on the verbal answers) that at first there was a big problem with unification – many people (educators) tried different channels and before some stabilisation was achieved, the students were quite disappointed. This is related to the fact that even people were learning on many platforms and did not know where or how to do. At the end of the pandemic, most of the affected had switched to MS Teams.

It should also be noted that even this software has gone through a big change and has been updated many times over the last few years due to needs such as screen sharing, team recording, etc.

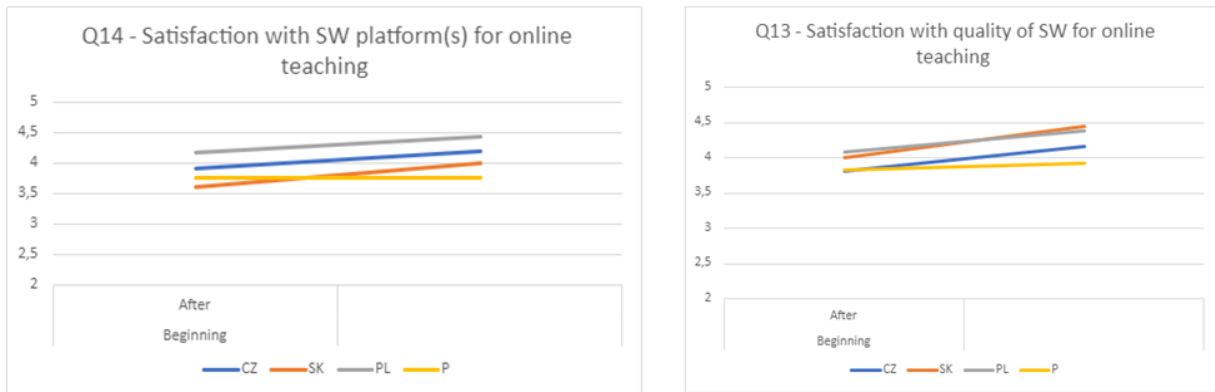


Figure 18. Results of the survey for students and teachers: Satisfaction with SW platforms(s) online teaching

6.4 Outline for the future

Teachers and students were asked their opinion on what parts/elements of the teaching process should also be kept online in the future (lectures, exercises, exams, credits, consultations, and final exams). The greatest consensus between students and teachers was found in the Czech Republic. Both groups almost completely agreed there. In general, students have shown greater flexibility to transition to the online environment. More than half of them would like to have fully online lectures; there was also great support from this group in the case of consultations with teachers. Teachers are apparently more conservative. Most of them can imagine that lectures and consultations with students would be partly managed online (except for Czech teachers, where more than 58% agree that lectures should be fully online). On the other hand, the vast majority of both students and teachers believe that the remaining parts of the teaching process should be preserved mostly on site (in person). The managers of universities have been asked the same questions. The results showed that they quite strongly support the use of the online mode for all processes, where students and teachers prefer it also. Their support of the distant setting is even stronger for consultations between teachers and students. The detail results are provided in Table 4.

Table 4. Results of preferences for the future

Lectures	Never	Partly	Mostly	Absolutely	I d't know	Lectures	Never	Partly	Mostly	Absolutely	I d't know	Lectures	Never	Partly	Mostly	Absolutely	I d't know	
S	4%	4%	25%	65%	2%	S	3%	6%	18%	73%	1%	S						
T	0%	15%	59%	22%	4%	T	7%	39%	26%	25%	4%	T	10%	44%	0%	38%	8%	
M	0%	17%	83%	0%	0%	M	17%	42%	42%	0%	0%	M	0%	88%	0%	0%	13%	
Seminars																		
S	24%	25%	30%	20%	1%	S	27%	28%	27%	18%	1%	S						
T	41%	30%	19%	11%	0%	T	47%	32%	18%	2%	2%	T	13%	44%	0%	35%	8%	
M	67%	33%	0%	0%	0%	M	50%	50%	0%	0%	0%	M	13%	38%	0%	38%	13%	
Consultations																		
S	8%	16%	41%	33%	1%	S	4%	13%	27%	53%	3%	S						
T	4%	4%	41%	48%	4%	T	4%	8%	32%	54%	2%	T	12%	33%	0%	48%	8%	
M	0%	17%	50%	33%	0%	M	8%	8%	42%	42%	0%	M	13%	50%	0%	25%	13%	
Credits																		
S	10%	18%	31%	37%	4%	Diploma semi	9%	13%	25%	50%	3%	Credits						
T	52%	15%	15%	15%	4%	T	8%	16%	41%	27%	9%	T	Missing data					
M	100%	0%	0%	0%	0%	M	8%	25%	42%	25%	0%	M						
Exams																		
S	13%	19%	30%	34%	4%	S	11%	15%	24%	43%	6%	S						
T	59%	7%	19%	11%	4%	T	59%	23%	7%	6%	4%	T	54%	27%	0%	10%	10%	
M	100%	0%	0%	0%	0%	M	75%	25%	0%	0%	0%	M	63%	25%	0%	0%	13%	
Final exams																		
S	Missing data					S	21%	15%	13%	39%	12%	S						
T	Missing data					T	53%	23%	2%	12%	10%	T	63%	17%	0%	10%	10%	
M	Missing data					M	42%	25%	8%	25%	0%	M	63%	25%	0%	0%	13%	

(S=Students, T=Teachers, M=Management)

The principles of the online mode and this advantage will persist for some time in the future also. Of course, it would be necessary to maintain it (or improve it), otherwise it can be lost. For example, teacher mobility programmes will return to the traditional way. Teachers will be again faced with how to find space to teach missed lessons in usually tight semester time slots. But they will be able to connect during their stays and provide lectures online. It will be a win-win strategy for teachers, students, their home institution, and host institution. Additionally, some elective courses can be taught by leading experts on board. They might travel for the key seminars; defences of seminar works and exams.

7 Evaluation of hesitance

In this section, the hesitance in the answers revealed by the respondents is investigated. Statistical analysis is performed to explore the dependencies among the answers of teachers and students, then the fuzzy functional dependencies between hesitance and motivation to work hard are explored.

Namely, the following questions have been investigated:

1. Is there a difference in the hesitance between teachers from different countries?
2. Is there a difference in the hesitance between students from different countries?
3. Inside each country, is there a difference in the hesitance between teachers and students?

To answer the questions above, we used:

1. Chi²-homogeneity test in contingency table (to determine the proportions of responses from more populations with regards to the categorical variable).
2. Wilcoxon test (to determine if the mean values of hesitance evaluation of two dependent groups differ significantly).
3. McNemar test (to determine if the proportion of hesitance of categories at two time periods significantly differ from each other).

More information about these tests can be found in, e.g., Agresti and Franklin (2007).

In Question 1, there were no statistically significant differences in reluctance between the Czech and the Slovak teachers. However, compared to other countries, Polish teachers were more cautious. When examining students (Question 2), it was discovered that Polish students are the least hesitant, while students from Slovakia were the most hesitant. Finally, the comparison of students and teachers within their own countries (Question 3) showed a statistically significant difference only in the case of Poland. Polish teachers were more hesitant than Polish students.

Second, using the McNemar test, we evaluated changes in hesitance over time (before the pandemic vs. during the pandemic) for individual questions and respondent groups. Of 13 different combinations of question groups where a statistically significant

change occurred, an increase was observed in 10 cases and a decrease was observed in 3 cases. These statistically significant changes are summarised in Table 5. It is worth noting that in many cases the change was relatively small. Considering, for example, the last record in Table 5, of the total of 333 responses, we saw a decrease in hesitance in 26 cases, and 14 students actually became more hesitant.

For further details, see Hudec et al. (2023).

Table 5. The results of the statistical analysis (McNemar test)

Question	Group	Significance of change	Increase in time	Decrease in time
Do you think that the exams are fair?	CZ-Teachers	**	10	2
Do you feel motivated enough to work hard?	PL-Teachers	***	33	8
Do you find your lessons attractive enough?	PL-Teachers	***	16	3
Do you think that the exams are fair?	PL-Teachers	***	14	2
Do you consider the course evaluation at the end of the semester beneficial?	PL-Teachers	**	7	0
Are you satisfied with the quality of digital communication with students?	PL-Teachers	*	15	6
Do you feel motivated enough to work hard?	CZ-Students	**	50	31
Are you satisfied with the quality of digital communication with teachers?	CZ-Students	**	8	23
Do you feel motivated enough to work hard?	SK-Students	**	60	31
Do you find the lessons attractive enough?	SK-Students	*	30	16
Do you think that the support by digital materials for courses is sufficient?	SK-Students	*	4	12
Do you find the lessons attractive enough?	PL-Students	**	29	14
Do you think that the support by digital materials for courses is sufficient?	PL-Students	*	14	26

Table 1: List of questions - respondent group pairs with statistically significant change of the hesitance over time. (* for $p < 0.1$, ** for $p < 0.05$, *** for $p < 0.01$)

8 Key findings and lessons learnt

The following conclusions can be drawn on the basis of the research performed:

- The proportion of positive opinions with performance differs with the explored countries, as well as with the stakeholder group, and the time period.
- In general, the institutions' management and the study affairs department staff were more satisfied than the students and teachers.
- In most cases, a similar pattern of satisfaction of students and teachers has been identified: a drop in satisfaction occurred at the beginning of the pandemic, and it increased back after the pandemic.
- The most significant decrease at the beginning of the pandemic was recorded in Portugal among teachers and students. This is probably due to the mentality that strongly prefers personal contact.
- The only stakeholder group revealing that most of the respondents are dissatisfied is the Slovakian IT department, mainly due to satisfaction with the IT equipment and poor fairness of the test in the online environment.
- Motivation to work hard for both students and teachers decreased at the beginning of the pandemic and has not recovered back to the pre-pandemic level yet.
- The pandemic helped to increase the support for electronic materials in all countries.
- The attractiveness of the lessons in the online environment is lower than in the classical regime. This is caused by the lack of social contact and, at the beginning of the pandemic, also by the lack of skills with the online environment.
- All respondent groups are aware that the fairness of the test is substantially lower in comparison to the classical regime.
- In general, direct communication with teachers continuously improved – this is proof of the high flexibility of teachers.
- Direct communication with students decreased substantially at the beginning of the pandemic in all countries. It is more difficult to make students more active when they are online.
- Most technical issues improved during the pandemic in all countries for all stakeholder groups: technical support, HW equipment, and SW skills.
- Mostly, students and teachers would prefer to keep at least part (or all) of lectures online in the future, as well as consultation between teachers and students. On the other hand, there is more or less a consensus that seminars and exams would have to be online only exceptionally in the future.
- Polish teachers revealed the highest level of hesitation in responses when considering included teachers.



- Slovak teachers revealed the highest level of hesitance in answers, and Polish students revealed the lowest hesitance when considering included teachers.

Based on the conclusive statements above, the following challenges would be:

- Keep up the skills and knowledge of online teaching – do not ignore this option even after the pandemic.
- Find some ways how to make exams in the online environment fairer.
- Use the acquired HW and SW skills for alternative communication between teachers and students (e.g., consultations, discussions...).
- Find ways how to make online teaching as attractive as in-class lessons. This could potentially be solved if only lectures and consultations were organised online.
- Find ways how to make students more active during the lessons. This could potentially be solved if only lectures and consultations were organised online.
- Maintain the quality of the support through electronic teaching materials in the future.
- Set up the rules for how to combine online and in-class sessions to take advantage of both.
- Offer a hybrid form of teaching where possible to give a choice to students, which form is the most suitable for them.
- Share best practices across universities.
- MS Teams turned out to be the best option for online teaching during the pandemic.

9 Conclusions

The survey carried out attracted multiple contributions. First, a very complex model, portable to any university (and after some modifications also to secondary schools) has been developed. Second, all important stakeholders at universities have been asked to get a better picture of the situation. As Duraku and Hoxha (2020) claimed, the satisfaction of different stakeholder groups is expected to be significantly dependent. Third, we allowed the respondents to express their feelings in a very precise way since they could answer how hesitant they feel in their answer and how important a given factor is for them.

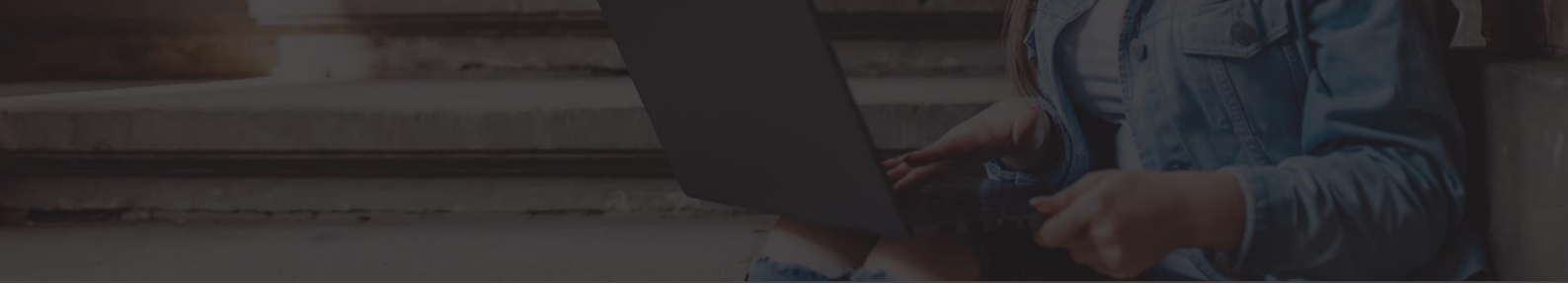
Regarding the results, it is quite surprising that all partner universities revealed a similar pattern in the answers. We confirmed the conclusions presented by Shim and Lee (2020) and Means and Neisler (2020) which showed that it is more difficult to keep the motivation of students and teachers in the online regime in comparison with the regular face-to-face option. Overall satisfaction dropped with the switch to the online environment and returned at the end of the shutdown. On the other hand, the results showed significant progress during the pandemic in terms of almost all the criteria considered. The conclusions were further confirmed by the results from Slovakia, where distance learning was still applied even at the time when the survey was launched. It was the only country where satisfaction did not return to pre-pandemic levels. We can only guess if the decrease in satisfaction during the pandemic corresponds to the negative impact on mental health, as Akour et al. (2020), and Hoofman and Secord (2021) claimed in their studies. Despite the decrease in overall satisfaction with distance learning, we should emphasise several important benefits: better support by digital materials, better skills with distant communication, improved SW and HW support. These benefits probably cause that most of respondents (from all stakeholder groups) would prefer to keep selected processes online even when schools are re-opened. Lectures and general consultations of students are good candidates to maintain (and improving) the skills acquired during the pandemic.

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APPENDIX



Python code

Fuzzify and aggregate distance learning survey results

We start by importing required libraries

```
import csv

import numpy
from matplotlib import pyplot as plt
```

We tell Jupyter where to find the survey results

```
FILE_PATH = '../tram_residents.csv'
```

We start the processing by loading the responses. Each line in the CSV file contains the answers of a single respondent. `csv.reader` automatically creates a Python tuple for each row.

```
respondents_answers_raw = []

with open(FILE_PATH, 'r') as fd_survey_results:
    csv_reader = csv.reader(fd_survey_results)
    csv_reader.__next__()
    for respondent_raw in csv_reader:
        respondents_answers_raw.append(respondent_raw)
```

Now we use the text-number maps to transform the answers of all respondents to a numerical form This will create a `(degree_of_agreement, hesitance)` tuple for each answer.

```
def answers_to_numbers(respondent_answers):
    num_questions = int(len(respondent_answers[1:]) / 2)
    answers = [respondent_answers[i*2+1] for i in range(num_questions)]
    hesitations = [respondent_answers[i*2+2] for i in range(num_questions)]
    answers = list(map(int, answers))
    hesitations = list(map(int, hesitations))
    answers = list(zip(answers, hesitations))
    return answers

respondents_answers = list(map(answers_to_numbers, respondents_answers_raw))

for r in respondents_answers:
    print(r)
```

```
def fuzzify_answer(answer):
    core = answer[0]
    spread = answer[1]
    left = max(1, core - spread)
    right = min(5, core + spread)
    return left, core, right

def get_mean(answers):
    core = numpy.mean([a[1] for a in answers]) # Simply the mean of all cores
    left = numpy.mean([a[0] for a in answers]) # Simply the mean of all left borders of all supports
    right = numpy.mean([a[2] for a in answers]) # Simply the mean of all right borders of all supports
    return left, core, right

respondents_answers_fuzzy = list(map(lambda r: list(map(fuzzify_answer, r)), respondents_answers))
respondents_means = list(map(get_mean, respondents_answers_fuzzy))

for i, r in enumerate(respondents_answers):
    print(i, 'Answers:', r, 'Mean:', respondents_means[i])
```

```
for i, answers in enumerate(respondents_answers_fuzzy):
    plt.title('Respondent %d' % i)
    plt.figure(figsize=(10, 5))
    for answer in answers:
        plt.plot(answer, [0, 1, 0], color='#5588ff', label=str(answer))
        plt.fill_between(answer, [0, 1, 0], color='#5588ff', alpha=0.3)
    plt.plot(respondents_means[i], [0, 1, 0], color='#ff8855', label=str(respondents_means[i]))
    plt.fill_between(respondents_means[i], [0, 1, 0], color='#ff8855', alpha=0.3)
    plt.xlim(0.5, 5.5)
    # plt.legend()
    plt.show()
    plt.close()
```

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