# Evaluation of Online Teaching in the Covid Period using Learning Analytics

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***Abstract*—The article compares education at the Faculty of Economics Matej Bel University before the pandemic and during the coronavirus pandemic. At the same time, it tries to outline what the education will look like after this situation is over. It finds out how the situation during the corona affected the education of economists and to what extent the changes it brought will be preserved in the future. The comparison of face-to-face and distance learning in 2019 and 2020 was made. This is because teaching in 2019 was carried out in a "classic", face-to-face manner, and on the contrary, in 2020, after the closure of schools in March 2020, teaching at Matej Bel University was carried out only distance online method. To get the best possible view of the researched topic, several research methods were used: the examination of the LMS Moodle with using of various Learning Analytics tools and Questionnaire Research. The results showed that face-to-face education before the Covid pandemic and after this pandemic will no longer be the same because distance online education will also cause changes in face-to-face education in the post-pandemic period. Questionnaire research showed that up to 78% of part-time students and 61% of full-time students would like their study program to use elements of distance education in full-time study as well. Since this is a large group of students, their opinion will be considered in the future when fully returning to face-to-face teaching.**

***Keywords*—Distance online learning; learning management system; moodle; collaboration platform microsoft teams***

## I. Introduction

The COVID-19 pandemic in Slovakia is part of the global pandemic of this infectious disease. The first case was confirmed in our country on March 6, 2020. From March 16, 2020, schools were closed and at the same time a state of emergency began to apply, which lasted with smaller or larger breaks until February 22, 2022. However, the state of emergency remains in force. The pandemic caused a revolution in education at all levels of schools, including university education. It also significantly influenced the education of economists at Matej Bel University (MBU) in Banská Bystrica. Before the pandemic, it was a classic face-to-face education, which was carried out either in large lecture rooms or specialized ones, e.g., computer classrooms.

The Matej Bel Virtual University portal is available at MBU, based on the LMS Moodle, from 2012.

Moodle is a free software, a learning management system providing a platform for e-learning, and it helps the various educators considerably in conceptualizing the various courses, course structures and curriculum thus facilitating interaction with online students [19].

Teachers use LMS (Learning Management System) to publish teaching materials in courses for individual subjects and to communicate with students, but not everyone had used this occasion in the past. Various communication platforms were also sporadically used - e.g., Skype, Zoom, Google Hangouts, etc. for communication, mainly with external students. Some teachers went further and prepared multimedia teaching materials for students - e.g., video sequences with the solution of tasks in the Camtasia Studio program, which they published as part of courses in LMS Moodle or in YouTube. Therefore, after the outbreak of the pandemic and the complete transition to distance online education, they had no problem quickly adapting to the new situation, when all teaching was moved to the online space. After the state of emergency was established, every teacher had the obligation to teach online with the support of the communication platform MS Teams, which was introduced as a unified platform for the entire university according to the previously prepared schedule for face-to-face teaching [20]. They also had to publish their teaching materials for subjects in courses in LMS Moodle. Invaluable help in these difficult times was provided by the MBU Institute of Automation and Communication, which organized courses for teachers who needed to learn/improve their work with LMS Moodle and MS Teams.

The exam period also took place online with the support of LMS Moodle and MS Teams. Most of the exam dates looked like this: students logged into MS Teams, where they had a channel ready for the test and had to turn on their webcam. At the same time, they signed up for the subject course in LMS Moodle, where they had a test with tasks prepared. They downloaded file with tasks to the desktop and, after processing, uploaded them to the storage in the LMS Moodle. In addition, many tests were also prepared directly in LMS Moodle through the Test activity.

The article compares the features of face-to-face and distance online education and their suitability for university students with support of Learning Analytics tools and questionnaire research.

Learning Analytics is a research area that focuses on the use of quantitative methods in learning research in and outside of the virtual environment [2]. The first definition of Learning Analytics was published by G. Siemens (on his blog) in 2010,

which was used in a modified form at the 1st international conference focused on Learning Analytics in 2011. Learning analytics is the measurement, collection, analysis, and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs [3].

But it's not just access to data that helps us make smarter decisions, it's the way we analyze it. That's why it's important to understand the four levels of analytics: descriptive, diagnostic, predictive and prescriptive [22].

### A. Descriptive Analytics

Descriptive (also known as observation and reporting) is the most basic level of analysis. This includes compiling reports and presenting what has happened in the past.

### B. Diagnostic Analytics

Diagnostic analytics is where we get to the why. We move beyond an observation and get to the "what" that is making it happen. This is where the ability to ask questions about the data and tie those questions back to objectives is most important.

### C. Predictive Analytics

Predictive analytics allows to predict different decisions, test them for success, find areas of weakness, make more predictions—and so forth. This flow allows institutions to see how the first three levels can work together. Predictive analytics involves technologies like machine learning, algorithms, and artificial intelligence, which gives it power because this is where the data science comes in.

### D. Prescriptive Analytics

Prescriptive analytics exist at a very advanced level and is the most powerful and final phase, and truly encompasses the "why" of analytics. It's when the data itself prescribes what should be done. Data-driven decision making is tied most closely to predictive and prescriptive analytics, even though these are the most advanced.

All four levels create the puzzle of analytics: describe, diagnose, predict, prescribe. When all four work together, we can truly succeed with a data and analytical strategy.

## II. Literature Review

A significant number of authors are engaged in research focused on the use of LMS Moodle with various type of plug-ins to improve the quality of teaching, especially in the Covid period. A greater number of authors use Learning Analysis tools for this purpose. Their work was a springboard for our research.

M. C. S. Manzanares at al. used a module UBU Monitor in Learning Management System for monitoring and detecting students at risk of dropping out during a lockdown caused by COVID-19 [6].

R. Kuo et al. designs a Moodle plug-in that not only can visualize students' learning behavior patterns from the log but also can cluster students into different groups based on their behavior patterns. The annotations made by the teacher can be a support for researchers to further analyze and design mechanism and algorithm to automatically recognize and identify a student's characteristics and conditions like learning styles, preferences, at-risk, and potential required assistances via the features extracted from a learning pattern and notify the teacher or administrative staff automatically [7].

Research's aim of [8] is to compare Moodle LMS usage before, during and after the first wave of COVID-19 pandemic, what resources and activities were used and what future tendencies have come from this scenario. Results show a huge growth of the LMS platform usage during the first wave and an increase afterwards, showing that teachers and students behaviors have changed, and technologies can complement traditional on premises classes, improving teaching and learning methods.

The study [9] illustrates the development of a learning analytics dashboard that can improve learning outcomes for educators and students.

The work [10] reinforces that local educational data analysis is feasible, opens new ways of analyzing data without data transfer to third parties while generating debate around the "local technologies first" approach adoption.

Learning management systems (LMSs) that incorporate hypermedia Smart Tutoring Systems and personalized student feedback can increase self-regulated learning, motivation, and effective learning. LMS with hypermedia Smart Tutoring Systems in Moodle increased the effectiveness of student learning outcomes, above all in the individual quiz-type tests. It also facilitated personalized learning and respect for the individual pace of student-learning [11].

Paper [12] presents an empirical study and related activity system analysis regarding the implementation and use of Moodle specifically, and learning management systems in general, in problem-based learning. The research involved an exploration of the characteristics that defined use of Moodle at a Danish university, the reasons why Moodle was or was not used in specific contexts and the way in which Moodle use was perceived by students. The investigation uncovered several reasons for the lack of focus on problem-based learning in Moodle structures and content and explored them through the contradictions identified within the activity systems and between the double contextual frame surrounding the interacting activity system.

Study [13] sought to determine the impact of using Moodle in teaching university courses on students' future anxiety and psychological happiness. It shows that implementing Moodle technology into teaching had a positive impact in reducing future anxiety and increasing psychological happiness among university students.

Paper [14] presents research work conducted at the University in Sri Lanka, to solve facilitate students learning in fully online and blended learning environments using Learning Analytics. The system was designed as a Moodle Plugin. As a result of the system, students could track their current progress and performance compared to the peers, which helps to improve their motivation to engage more in the course. Also, the increased engagement in the course enhances the student's self-confidence since the student can see

continuous improvement of his/her progress and performance which in turn improves the student's grades.

Qualitative case study [16] explores the perceptions and experiences of embedded experts in a global learning community that occurred over a 12-year period. The study was designed using the Online Collaborative Learning Framework developed by the authors in 2006. The goal of the study was to provide a nuanced understanding of embedded experts in online discussion that engage in real world issues related to today's diverse and digital classrooms. From the thematic analysis of the data, the following three implications emerged: Purposeful selection of technology; orientation and supports for the experts; and design of an organic environment that fosters the development of community including embedded experts.

The study [17] examines the effects of interactive and learning structures enabled by different Learning Management Systems (LMS) on satisfaction and learner engagement in online courses. An LMS can support or hinder active engagement, meaningful connections between segments of the course, easy communication, and formative feedback by making it easier or more difficult for faculty to communicate course requirements, provide open-ended feedback, and place course elements that are used together contiguous to one another.

Drawing on design experience of developing learning analytics and inducting others into its use, the article [18] presents a model that researchers have used to address five key challenges they have encountered. In developing this model, they recommend: a focus on impact on learning through augmentation of existing practice; the centrality of tasks in implementing learning analytics for impact on learning; the commensurate centrality of learning in evaluating learning analytics; inclusion of co-design approaches in implementing learning analytics across sites; and an attention to both social and technical infrastructure.

The paper [28] examines how training support and LMS readiness factors influence the capability of faculty to adopt e-learning and student perceived benefits. The results reveal that training support and LMS readiness have a positive influence on the faculty's capability to adopt e-learning, which leads to enhancing students' perceived benefits. By identifying the factors that influence e-learning adoption, universities can provide enhanced e-learning services to students and support faculty through providing adequate training and powerful e-learning platform.

## III. Methodology

The comparison of face-to-face and distance online education was carried out for years 2019 and 2020. The reason was the teaching in 2019 took place "classically", face-to-face, and on the contrary, in 2020, after the schools closed on 16/03/2020, teaching continued solely online. The year 2021 was different from this point of view and there was an irregular alternation of face-to-face and distance education depending on the current pandemic situation, and therefore it is not suitable for our research.

To get the best possible view of the researched topic, we combine a few research methods:

*1)* The examination of the LMS Moodle (version 3.11.8) with using of Learning Analytics tools:

*a)* Google Analytics,

*b)* Data analysis from the MySQL Standard Edition Database System (Data storage of LMS Moodle),

*2)* Questionnaire research.

During the data processing we followed the recommendations given in the sources [1], [4], [5], [15], [23].

Google Analytics is a website traffic analysis application that provides real-time statistics and analysis of user interaction with the website. Google analytics enables website owners to analyze their visitors, with the objective of interpreting and optimizing website's performance [21]. In this research, we use Google Analytics to explore data from LMS Moodle at MBU.

By default, LMS Moodle at MBU uses the relational database system MySQL (version 8.0.29) for data storage. Given that, we planned to prepare SQL queries in MS SQL Server 2019, we first converted the data from MySQL to MS SQL Server, using the tool MS SQL Server Migration Assistant for MySQL (SSMA) [26], [27].

SQL Server Migration Assistant (SSMA) is a free supported tool from Microsoft that simplifies database migration process from MySQL to SQL Server. SSMA automates all aspects of migration including migration assessment analysis, schema and SQL statement conversion, data migration as well as migration testing. This download includes a GUI client-based application to manage migration process. A separate extension pack will install functionalities in SQL Server to emulate MySQL features not natively supported in SQL Server [24].

We have more user experience with MS SQL Server than with MySQL, which is why we are more comfortable working with it. We used the Microsoft SQL Server Management Studio graphical interface to communicate with SQL Server.

SQL Server Management Studio (SSMS) is an integrated environment for managing any SQL infrastructure. SSMS provides tools to configure, monitor, and administer instances of SQL Server and databases [25].

The investigated database consisted of more than 460 tables and its size was 9.36 GB and its preview is in the Fig. 1.

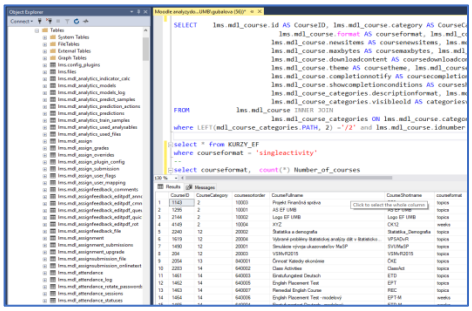

Fig. 1. The Moodle Database in the SSMS Tool.

## IV. Results and Discussion

The research of the LMS Moodle at MBU with support of Google Analytics tools shows how the number of users in LMS Moodle increased during the pandemic in 2020, compared to the previous year 2019, when "classic" face-to-face teaching was taking place.

As shown in Fig. 2, the curves had an approximately same course until March 2020. The turning point occurred on March 16, 2020, after the declaration of a state of emergency and the closing of schools, when teaching was fully moved into the online space and continued in this mode until the end of 2020.

The number of users in 2020 increased by 118.21% compared to the previous year 2019, and the number of new users increased by up to 132.08%. The number of sessions more than doubled - 210.67%. The number of sessions per user increased by 42.13%, and on the contrary, the number of exits - Bounce Rate decreased (-16.19%). The total number of displayed pages (Pageviews) increased almost 3.5 times (342.37%), while the average number of pages viewed by users during one session (Pages/Session) increased by 42.39% and the average duration of one session (Avg. Session Duration) increased by 42.13%.

The enormous increase in users results in higher hardware and software requirements for LMS and next learning-related systems to be reckoned with in similar crisis situations.

During both monitored years, users worked with LMS Moodle most often with the support of these browsers. Based on Fig. 3 we state that most sessions were made through the multi-platform Chrome browser - 69.63%. Another 10.89% of sessions were made through the Safari browser for the operating system Mac OS X and for Windows. The third in the order is the Firefox browser with a 7.88% share. It is followed by Edge with a share of 3.64%, which also has the lowest Bounce Rate - 18.13%. A slightly higher Bounce Rate have Firefox (19.27%) and Chrome (23.04%).

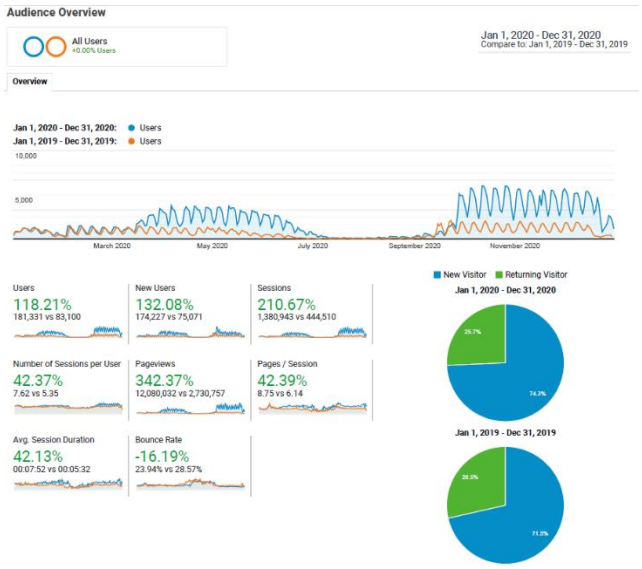


Fig. 2. Audience Overview in LMS Moodle via Google Analytics Tools (Jan 1, 2020 – Dec. 31, 2020, Compared to: Jan. 1, - Dec. 31, 2019).

| Browser | Acquisition | | | Behavior | | |
|---|---|---|---|---|---|---|
| | Users | New Users | Sessions | Bounce Rate | Pages / Session | Avg. Session Duration |
| | 405,354 % of Total: 100.00% (405,354) | 402,380 % of Total: 100.06% (402,138) | 3,274,375 % of Total: 100.00% (3,274,375) | 24.02% Avg for View: 24.02% (0.00%) | 8.45 Avg for View: 8.45 (0.00%) | 00:07:38 Avg for View: 00:07:38 (0.00%) |
| 1. Chrome | 230,108 (56.98%) | 229,388 (57.01%) | 2,280,059 (69.63%) | 23.04% | 8.43 | 00:07:44 |
| 2. Safari | 92,467 (22.90%) | 91,374 (22.71%) | 356,437 (10.89%) | 30.37% | 6.48 | 00:04:51 |
| 3. Firefox | 30,317 (7.51%) | 30,587 (7.60%) | 257,970 (7.88%) | 19.27% | 10.92 | 00:09:59 |
| 4. Edge | 14,694 (3.64%) | 14,717 (3.66%) | 179,081 (5.47%) | 18.13% | 10.51 | 00:09:47 |
| 5. Internet Explorer | 12,229 (3.03%) | 12,138 (3.02%) | 24,891 (0.76%) | 47.68% | 8.86 | 00:06:19 |
| 6. Opera | 8,412 (2.08%) | 8,387 (2.08%) | 119,215 (3.64%) | 28.50% | 7.79 | 00:07:46 |
| 7. Samsung Internet | 6,375 (1.58%) | 6,516 (1.62%) | 37,887 (1.16%) | 42.25% | 4.88 | 00:03:15 |
| 8. Safari (in-app) | 3,331 (0.82%) | 3,329 (0.83%) | 4,139 (0.13%) | 52.55% | 2.67 | 00:02:01 |
| 9. Android Webview | 3,320 (0.82%) | 3,405 (0.85%) | 5,037 (0.15%) | 52.11% | 2.98 | 00:02:22 |
| 10. Mozilla Compatible Agent | 839 (0.21%) | 835 (0.21%) | 842 (0.03%) | 99.52% | 1.01 | 00:00:02 |

Fig. 3. Browsers Overview in LMS Moodle via Google Analytics Tools (Jan. 1, 2019 – Dec. 31, 2020).

The Pages/Session indicator is the highest for Firefox (10.92), followed by Edge (10.51) and Internet Explorer (8.86) with Chrome (8.43). These browsers also have the highest Avg. Session Duration in this order: Firefox (00:09:59), Edge (00:09:47), Opera (00:07:46) and Chrome (00:07:44). Therefore, we note that these browsers are most used for online study and should be given more attention. Electronic learning materials available over the web (e.g., in LMS Moodle) should be adapted mainly to these browsers.

Other browsers for mobile devices (Samsung Internet, Safari (in-app), Android WebView or Mozilla Compatible Agent) are used to search for information in LMS Moodle, but not for e-learning because of their small screen. There is no need to prepare e-learning materials tailored to these browsers.

Fig. 4 shows the Devices Overview in LMS Moodle in the examined period.

| Device Category | Acquisition | | | Behavior | | |
|---|---|---|---|---|---|---|
| | Users | New Users | Sessions | Bounce Rate | Pages / Session | Avg. Session Duration |
| | 405,354 % of Total: 100.00% (405,354) | 402,380 % of Total: 100.06% (402,138) | 3,274,375 % of Total: 100.00% (3,274,375) | 24.02% Avg for View: 24.02% (0.00%) | 8.45 Avg for View: 8.45 (0.00%) | 00:07:38 Avg for View: 00:07:38 (0.00%) |
| 1. desktop | 222,699 (55.17%) | 222,786 (55.37%) | 2,497,557 (76.28%) | 19.47% | 9.44 | 00:08:55 |
| 2. mobile | 175,643 (43.51%) | 174,268 (43.31%) | 760,057 (23.21%) | 38.60% | 5.23 | 00:03:28 |
| 3. tablet | 5,346 (1.32%) | 5,326 (1.32%) | 16,761 (0.51%) | 40.77% | 5.78 | 00:04:40 |

Fig. 4. Devices Overview in LMS Moodle via Google Analytics Tools (Jan. 1, 2019 – Dec. 31, 2020).

We note that 76.28% of all sessions were made from desktop devices. The relatively high share of mobile devices (23.21%) was a surprise, so we will focus on it in the next analysis (Fig. 5). Tablets with a share of 0.51% represent rarely used devices.

The most widespread mobile platform is represented by Android-fcm (2360 devices), followed by iOS-fcm (2222), Android (265) and iOS (125).

```
SELECT [PLATFORM], COUNT(*) NUMBER_OF_DEVICES
FROM [LMS].[MDL_USER_DEVICES]
GROUP BY [PLATFORM]
ORDER BY 2 DESC
```

Results | Messages

| | platform | Number_of_Devices |
|---|---|---|
| 1 | Android-fcm | 2360 |
| 2 | iOS-fcm | 2222 |
| 3 | Android | 265 |
| 4 | iOS | 125 |

Fig. 5. Overview of Mobile Device Platforms in LMS Moodle through Data Analysis of the Moodle Database (Jan. 1, 2019 – Dec. 31, 2020).

Fig. 6 shows the number of newly created courses during the entire operation of LMS Moodle at UMB in the years 2012 – 2022.

```
SELECT YEAR(DATEADD(SECOND, STARTDATE + 8*60*60,
'19700101')) [YEAR], COUNT(*) NUMBER_OF_NEWCOURSES
FROM LMS.MDL_COURSE
GROUP BY YEAR(DATEADD(SECOND, STARTDATE + 8*60*60,
'19700101'))
ORDER BY 1
```

Results | Messages

| | Year | Number_of_NewCourses |
|---|---|---|
| 1 | 2012 | 72 |
| 2 | 2013 | 399 |
| 3 | 2014 | 156 |
| 4 | 2015 | 208 |
| 5 | 2016 | 229 |
| 6 | 2017 | 103 |
| 7 | 2018 | 109 |
| 8 | 2019 | 411 |
| 9 | 2020 | 2082 |
| 10 | 2021 | 1131 |
| 11 | 2022 | 11 |

Fig. 6. Comparison of the Number of Newly Created Courses in LMS Moodle in Individual Years.

We note that the number of newly created courses increased more than five times in the pandemic year 2020 (2082) compared to the previous year 2019 (411). Next, we analyze their formats in more detail in the Fig. 7.

We constate that the biggest increase (26 times) occurred in the format Collapse Topics (topcoll), but its share in the total number of course formats is minor (1.2%). By researching courses with this format, we found that the reason for choosing this type of format was the large number of sections with learning materials that needed to be expanded or collapsed for clarity. The second highest increase (15 times) was recorded by the Single Activity format, but its share is also minor (0.7%). Teachers used it to present one study obligation - e.g., term paper, case study or seminar paper. The Topics format follows with a 7.37-fold increase and a 46% share of the total number of course formats. The lowest increase occurred in the case of the Weeks format (3.88 times), which still dominated with its 52% share in the number of course formats. During the pandemic, course creators chose the Topics format more often than in the past.

```
--2019
SELECT [FORMAT], COUNT(*) NUMBER_OF_COURSES_2019
FROM LMS.MDL_COURSE
WHERE YEAR(DATEADD(SECOND, STARTDATE + 8*60*60,
'19700101'))=2019
GROUP BY FORMAT
ORDER BY 2 DESC
--2020
SELECT [FORMAT], COUNT(*) NUMBER_OF_COURSES_2020
FROM LMS.MDL_COURSE
WHERE YEAR(DATEADD(SECOND, STARTDATE + 8*60*60,
'19700101'))=2020
GROUP BY FORMAT
ORDER BY 2 DESC
```

Results | Messages

| | format | Number_of_Courses_2019 |
|---|---|---|
| 1 | weeks | 279 |
| 2 | topics | 130 |
| 3 | singleactivity | 1 |
| 4 | topcoll | 1 |

| | format | Number_of_Courses_2020 |
|---|---|---|
| 1 | weeks | 1082 |
| 2 | topics | 958 |
| 3 | topcoll | 26 |
| 4 | singleactivity | 15 |
| 5 | tiles | 1 |

Fig. 7. Comparison Formats of Newly Created Courses in LMS Moodle in 2019 and 2020.

At the pandemic time, the testing and verification of knowledge has fully moved to the online space. As Fig. 8 shows, in 2020 the number of newly created quizzes increased 75.73 times compared to 2019.

```
SELECT YEAR(DATEADD(SECOND, TIMEOPEN + 8*60*60,
'19700101')) AS [YEAR], COUNT(*) NUMBER_OF_NEWQUIZZES
FROM LMS.MDL_QUIZ
GROUP BY YEAR(DATEADD(SECOND, TIMEOPEN + 8*60*60,
'19700101'))
ORDER BY 1
```

Results | Messages

| | Year | Number_of_NewQuizzes |
|---|---|---|
| 1 | 2012 | 45 |
| 2 | 2013 | 16 |
| 3 | 2014 | 30 |
| 4 | 2015 | 46 |
| 5 | 2016 | 8 |
| 6 | 2017 | 27 |
| 7 | 2018 | 21 |
| 8 | 2019 | 15 |
| 9 | 2020 | 1136 |

Fig. 8. Comparison of the Number of Newly Created Quizzes in LMS Moodle in Individual Years.

Therefore, at the beginning of the pandemic, the LMS Moodle portal collapsed under the onslaught of testing activities. The schedule had to be prepared in such a way that several testing activities did not take place at the same time. The limit was max. 250 test users simultaneously.

Fig. 9 presents that in 2020 there was also a 26-fold increase in the number of Questionnaires, compared to 2019. By researching in the LMS Moodle, we found out that it was mainly about surveys of satisfaction with teaching, finding suitable dates for an exams or defense of seminar papers by students.

```
SELECT YEAR(DATEADD(SECOND, TIMEMODIFIED + 8*60*60,
'19700101')) AS [YEAR], COUNT(*)
NUMBER_OF_NEWQUESTIONNAIRES
FROM [LMS].[MDL_QUESTIONNAIRE]
GROUP BY YEAR(DATEADD(SECOND, TIMEMODIFIED +
8*60*60, '19700101'))
ORDER BY 1
```

Results | Messages

| | Year | Number_of_NewQuestionnaires |
|---|---|---|
| 1 | 2012 | 19 |
| 2 | 2013 | 20 |
| 3 | 2014 | 86 |
| 4 | 2015 | 117 |
| 5 | 2016 | 8 |
| 6 | 2017 | 15 |
| 7 | 2018 | 7 |
| 8 | 2019 | 5 |
| 9 | 2020 | 130 |
| 10 | 2021 | 49 |
| 11 | 2022 | 1 |

Fig. 9. Comparison of the Number of Newly Created Questionnaires in LMS Moodle in Individual Years.

After the end of the winter term, during the month of February 2021, we prepared an anonymous questionnaire in LMS Moodle for students, regarding the evaluation of the progress and organization of online teaching at Faculty of Economics MBU. There were 231 students (respondents) – 202 full-time and 29 externals, answered the questionnaire.

The questions Q1 - Q5 were aimed at surveying satisfaction with distance online education and utilized a five-point Likert scale (1-Very dissatisfied, 2- Rather dissatisfied, 3-Neutral, 4- Rather satisfied, 5-Very satisfied). For the analysis, a Likert score of 1-2 was regarded as a negative response, 4-5 as a positive response and 3 as a neutral response. The Likert scores for the questions Q1 - Q5 are presented in Table I.

We constate that the highest satisfaction was with the collaboration platform MS Teams (4.31), educational support of LMS Moodle (4.28) and with studying at Faculty of Economics MBU generally (4.05).

TABLE I. LIKERT SCORES FOR QUESTIONS Q1 – Q5

| | **How satisfied are/were you:** | **Likert Scores** |
|---|---|---|
| Q1 | with studying at Faculty of Economics MBU? | 4.05 |
| Q2 | with the process and organization of distance online education in year 2020?" | 3.90 |
| Q3 | with educational support of LMS Moodle | 4.28 |
| Q4 | with the provision of teaching through collaboration platform MS Teams | 4.31 |
| Q5 | with e-learning materials from teachers | 3.14 |

Q7 investigated how students prefer individual forms of lectures with using of five-point Likert scale (1- I don't prefer it at all, 2- I don't prefer it, 3- neutral attitude, 4- I prefer it, 5- I strongly prefer it).

TABLE II. LIKERT SCORES – EVALUATION OF LECTURES

| | **Form of lectures** | **Likert Scores** |
|---|---|---|
| L1 | Publication of study materials in the LMS | 4.82 |
| L2 | Online video lectures with recording | 4.82 |
| L3 | Off-line video lectures (video recordings) | 4.75 |
| L4 | Audio recording to the published presentation | 3.25 |
| L5 | Online video lectures without recording | 3.05 |

Based on the results in Table II, we conclude that students prefer persistent forms of lectures for which there is a record and to which they can return in the future if necessary.

Q8: "In what form were the lectures carried out?"

TABLE III. FORM OF LECTURES IN THE MONITORED PERIOD

| **Form of Lectures** | **Very Often & Often** | **Less Often & Not at all** | **I don't know** |
|---|---|---|---|
| L1 - Publication of study materials in the LMS | 79.65% | 12.12% | 8.23% |
| L5 - Online video lectures without recording | 79.22% | 12.55% | 8.23% |
| L2 - Online video lectures with recording | 28.14% | 63.64% | 8.23% |
| L4 - Audio recording to the published presentation | 8.23% | 83.55% | 8.23% |
| L3 - Off-line video lectures (video recordings) | 7.79% | 83.98% | 8.23% |

It follows from Table III that in period of online teaching, lectures were very often provided to students in the form of publishing in LMS Moodle, the second most common form was "online video lectures without recording" and, to a much lesser extent – "online video lectures with recording".

Q9 investigated which individual forms of seminars/exercises students prefer with using of five-point Likert scale (1- I don't prefer it at all, 2- I don't prefer it, 3- neutral attitude, 4- I prefer it, 5- I strongly prefer it).

According to Table IV, students prefer persistent forms of Seminars/Exercises (with recording).

TABLE IV. FORM OF SEMINARS/EXERCISES IN THE MONITORED PERIOD

| x | **Form of Seminars/Exercises** | **Likert Scores** |
|---|---|---|
| S1 | Online video seminars with recording | 4.82 |
| S3 | Off-line video seminars (video recordings) | 4.55 |
| S4 | Online video seminars without recording | 3.35 |
| S2 | Assignments you could consult with teacher | 3.25 |
| S5 | Published assignments with solution procedure | 3.20 |
| S7 | Writing term papers/case studies/projects, etc. | 3.16 |
| S6 | Posted assignments with results only | 2,56 |

Q7: "In what form were the seminars/exercises carried out?"

TABLE V. FORM OF SEMINARS/EXERCISES IN THE MONITORED PERIOD

| Form of Seminars/Exercises | Very Often & Often | Less Often & Not at all | I don't know |
|---|---|---|---|
| S4 – Onlin e video seminars without recording | 75.76% | 16.02% | 8.23% |
| S7- Writing term papers/case studies/projects, etc. | 57.58% | 34.20% | 8.23% |
| S2 - Assignments you could consult with teacher | 50.22% | 41.56% | 8.23% |
| S5 - Published assignments with solution procedure | 35.50% | 56.28% | 8.23% |
| S1- Online video seminars with recording | 27.27% | 64.50% | 8.23% |
| S6 - Posted assignments with results only | 21.65% | 70.13% | 8.23% |
| S3 - Off-line video seminars (video recordings) | 9.96% | 81.82% | 8.23% |

Table V presents that during online teaching, the seminars/exercises were carried out particularly in form of "online video exercises without recording", at second position was "Writing term papers/case studies/projects" and at third position "Assignments you could consult with teacher".

The answers to questions Q8, Q9 and Q10 differed significantly for full-time and external (part-time) students, so we evaluate them separately.

Q8: "I acquired comparable knowledge as during face-to-face teaching."

Q9: "The method of evaluating subjects took into account the specifics of distance education."

Q10: "There is a lack of live contact with the teacher (the teacher usually sends texts and assignments; students send completed assignments)."

As for the answers, students could choose from the options: Majority of subjects, Minority of subjects, I don't know.

Based on the Fig. 10 and Fig. 11, we conclude that distance learning is perceived more positively by external students. It is also because the main way of their education in the past was self-study. The Covid era brought them a benefit in the form of a large amount of e-learning teaching materials and better support in LMS Moodle and MS Teams.

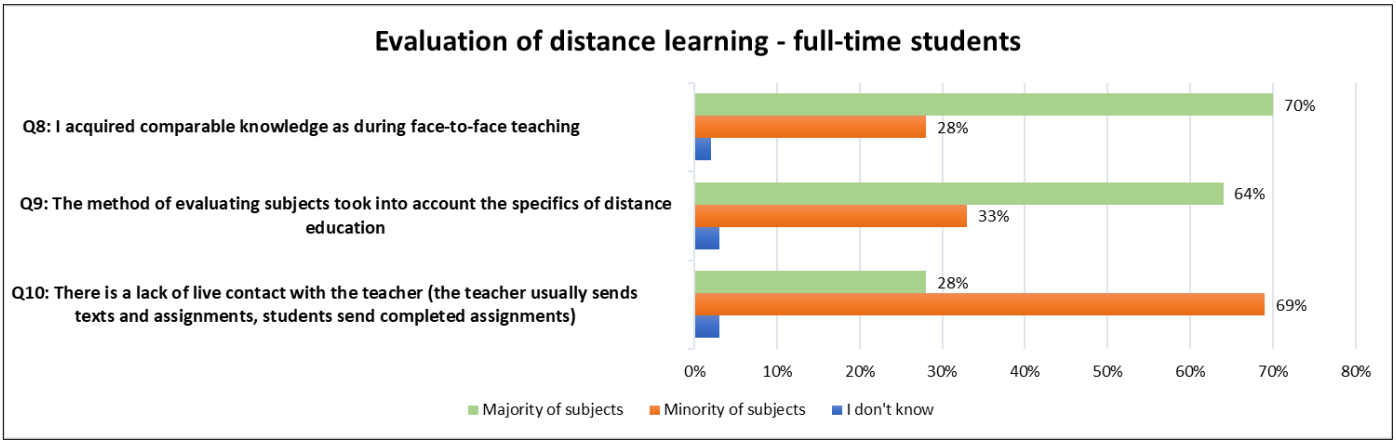


Fig. 10. Questions Q8, Q9, Q10 - Answers of Full-time Students.

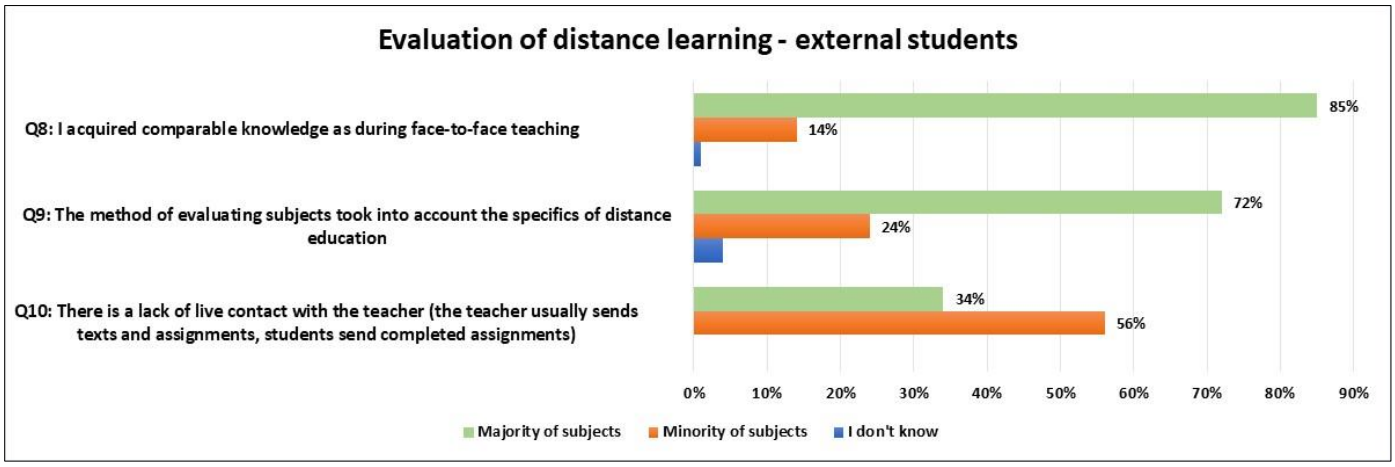


Fig. 11. Questions Q8, Q9, Q10 - Answers of External Students.

TABLE VI. ADVANTAGES AND DISADVANTAGES OF DISTANCE LEARNING

| Advantages: | Disadvantages: |
|---|---|
| **1** reduction of travel and accommodation costs (students could use the saved time for longer sleep, self-study or sports activities),<br>**2** the opportunity to learn in the home comfort,<br>**3** the possibility of education even with a weaker illness,<br>**4** the possibility to replay the learning activity from the record,<br>**5** the possibility to use new information and communication technologies in education,<br>**6** there is no need to look for someone to supervise the children, as was the case with full-time studies (in case of external students). | **1** absence of social contact with teachers and classmates,<br>**2** inability to maintain long-term attention when working with a PC,<br>**3** lack of motivation to study, procrastination,<br>**4** health problems (e.g. vision impairment, back pain),<br>**5** increased demands on technology, technical problems, especially poor internet connection on the part of students,<br>**6** inability to understand the subject matter as in face-to-face studies,<br>**7** less movement,<br>**8** during online classes they can eat, look at their mobile phone, etc. When a person is in a comfortable environment, it is easy to lose focus,<br>**9** external distractions (family, pets, couriers, housework). |

Q11: "Even after the pandemic, my study program should use elements of distance education". We note that 78% of external (part-time) students and 61% of full-time students agreed with this statement.

Q12: Prepare list the advantages of the distance learning method from your point of view. Table V lists the most frequently mentioned advantages and disadvantages.

Questionnaire research showed that up to 78% of part-time students and 61% of full-time students would like their study program to use elements of distance education in full-time study as well. Since this is a large group of students, we will take their opinion into account in the future when fully returning to face-to-face teaching.

Based on the results of the research, we declare the following recommendations for face-to-face education in the post-Covid period:

- In time of building university information systems for e-learning (e.g., Learning Management Systems, Communication Platforms), emphasize their expandability and scalability (the system's ability to advantageously use additional resources such as processors, memory, or disk space) in case of need.
- To adapt the prepared e-learning teaching materials to the most used internet browsers and desktops.
- To enable students who cannot participate in face-to-face teaching (e.g., due to a minor illness) to participate in it online, via a communication platform - the so-called hybrid method of teaching.
- To prepare records from educational events (lectures, seminars/exercises) so that students can return to them in the future, e.g., when preparing for the exam.
- To provide external students with the option of participating in classes either face-to-face or online (and not only in the case of e.g., illness).
- Regularly implement training for teachers, focused on working with modern information and communication technologies (ICT), which are applied in teaching, so that the next pandemic or similar event does not catch them unprepared.
- To organize trainings of effective work with ICT for teachers and students.

## V. CONCLUSION

The article deals with the comparison of face-to-face education and distance online education in Covid period. In frame of research, we combine a few research methods: the examination of the LMS Moodle with using of Learning Analytics tools: Google Analytics, Data analysis from the MySQL Standard Edition Database System and Questionnaire research.

The results showed that face-to-face education before the Covid pandemic and after this pandemic will no longer be the same because distance online education will also cause changes in face-to-face education in the post-pandemic period.

Future research is planned to determine the extent to which these recommendations will be implemented in the UMB environment and what their impact on education will be.

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