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THE SHIFT TO ONLINE TEACHING OF TECHNICAL SUBJECTS DURING THE PANDEMIC

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Abstract

The aim of the article is to compare the results of the study before and during the pandemic. It is also a reflection on what we experienced and how we undertook pedagogical work with students in critical teaching conditions. The coronavirus pandemic brought about an unexpected and rapid change in all aspects of education. It seems like neither the teachers nor the students were ready. The article describes how the transition to online teaching took place overnight. It describes how technical subjects were taught and examined in a new online environment. This is about how the students evaluated that form of education in the subjects of 'Heat Treatment and Metal Surface Treatment' and 'Material Science I'. The results of the study confirmed that even in the conditions of complete separation in the social and work contact, it is possible to study by conscientious preparation and self-access.

Keywords

Online teaching in technical subjects, evaluation of subjects after the pandemic, using programs in online teaching

INTRODUCTION

Changes in the pedagogical process are mostly associated with planned reforms of the pedagogical process. Introducing novelty is part of the teacher's daily job.

The scientific disciplines of didactic and pedagogy are a constant subject of human interest. It is a manifestation of knowledge and a pursuit of continuous progress [1]. Neuroscience, among many other fields, has become extremely important. Non-scientific views innovate approaches to motivation, to teaching methods, and to the emotionalization of teaching.

In the past, J.A. Comenius (1592 – 1670) the great teacher of nations, determined the didactic principles that formed the basis of teaching of his time. There were around 200 of them, and they related to face-to-face teaching. They addressed not only the content of teaching,

motivation, harmonization of pedagogical systems, but also the course of social relations and activities of students in the process of education.

Today, it is often emphasized that a person is not capable of knowing everything due to the influx of information. Polymaths simply do not exist in our era. Each person has to develop knowledge in the chosen field and maybe use creativity to come up with new ideas, experiments, etc. The latest trend in education is the one that does not end with the completion of school/university at various levels, but a lifelong process.

Are we already living at a time of online learning, and the pandemic has just accelerated it? Are we just on its doorstep? We return in a spiral to the past, where the professor taught his students at home. He passed on his knowledge to them. As mentioned before, the amount of knowledge back then cannot be compared to the present. The professor lived for them and was in close contact with them. It is questionable whether it is possible to apply it in this world of diverse knowledge and information. Perhaps, it can be applied in a narrow specialization. How and under what conditions can a teacher himself develop to such a high level of knowledge and then pass it on? For now, the only thing we can do is wait and see how this will unfold.

At present, you can feel the effort to improve the conventional model of teaching. Teaching becomes truly effective and prepares creative graduates with rich knowledge. In addition to the emphasis on new knowledge, it is also required to apply skills in practice. That is why we have to look at the problem from a different point of view, which is what we try to teach this generation. This view is a characteristic of our students - Z Generation, for which the use of technology and the Internet, drones, and virtual reality is typical [2]. It is the generation of people born between 1996 and 2009. Coming after the generation of "millennials", also referred to as Y Generation. For the previous generation, the central tool was the mobile phone. The demands of this generation for the employer and the expectations from the working regime are completely different from those that employees had 20 years ago. This phenomenon of the digital generation and its influence on the labour market can be observed mainly in the reality of the jobs currently available.

The terms such as flexible working hours, the possibility of home-office, or employee benefits dominate here.

In all the developed countries of the world, there is an effort to find, define, and develop competences that would be useful in most (even in not yet existing) professions. These would enable an individual to hold a number of positions and functions and perform various professions [3]. They would be suitable for solving a whole range of mostly unpredictable problems and would enable an individual to successfully cope with rapid changes in work, personal, and social life. They are called key competencies.

The primary competence is the competence of learning [1]. Of course, it is not only about the student acquiring a lot of knowledge, but above all about working on it based on his/her own activity and solving various problems. So that the student learns to manage his/her activity, to be able to evaluate it, set goals, and constantly improve himself. The development of original thinking is a competence that we are convinced of especially by the results of international comparisons, where the emphasis is placed on the results rather than the path in which those results were reached.

The competence of search and investigation is a less well-known, but also a less appreciated competence. Its essence lies in the fact that the student is led to search, discover, compare, etc. the present with the past.

The competence of improvement is expressed in such a way that students must be systematically guided to learn to critically evaluate their work, to set tasks for self-development, etc. The literature talks about more competences, for example, communication, cooperation and also pro-activity. Many more competencies could be listed, both in relation to teachers and in

relation to students. How to apply them under the conditions of a pandemic without real contact between the teacher and the student?

The introduction of any novelty in the field of education is primarily based on the effort to make education processes more efficient and improve the quality of their outputs [4,5]. The development of critical thinking in teaching is still a topic of current and discussed. Many experts agree that it is necessary to develop critical thinking at all levels of study [6]. It means that there are at least two meanings to the word 'critic'. Firstly, in the sense of examining the fact, the goal of which is to arrive at an evaluative judgment. Second, in the sense that it is an understanding of the term critic, as we often encounter it in common speech, i.e. as an unfavourable evaluation. The first meaning does not have a negative charge, but is more about evaluation, assessment, which, on the contrary, does not focus only on shortcomings, but rather its effort is to arrive at an optimal evaluative judgment. It highlights, e.g. positive and negative aspects of face-to-face and on-line teaching. An example of the second could be feedback from students to a teacher on shortcomings in teaching. Therefore, two possible approaches to the interpretation of critical thinking can be considered. It is difficult to say which of the terms was used by the students in their written statement regarding the evaluation of the subject.

Similarly to the case of the word criticism, here we also come across the multi-meaning of the word thinking. The first meaning approaches thinking as a mental activity in general, so any mental activity can be included here. So also perception, imagination, and memories. The second meaning understands thinking only as active understanding, i.e. it is only a subject's higher intellectual activity. How can this be perceived during online teaching when we cannot see each other and are deprived of emotion? Evaluation of the quality of teaching becomes a problem on the part of students and teachers.

Critical thinking is above all thinking without prejudice within alternative systems of thought, and to communicate effectively with others in search of solutions to complex problems.

Critical thinking is complex, which can be defined as the ability to think reflectively and independently [7]. Being a critical thinker takes some effort, and no one becomes one unless they develop the required skills through practice. Basic critical thinking skills include interpretation, analysis, reasoning, argumentation and evaluation.

The labour market of the 21st century is influenced by the demands that must also be reflected in labour regulations. Employers have been warning about the shortage for a long time. They claim a lack of qualified workforce, which causes greater competition on the labour market, and, at the same time, greater expectations of employees from the employer regarding the benefits associated with a specific job. The development of the labour market has recently been characterized by a lack of a labour force capable of performing the offered work [3].

The labour market is much diversified, and many students who finish the educational process have no idea what professions the practice requires. It is despite the possibility of information on the Internet today. The economic background of the students plays an important role here. If they are provided for by their parents, they are not looking for part-time jobs and do not know the world of the labour market. On the other hand, if they want to be independent of their parents, in contrast, they quite often find themselves on this labour market when they earn part-time jobs in addition to school. They gain additional experience that can orient them in this environment, or, in contrast, they might even lose the motivation to further their education and development. They choose the path of least resistance when approaching education. High school and university graduates can use this experience to their advantage.

METHODS AND RESULTS OF ONLINE TEACHING

Several aspects of educational changes have been published and proposed in scientific circles, but their practical applications have been sporadic. In online teaching, inappropriate technical equipment with computers was most commonly encountered. It has been hard to apply in reality. In an instant, everyone became virtually connected due to the pandemic. We were in different physical and mental states without social contacts. Applying policies was hard. First, the technical side of connecting in a virtual environment was addressed. After that, we asked how could we improve it or what else would be possible in this new environment. What are the students' reactions to the transmission of information and mutual interaction had to be solved in a live broadcast. The transition to online teaching was quick. Teachers and students were not prepared for it. In technical subjects, the curriculum is often explained using pictures that are gradually shown and explained. A problem arose because the blackboard and marker suddenly disappeared.

The drawing with the mouse on the screens was a huge effort for the hand, and the graphics of the images also suffered. It took longer to draw. It was necessary to switch to tablets, where this could be applied with an electronic pen. A different program was used in lectures and a different one in exercises. The programs had several options for teacher-student communication, which we gradually mastered. Assignments and all documents had to be saved in the folders under the specific name of the student. Teachers needed a space for uploading and downloading the assignment. The same applied for the credit and exam tests. New test combinations were developed for each exam. It was difficult to exactly measure the real knowledge of the students. What could students write in and copy from another source in a virtual environment?

Teachers lacked feedback on whether students understood the material. Though students could ask questions, they scarcely did so. They relied on the curriculum materials they could find on the topic in the Academic Information System (AIS) or in emails. How long could they keep their attention when they were not being observed? They could just join and not even physically be there. How did they manage to grasp online education? There are a lot of questions to which there are a lot of answers.

The students' reactions were different about how they couldn't keep their attention, they couldn't join the right group in the virtual class, the internet connection was failing, they were alone with problems and their solutions without social contact. It was necessary to create a group and discuss the problems in it. Has Z Generation become a victim of the Internet and its traps during the pandemic? What they used as a tool of entertainment and knew how to move in the virtual world of their interest suddenly became a problem. Online teaching was no longer fun, but a necessity for learning and mastering multiple tasks that had to be mastered in a relatively longer time than face-to-face teaching. This was no longer easy to do and was more of a hassle because there was a lot to do. Before they started to recover from it, they already felt tension and stress. In isolation, they had to perform various tasks that other people did for them at school or at home, e.g. cook something, go shopping, wash clothes, etc. The reality of a person depends on how he can control himself in a disciplined manner. It is very easy for a person to slip into the laziness that is so natural to him if he is not confronted by anyone.

Each virtual environment for online teaching has different options, so it was necessary to get oriented. It was practiced with the students during the exercises on how to send the answers so that they already knew it on the exam. If the Internet connection failed, nothing could be done. The exam (interim test) had to be repeated. In this case, it was very stressful and frustrating for the students. Technical equipment played an important role here, not only with computers, but also with the quality of the Internet connection. They often made the connection

via mobile phones and tablets or laptops at the same time if the camera on the PC failed. These were technical issues that had to be dealt with.

In the subject 'Heat Treatment and Surface Treatments' in the winter semester of the third year of bachelor's studies, teaching was carried out through Gmail and GSuite Classroom. It is a compulsory subject for students majoring in Materials Engineering and Production Technologies. A successfully completed course is worth 6 credits. This subject connects all knowledge from previous material subjects. Many topics are included in the State Exam for the B.Sc. study for both specializations. This fact should lead students to try to master the subject as best as possible, because it is already preparation for the state exam. It was not so according to the results of the exam.

They received the teaching materials through AIS in the form of emails. Classes were created for online teaching, through which two-hour lectures were held in a week. Two classes were created for the exercises according to the valid schedule and the exercises were also 2 hours per week. Two assignments were made on the subject and two tests were written on the practiced material. The four scores from the exercises are part of the assessment on the subject exam. Assignments were entered for elaboration via PC in pairs. Teamwork should contribute to building the ability to cooperate in solving technical problems. As an independent activity, they prepared and presented a Power Point presentation on various technical topics. It was also preparation for how to present at the Student Scientific Conference on-line.

The exam was held online and in the form of an individual test. The duration of the test was 1 hour. The test was corrected on the day of the exam, and after adding the points from the exercises on the day of the exam, the final grade was made. Errors in the test were consulted in writing via Classroom individually with each student.

In online teaching in the academic years 2020/2021 and 2021/2022, the final grades generally worsened compared to the years without the pandemic. This can be seen in the graphs in Figure 1 [8].

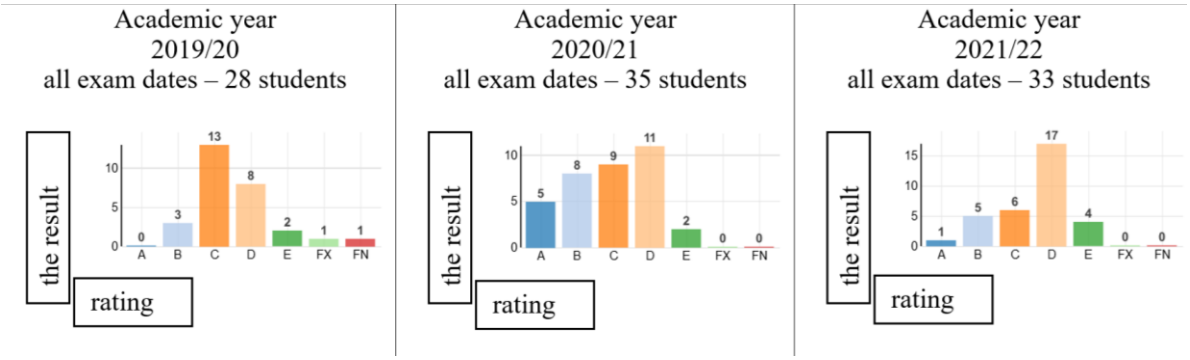

Fig. 1 *Assessment of success in the "Heat Treatment and Surface Treatments" subject*

The completion of questionnaires in the evaluation of subjects in AIS is done on a voluntary basis. A relatively small number of students participated in order to determine real feedback. Table 1 shows the number of students in the academic years of the pandemic.

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Table 1 Number of students who participated in the survey on the subject of "Heat Treatment and Surface Treatments"		
	Academic year 2020/2021	**Academic year 2021/2022**
Number of students in the subject Heat Treatment and Surface Treatments	38	36
Number of completed sheets / percentage	10/26 %	7/19 %

From the evaluation of the subject in AIS [8] compared to the years without online teaching, it is clear that the comprehensibility of the lectures and exercises did not change much because it was the same teacher. Changed attention retention during online teaching was very different compared to the face-to-face teaching method. In the privacy of the home, there are various altitudes to which the student can easily succumb. Then comes a period of procrastination and the resulting backlog of tasks. The subsequent realization of the fact that s/he does not have time to prepare for all subjects and a stressful situation immediately arises. Several students were able to catch up with everything when the face-to-face form of teaching was taking place, but, when online, they did not know how to properly control themselves and organise the time of the day reasonably.

They took an unreasonable amount of time to solve assignments and tasks. Social contact was also only online and, therefore, absent. All efforts to rely on the support of the whole group within the test in the exercises or in the exam were suppressed to a minimum. Each student had different questions and the length of the test was proportional to the number and difficulty of the questions. During the test, cameras and microphones were switched on. How the student prepared for tests and exams is only within his consciousness and conscience competence. In the virtual world, we do not try to prove to him that he used illegal means. That they tried to use them was found from the answers on the mid-term tests, where everyone (who practiced it) had wrong answers but written in the same way. That cannot be a coincidence, or could be a proof of sharing the wrong results. During the online exam, students had to develop and adopt a system of communication with the examiner. They also created a group where they shared their study problems.

For the subject of Science of Materials I., for the first year of Bachelor's studies, where there were more than 100 students in two parallels (up to 300 students in total), lectures were given via Microsoft Teams and the exercises were via Gmail and GSuite Classroom. The subject is in the first year and first semester for all areas of study at MTF. There are 6 credits for completion. In this subject, the theoretical and practical basis for many other subjects is obtained. Students, according to their focus of study, often behave in such a way that they just survive it with the expenditure of as little energy as possible.

They received the teaching materials via AIS in the form of emails, or found them in the subject's document server at AIS. For online lecture teaching, two groups were created in Microsoft Teams according to the schedule through which the 2-hour lectures were held. in a week. Classes were created for the exercises in Gmail and GSuite Classroom according to the current schedule. The exercises were also 2 hours per week. In AIS, test questions were prepared separately for lectures and exercises. These questions were always available in AIS. From these questions, four control tests were written throughout the semester, both from lectures and exercises. All students wrote the tests at the same time. It was possible to retry the test two more times. During the exercises, two assignments were prepared and submitted in the agreed form. The students could get a grade for the exam from them. There was a minimum

number of points that the student had to obtain in the exercises in order to take the exam (there were points from four tests and two assignments).

The exam was conducted in such a way that the identity of the student was initially checked. Two questions on PC and two questions on paper were prepared at the time and sent through GSuite and Classroom. It is proof that the student was really connected that day and class, and we also have his manuscript in the exam archive. Then, a test was carried out via AIS. All results of the exercises and the test were calculated and the test grade was on the day of the exam in AIS.

Figure 2 shows a graphic representation of the success of the exam in three years [8].

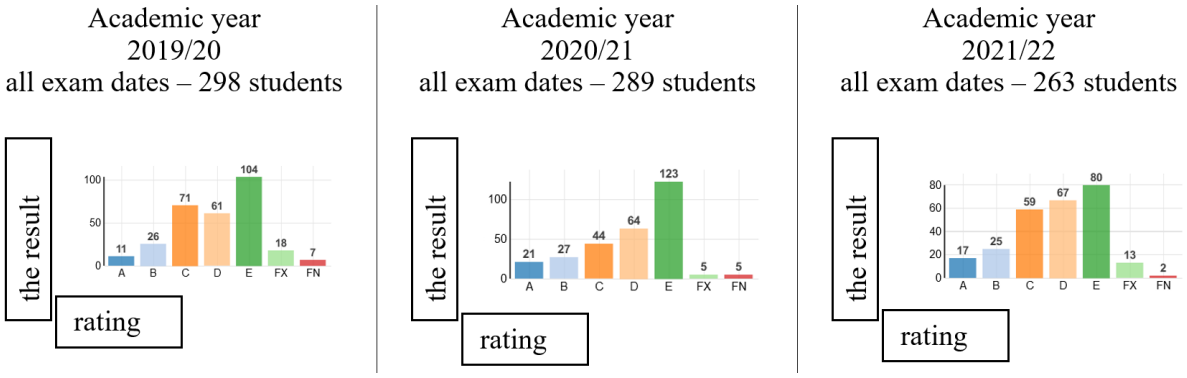

Fig. 2 *Assessment of success in the subject Materials Science I*

Due to testing during the semester, there were no rapid changes in the success rate on the exam. It has been confirmed that if a student continuously prepares throughout the semester, he is not exposed to stress before the exam. The exam is the culmination of the entire process of education in the given subject. If the student has been tested continuously, s/he performs in a familiar test environment, and the result is positive. There is more pressure to discipline oneself to test oneself every week during the semester. This could also be a guide on how to learn successfully in online teaching. Is the generation "Z" student able to prepare in this way? If a student studied what s/he really enjoyed and devoted himself/herself to it seriously, the result would definitely come. Those who study what really interests them have a great advantage. Table 2 shows the number of students who participated in the survey on the subject Materials Science I.

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Table 2 Number of students who participated in the survey on the Materials Science I subject

	Academic year 2020/2021	**Academic year 2021/2022**
Number of students on the subject Materials Science I.	471	422
Number of completed sheets / percentage	99/21 %	60/14 %

The table shows that in the evaluation of the subject Science of Materials I, it is clear that those who listened to the lectures, their interest in the subject was also supported by the teacher. If they attended only a few lectures, they did not express their opinion in the survey. If they are not interested in the materials, the teacher did not support their interest in the subject. Few students took part in the survey considering the number of people who graduated from that

subject. Therefore, it can be concluded that more detailed research would have to be done to obtain authoritative conclusions and results from online learning.

It is generally accepted that a child is born "unready", as a being that is richly endowed by nature with the prerequisites to learn. In order to become a person who can navigate their own environment, understand it, and actively intervene in it, they need other people. Close people and teachers who care for them and fulfil their needs [3]. It is their teachers and loved ones who are responsible for who they become...

The superficiality of today's world and the reluctance to go deeper are attributed to the possibilities we have. Not just for fun, work, communication, and access to information, but also in socialization. In general, we want to accomplish much at the expense of how we live. We say that we live fast, but it will not be time that passes faster, but rather by what we experience and how we experience it. It is up to us how we grasp teaching and in which direction didactic and pedagogy will go.

CONCLUSION

The facts found confirmed that if students study systematically even in the conditions of a pandemic, results will appear that are favorable for their studies. On the contrary, if they are not forced to study, the results do not appear, or are worse. Even in limited study conditions, the teacher must try to teach the subject with patience and enthusiasm. A student who is a recipient of knowledge must learn systematically. This symbiosis brings quality results in studies.

Online teaching has its positive and negative aspects. After these teaching experiences, it can be concluded that it could be addressed as a possible partial alternative, but not throughout the educational process. If they were, e.g. selected parts and delivered by an expert in the field. A teacher who lives in a different part of the world. Online teaching unites those who are far away but divides those who are close. Man is a community creature, and therefore he must meet people and live with other people.

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