

# Comparison of Pandemic and Post-Pandemic Education at Higher Education Computer Science Course

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**Abstract** - Many people see the period of COVID-19 pandemic as a challenge. This period causes many challenges in the teaching process. The post-COVID-19 period is also full of challenges. E-learning is an integrated part of classical education. It opened a new space for students and teachers. We provide the subject Informatics I at our faculty. We assumed that this subject is easy to pass, but the opposite is true. The proof is the repetition of the subject by a high number of students. Our goal is to investigate the reasons of failure on the form of teaching during and after the pandemic. Therefore, we approached students who participated in both forms of the educational process of this subject. We investigated the obstacles in education that they had to overcome during individual periods. We were interested in what they consider positive and negative in both forms of learning. These results will better help us design the structure and organization of the subject. This contribution is aimed at identifying problematic parts of the educational process.

**Keywords** – comparison, education, pandemic, COVID-19

## I. INTRODUCTION

As Albert Einstein once said: “*It is the supreme art of the teacher to awaken joy in creative expression and knowledge.*” We, as university educators, are always trying to achieve this in our teaching process.

The education in the field of basics of informatics is provided at our faculty to students at the first year of study. If students are not successful in finishing the course, they might repeat it in next year of study. The rate of the repetition of this course is relatively very high. It is important to identify reasons why some of the students are not successful to pass the subject in the first semester of their university study. Whether it lies in students’ attitude to the study (their insufficient preparation, problems to adapt to demanding education process etc.) or it is caused by inappropriate teaching method.

Also the COVID-19 pandemic didn’t help us with answers. Social distancing during the pandemic could also be the cause of students’ failure and low level of knowledge to pass the exams. But when the face-to-face learning came back, and results were not any different. Multiple students took part in the course in both forms of education due their repetition of the course. So, students’

experience with both types of learning can be compared, as it might be interesting issue to investigate the reasons of failure in the course completion on the form of education during and after the pandemic. Therefore, we approached students who participated in both forms of the educational process of this subject.

## II. COVID-19 PANDEMIC EDUCATION CHALLENGES AND CHANGES

The shift to distance learning has had a significant impact on students’ lives, access to resources and technology, digital literacy, and mental health. Many world universities, as well as ours, closed on-campus residence halls, forcing many students to return home to their families and continue their education via distance learning. When learning from home, many students faced challenges, including family conflicts and obligations and lack of adequate resources. Without the right environment, students found it difficult to concentrate while learning. This affected student’s mental health [1], [2], [3]. Up to 42% of university students reported feelings of stress, depression, and anxiety while learning from home [4].

However, the essence is the realization of one fact. A successful transition to higher education requires that the learner learn how to adapt to educational requirements, i.e., how to become an effective learner. Effective learning occurs when the learning leads to the desired outcome. It as long been known that learner’s success, as evidenced by continued study, is influenced by student attributes and experiences combined with institutional factors. These attributes include prior educational achievement, family history, and personal ability, while institutional factors focus on performance during study and interactions with faculty [4], [5].

Because of the switch to distance learning, faculty and students have had to quickly learn how to use the new software for their courses. Also, the need for digital education platforms, internet access, and technological devices increased. Because computer science is also taught during normal teaching in the digital world, teachers were more confident and positive about the transition to distance learning than teachers in other disciplines [4], [6], [7].

Radić et al. also found that despite the change, students' grades were in the average range and students were very satisfied with the quality of instruction [8], [9]. In addition, flexibility and access to course materials during distance learning have been improved. While studies show that Computer Science Education has been influenced in some ways, it is unclear how these students' study habits have changed [1], [10].

Cooperative learning structures and processes increase academic achievement, enhance lifelong learning competences and develop the personal and social competences of every single learner in a more effective and fairer way when compared to traditional structures of learning in schools. In a traditional classroom structure there is usually one type of interaction, with the teacher the principal participant. The teacher makes a presentation, asks and answers questions, shows materials from the Internet, checks and discusses individual learning behaviors. These interactions are mainly conducted in the presence of passive listeners. How can a teacher deconstruct these traditional structures of interaction in a classroom practice to provide personal and individual access to learning interaction as many participants as possible during classes? That is the reason why we completed this principle with „personal involvement“, which means that a cooperative teacher should provide interactions in which every single class member can participate with his/her full personality [11].

### III. THE COURSE OF INFORMATICS I

The course of Informatics I is a compulsory subject at our faculty. Our students have majored in Economics but it is indisputable that, the basics of informatics are necessary for their future careers. The course Informatics I reflects the demands of the labor market and the situation on the market with information technologies and therefore it is always updated (similarly as the tools used in the course).

#### A. Course education goals and content

The aim of the subject is to provide students with basic knowledge, skills and competences based on knowledge of informatics and information technologies. The subject deals with the basics of information theory, the basics of ICT, the basics of algorithmizing and programming in a programming language R, the basics of networks and network communication, the security of data protection and the principles of network communication security, and finally, the possibilities of cloud solutions and their use in the business environment.

After completing the course, the student should achieve:

- *Knowledge* - basic terms in the field of information theory and ICT, terms in the field of computer hardware and software, algorithmizing and programming languages, cloud technology and cloud services, terms in the field of computer security and communication security through an open Internet environment.

- *Skills* – passing the course students achieve ability:
  - to safely protect personal data and face attacks from the Internet,
  - to create simple algorithms and programs in the currently taught programming language and algorithmically solve given problems,
  - to process data using selected ICT tools and programming languages,
  - to create a simple HTML page.
- *Competences* – the subject significantly develops logical and critical thinking, provides the ability to navigate in the environment of various ICT tools used and then use them to handle simple problem tasks. Through the defense of an independently prepared semester project, the student develops the ability of presentation, communication and argumentation. The subject is followed by almost all subjects taught in higher years of study.

The mixture of classical and alternative teaching methods is used during the course realization. During the semester, students work out problem assignments in the software currently being taken over, the emphasis is on self-study and then consultations on the problems that have arisen. During the semester, they develop a complex semester project on a given topic and, after handing it over, defend the given project to the teacher through a presentation. As exposure and fixation methods, we use: classic (frontal) and interactive lecture, explanation, repetition, consolidation and practice of the subject matter, as well as discussion during the exercises.

The nature of the subject requires methods of independent student work, work with information sources, self-study of relevant literature.

#### B. Changes done during the COVID-19 pandemic

COVID-19 attacked world in enormously fast pace. Healthcare professionals, politicians and also us teachers had to adapt in a short time and prepare for functioning in this period. Considering the difficulty of the situation we searched for options how to make it easier and upgrade the realized course to be more interesting for students while they miss social contact and motivation to study regularly, because of the shift to online education. Nobody of us was experienced with full distance learning in our courses, but we try to the best implementing our personal experiences from already attended online courses, webinars and our experience with part-time students who were educated this way before the COVID-19 pandemic. Besides the supportive study materials that were already published on course LMS Moodle page, we came up with necessary news within the course:

- *use of the videoconferencing system MS Teams* to replace missing face-to-face lessons that were held in PC labs. This system was used also to support fast message exchange between students and teachers, so provided us more flexible and supportive approach to students who identify any

kind of problem while they are studying particular topics.

- *different kinds of supportive materials* like video tutorials, e-books, and online activities that are aimed to enhance students learning regularly. One of example were extra activities that are optional, but they were concerned especially on further development of achieved skills and implementation them while they are solving the problem connected to real life. Materials and activities were published to our students on the Moodle course page. The developed video tutorials seemed to be the best option for help for those students that had some problems during our live online session. It provides the to study at their own pace at home. The videos consisted of commenting on the task development process. We also gave students option to participate in teaching by making those videos themselves. After creating the video, they received points for activity. That scoring system helped with better motivation of our students, and they also practiced and consolidated their knowledge.

These materials and activities were updated every year based on the expectation and problem identified by education process. Nowadays they are used as materials for the students, despite the fact that we already teach the subject in an original pre-covid regime, i.e. face-to-face in PC labs.

#### IV. RESEARCH ON INFORMATICS I COURSE

As was mentioned above, during COVID-19 we were forced to change our education style and also students need to change their learning style. We designed and developed a mass of study materials and different supportive assignments, exercises, etc. to help students successfully pass the course Informatics I. However, we have had students who have not been successful in their studies of this subject. These students attended thanks to the pandemic situation the course in two different modes – fully online and face-to-face learning. We are interested in their opinion on the education process of the course Informatics I. They were asked to compare both modes and define benefits and shortcomings that helped or didn't help in their study of the subject Informatics I.

After passing the course this academic year we asked students to answer the feedback questionnaire that contained the questions concerning the course content, developed study materials, e-books and video-tutorials. They were asked to identify the main issues that problems due to which they could not successfully finish the subject during the pandemic.

To answer the feedback were asked just students who were not successful last year and attended the course again this academic year. Their opinion is important because they can compare both modes of realizing the course – online and face-to-face and achieved outcomes help us to identify the problems and develop materials and implement changes that could be helpful independently in the pandemic situation. We collected data from 28 students who participated in both forms of the educational

process of computer science. Using descriptive statistics, we analyzed the problems and came to conclusions that we will try to implement as much as possible in the creation of the course.

##### A. Data and methods

This is an online study based on a survey of 60 students who participated in both forms (Pandemic and post-pandemic education) of the educational process of this subject. The survey was optional, so unfortunately we received feedback just from 28 students, which represents almost half of the respondents.

To collect the information, an online survey was conducted from December 17 2022 to January 27, 2023. A link to a structural questionnaire (<https://tinyurl.com/32zz4k23>) created using Microsoft Forms was sent by email to students. It contained 56 questions (closed, opened) about the different components of the education process. The questions were compiled after studying scientific articles [1], [3] with a similar issue and then after a departmental discussion and an open discussion with students.

The simple percentage distribution was estimated to assess learning status, type of learning, opinion on educational decisions, and problems related to studying due to closure.

##### B. Results and discussion

Because during COVID-19 pandemic the lectures and seminars were shifted to online space, we were interested in the different aspects of online learning: students' need to be interactive during the lessons, the application that was used for the lecture or seminar, the way how the lectures and seminars were realized and content presented, etc. Because the lectures and seminars are realized by different methods, we decided to evaluate every part differently (i.e. online – lectures, seminars and face-to-face – lectures and seminars). Out of 60 survey questions we decided to present the most interesting and unexpected ones in next parts.

###### 1) Online lectures

Of the students surveyed who took online courses, 64.3% took online courses daily, while 35.6% of them took online courses mostly. The lectures were mostly understandable for 71.4% of respondents. Even though 60.7% of students said that the content of the lectures corresponded to the tasks solved at the seminars, for 67.8% of them lectures did not help them solve the problems with the tasks at the seminars. Here the question arises, if the lectures are created in an interesting way, including the practical part of this subject, or is it just a theory that the students aren't able to connect it with practice. We can deduce the answers from the questions aimed at the online seminars.

###### 2) Online seminars

All of the students were attending seminars on weekly basis. The main problem that answers our question is that only 50% of the students regularly prepared for the seminars and 42.9% of them actually read the materials and instructions. Second problem is active involvement of

students during online seminars. Namely 78.5% of them were passive during the lesson (Fig. 1). We can't expect high results with low preparation and a pinch of effort. Up to 10.7% of students for whom the content of seminar was not clear, did not try to solve it in any way, left it as it was. Fig. 1 illustrates these results.

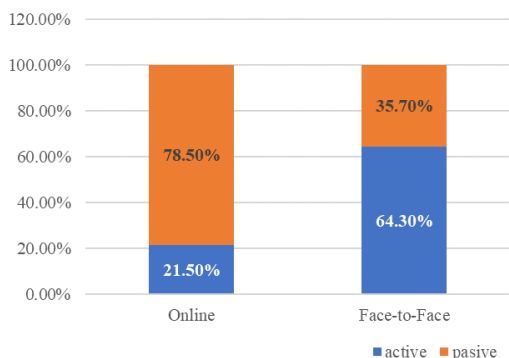


Figure 1. Students' activity during seminars

Communication is the basis of functioning. During online seminars, 64.3% of students felt a deficit of social interaction with classmates, which leads to stress and depressed emotions. In lectures, up to 57.2% (Fig. 2). In compared to West Bengal [4], where up to 42% of student felt stressed followed by the absence of a favorable environment to study at home. Up to 32,4% of their students had problems with internet connection. Even though our students have better conditions at their homes, as for the internet connection, they still felt more stressed and depressed. Still the main problem, due to our conditions, that can reflect the quality of seminars is the fact that 17.8% of our respondents addressed the frequent dropout of the internet connection. The use of cameras during online learning is another interesting capture. People are used to a kind of anonymity in the internet environment. They have freedom of speech, they can write where they want, what they want. This was reflected in online learning.

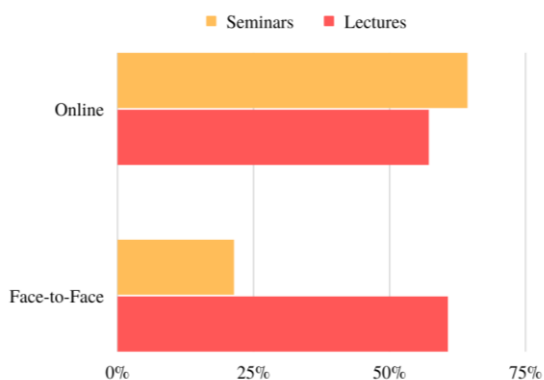


Figure 2. Deficit of social interaction during seminars and lessons

As our survey says, up to 67.9% of students had the camera off during online classes. It was due to discomfort feelings and shyness in front of classmates (Fig. 3).

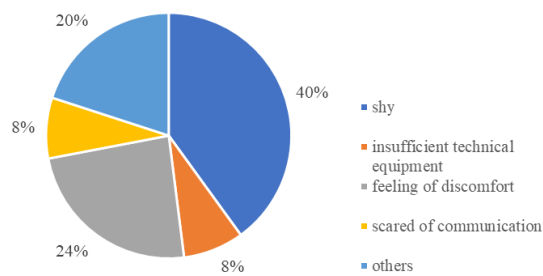


Figure 3. Reasons of not using camera during online lessons

### 3) Face-To-Face lectures

With the advent of face-to-face lectures, we can see a drop in attendance by 21.4%. The lectures were mostly understandable for only 42.8% respondents and 53.6% of them were confused. Even though 42.9% of students said that the content of the lectures corresponded to the tasks solved at the seminars, we can see a small improvement in lectures. From 67.8% online problems, now it is only 50% of them that lectures did not help them solve the problems with the tasks at the seminars. The question again arises. Why is that so? Did the lectures really improve or was there a problem in personal communication and motivation?

### 4) Face-To-Face seminars

Mostly all of students (96.5%) were attending seminars on the weekly basis. Yes, it is a bit lower number, but we can say that all of them were directly focused on learning. But still the main problem, which is regular preparation for the seminars, didn't improve. We are on 50% of students that are preparing regularly and only 42.9% really read the materials and instructions. But a high shift for the better occurred in activity of the students. Up to 64.3% of students were active during seminars (Fig. 1). If something wasn't clear, 82.2% of them asked teacher for help and 78.5% ask their classmate.

These results came in response to improvements in social interactions at seminars. Through the lectures only 39.3% of students were positively influence by social interaction with classmates and during seminars it was up to 78.6% of them (Fig. 2).

The question is, why less students were positively influence by social interaction at face-to-face lectures than online. Maybe we should focus more on interactive lectures using recommendations from students.

## V. CHALLENGES AND RECOMMENDATIONS

### A. For students

The most common recommendation was regular preparation for classes. Through our survey we find out that just a small percentage of students were really preparing for classes. Therefore, we are pleased to see students' awareness of this problem. Also, in Slovakia we tend to say, "Fortune favors the bold". Unfortunately, our students understood this only after completing the course. Because another common recommendation was for

students not being ashamed or scared of asking questions that they are not understand.

Very helpful for them was when they took notes in words, not only functions from the seminar. And the last very important is study hour. Which is alfa and omega at university and a lot of new students are not used to this style of teaching.

#### B. For teachers

Students perceived the high speed of learning and asked for video recordings of seminars. The video assignment solutions were therefore provided to students. Then teachers could focus on the problematic parts of the assignment and thus slow down the pace.

For better student motivation, they would like to have points from assignments added to the credit not to the exam. In most cases, successful achieving of credit tests is the main problem for students within the Informatics I course. This could be also good motivation in regularly preparing and working out assignments and it could help with better understanding the problematic of subject.

### VI. CONCLUSION

As the online world is saturated with information, young people have difficulty distinguishing the importance of information, selecting the unnecessary and consolidating the necessary information. It is necessary to connect this Informatics I course more with practice, to show them the concrete use of the programs with which they work during their study within the course. A significant problem, that was captured by the questionnaire, was the impact of online teaching on the psychological health of students. The lack of direct interaction with classmates and teachers, feelings of loneliness and senselessness of what they do, what they learn, led to depressive states and stress which we analyze in part IV. All these aspects have been underlined by the COVID-19 situation. Our feedback outcomes correspond with the findings of other studies (e.g. [12], [13]).

However, the onset of the post-COVID-19 period did not bring the expected positive changes. The post-COVID-19 period was and still is marked by a tense situation in the world in relation to the war between Ukraine and Russia.

From the results of the responses to the open-ended questions, it can be concluded that in the post-COVID-19 period, with the start of face-to-face classes, there have been slight positive changes in terms of the success of the course Informatics I, despite the negative impact of the political-military world situation on the students' psyche. An important finding is that the face-to-face form of learning is more beneficial and satisfying to students than the online form. From the students' point of view, the problem with both forms of teaching was also the fast pace. It seems that another chapter of failure in passing this course, in both forms of instruction, is the indifference of the students and their lack of regular preparation. This course is taken by first year students. Therefore, failure can also be connected with unpreparedness for university

studies, the basis of which are self-study, but also to the student's own inner motivation.

We evaluate this survey as useful for us teachers. It has helped us to think better about an unflattering trend that has accompanied us and the students in recent years: the repeated completion of the course Informatics I. The results of the questionnaire not only gave us a high information value about the Informatics I. teaching itself, but, what is very important in today's difficult times, it captured the issue of the influence of the online world and teaching in it and its impact on students' psychological health. These forces us to reevaluate the content (prioritizing quality over quantity) as well as the form of face-to-face teaching of Informatics I., in the hope that the future new approach to this subject will bring about positive changes in student outcomes.

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