Thoughts of a Post-Pandemic Higher Education in Information Systems and Technologies

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─── **Abstract** ───

In late 2019, a new class of coronavirus appeared in China that triggered a worldwide pandemic declared by the World Health Organization. Several businesses were affected and people had to adapt their social life to a virtual mode. Higher education institutions suffered from this sudden change, and had to adapt without any preparation or planning. After almost two years of carrying out activities in an online format, face-to-face activities in higher education have returned. This case study aims to analyze the performance of students in a new curricular unit of the Engineering and Management of Information Systems course at the School of Engineering of the University of Minho in Portugal. The study is applied to 142 students who entered the 1st year of the 2019/2020 school year and returned to face-to-face activities in the 3rd year of the 2021/2022 school year. Two questionnaires were applied, one at the beginning of the semester with 71 answers and another at the end of the semester with 39 answers. The main objective was to understand the students' feedback regarding the functioning of the classes, in which a great difficulty in teamwork was highlighted.

1 Introduction

Since the World Health Organization (WHO) declared COVID-19 a global pandemic on 11 March 2020, the crisis hit higher education worldwide, including in Portugal. The Coronavirus catalysed changes, seemingly overnight, from face-to-face to remote classes. Learning online can be challenging in general, for both teachers and students and remote classes requires careful preparation and planning [7].

However, in March 2020, there was no time to do this preparation and planning work, causing a sudden Emergency Remote Teaching (ERT), temporary move to distance education in response to a crisis that prevents in-person class meeting, may be considerably more challenging, particularly because of the variation in delivery. Instructors varied in how they introduced remote teaching. Some approaches focused on classes were limited to set times of the day or week, with synchronous online teleconference meetings, other classes were completely asynchronous, with pre-recorded lectures and/or written materials in lieu of live meetings. However, this affected the students who met a learning experience that for many was a new experience.

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This case study was applied in students who started their studies at the University of Minho in the 2019/2020 academic year, that is, students who were in the 1st year at that time. In the following academic year 2020/2021, learning should have taken place in a blended format, that is, a mix between face-to-face and remote; however, most classes took place in a remote format. What happened is that the theoretical and theoretical-practical classes are recommended to be in a remote format and the practical classes should have taken place in a "face-to-face" format; in fact, this did not happen, as the teachers chose to teach these classes in a remote format. In the actual academic year 2021/2022, classes are mandatory taught in a face-to-face format.

When the universities closed their campuses in March 2020, the 1st year students of the 2019/2020 academic year had not yet acclimated to the university context [6], so these students stayed since March 2020 to September 2021 practically working remotely. This distance meant that students were deprived of socializing with colleagues (from the academic year, as well as from later years). Because in addition to the remote classes, all socializing events between students (new and older) have been cancelled.

At the time of writing this study, these students are in the 3rd year of their study cycle, in the academic year 2021/2022, and the classes are mandatory in face-to-face format. In the 3rd year of the study cycle, most courses require students to work in a team and the number of students can vary from three to eight elements per team. Thus, students currently attending the 3rd year were faced with the need for face-to-face classes, which for them is almost a novelty and with the need to work as a team with colleagues that are strangers to them.

This study focuses on students who attend the last year, 3rd year, of the first cycle of Engineering and Management of Information Systems (EMIS), of the School of Engineering of the University of Minho. The course subject of this study is called Data Engineering for Decision Making Support (DEDMS) which has 162 students enrolled and is a new new curricular unit created from the restructuring of the EMIS course. This course provides students with first contact with data engineering to support decision making in organizational context, providing fundamental knowledge to students to understand the importance of data and how information technologies enable data collection, processing and analysis. In this case study, two questionnaires were applied in order to understand the expectations and opinions of students regarding the DEDMS subject.

This article is structured in five sections, starting with an introductory part. A background on the pandemic in higher education is presented. The third section address the course structure and the applied subject. Section four describes the methods used and the results obtained. Finally, conclusions are made.

2   Background

The Covid-19 pandemic declared in March 2020 affected the entire world, forcing people to close their businesses and working from home. Higher education was also affected, as universities were forced to shut down campuses by interrupting classroom education. Universities were not prepared to suspend their activities, nor were students and teachers prepared for distance learning. In the beginning, a lot of time was spent choosing the right methods and resources, such as online platforms for video conferencing classes or platforms for recording classes.

It can be said that this caused a crisis called Emergency Remote Teaching (ERT) which translates into a temporary change in the way of teaching due to the circumstances of the crisis, involving the use of solutions for distance learning. The main objective was to

provide fast and reliable access available to perform daily tasks. However, the robustness and quality of teaching/learning have been compromised [3], as online learning can be a challenge in general, both for teachers and especially for students who expected a face-to-face experience [7]. Higher education teachers have approached remote education in different ways. On the one hand, classes were limited to fixed times of the day or week, with synchronous online video conferencing meetings. On the other hand, the classes were asynchronous with pre-recorded classes and with materials available on some platforms. All students, however, were faced with a learning experience they did not anticipate and that many would not have chosen for themselves [3].

ERT differs from online education that already existed. Teaching in ERT was a rapid response to the emergency health crisis that delivered content in a varied, unplanned and difficult way, without predicting the consequences of these actions. The online teaching or e-learning method does not compromise the structure of classes and learning content. Although both methods use evidence-based teaching, this difference suggests that ERT may be associated with a different learning experience. Some studies focused on the involvement and motivation of students during the ERT period [5, 2], but did not bother with objectively measuring the learning [3]. Much discussion around ERT between teachers and administrators is correctly related to how well students are learning during ERT, and how learning outcomes we have the knowledge, skills, attitudes and habits that students acquire [3].

However, no distinction was made in the application of ERT education among students who had just entered university in the 2019/2020 school year, that is, they were attending their first year, and students who already attended university, that is, who were already in the 2nd, 3rd, 4th or even 5th grade. This distinction is important, because this group of students, in the school year 2020/2021, had all their classes remotely and only in 2021/2022 do they attend face-to-face classes.

From our knowledge we did not identify any study directed at these students, we found that there are studies that report that students who attend the most advanced years of study tend to be more favourable to the online learning environment than younger students, evident a tendency to a more favourable engagement in online learning environments with increased specialization, on the other hand, an important factor is lost which is student-student interaction [8] and that ERT caused a loss in personal relationships and even loneliness and depression [1, 4].

Thus, ERT affected the success of teaching and it is urgent to study how universities implemented organizational, pedagogical and educational concepts to minimize the loss of learning time due to the closure of schools [9]. In our opinion, this study should include other factors, such as that proposed in this study, which is the year attended by the student when the ERT occurred.

3 Course Structure

3.1 EMIS Scope

The Engineering and Management of Information Systems (EMIS) is a high school course offered by the School of Engineering of the University of Minho in Portugal. The professional profile associated to the EMIS course combines competences from informatics engineering and Information Technology (IT) management. The role played by Information Systems (IS) engineers and managers is to use IT and its applications to the benefit of organizations. IT is a means to the improvement of organizations and not an end in itself. Therefore, Information Systems and Technology (IST) professionals are expected to intervene in the adoption of IT and to manage the organizational and work engineering processes.

IST graduates should also possess competences for building IT applications and for getting involved in the activities related to the organization IT infrastructure. The scientific areas present in the course program reveal the combination of competences mentioned above. Higher education in IST involves characteristics typical from informatics engineering together with aspects that enables understanding organizations and their workings, their processes and management activities. The informatics component of the program emphasizes the configuration and customization of existing IT products and platforms either for operational or managerial work.

It is important to mention that the course was recently reformulated, separating the bachelor (1st cycle – 3 years) and the master (2nd cycle – 2 years). The new program will substitute one already existing programs: an integrated Master (1st cycle and 2nd cycle – 5 years) program, due to the imposition of Portugal Government. This change will have implications on the EMIS professionals, because the competences that it is possible to achieve during the 3 first years of the program correspond to a quite undifferentiated professional profile. Entering in the labour market with such competences has 2 inconveniences: less competitiveness of graduates; and obstacles to the development of a professional profile with higher potential impact in organizations.

In a nutshell, an EMIS professional acts mentioned above demand competences typical of 2nd cycle education, in what concerns: understanding of technology; understanding the context where technology will be deployed; application of techno-scientific knowledge; criticism and judgement capacity; communication of scientific and technological subjects. In order to achieve an effective integration of the program competences, it is understood that the informatics component of the program should be well articulated with the managerial component.

3.2   DEDMS Curricular Unit

Within the scope of Engineering and Management of Information Systems (EMIS) course, the Data Engineering for Decision Making Support (DEDMS) curricular unit is inserted in the first semester of the 3rd year and is a new subject resulting from the reformulation of the course. We selected this curricular unit because it is extremely important for the third year and has a larger dimension. This course is 10 ECTS (European Credit Transfer System) and it is divided into 2 theoretical hours (T class), 2 theoretical-practical hours (TP class) and 2 practical and laboratory hours (PL class) per week, with a teaching team composed of seven professors. In T classes, the teaching learning method is expository, where the relevant concepts are presented and students are encouraged to investigate and expose concepts related to the topics covered. TP classes are an active learning method where activities are planned that involve students' participation, both in the accomplishment of tasks and in the systematization of results and difficulties. In the PL students are involved in the realization of a practical project.

The scope of DEDMS is to develop a Big Data project through a Delta Lake architecture. Distributed technologies such as Apache Spark were adopted. This course provides students with first contact with data engineering to support decision-making in organizational context, providing fundamental knowledge for students to understand the importance of data and how information technologies enable data collection, processing and analysis.

This course is project-oriented having 280 working hours, 90 hours of which relate to teacher and student contact and the remaining to students' self-study or project work. In addition to the permanent involvement of students in this process of continuous interaction, the course provides the involvement of students in a team to the realization of a project. For

this project, students dedicate hours of autonomous work. The work is evaluated in stages that are predefined and the delivery date is set at the beginning of the course. The project is followed weekly in PL classes, with the objective of identifying the evolution of each work team and clarifying the doubts that arise as it unfolds.

In general, the main goal is to understand the importance of data in supporting decision-making; identify the different data sources, data types, data quality and data profiling and the necessary transformations in a given analytical context; develop extraction, transformation and loading (ETL) processes whose specification includes mechanisms for optimizing the resources used; Explore data through presentation and visualization technologies such as dashboards, reports or tables,highlighting concerns about the effectiveness and efficiency of the visualization process; Define technology architectures that take advantage of different data storage and processing systems, supporting the needs of analytical information systems in organizations.

4   Results

4.1   Materials and Methods

This article approaches a case study developed with the objective of analyzing and understanding the performance of a group of students in the return of classroom activities. The present case study covered 142 students from DEDMS curricular unit of the EMIS course at the University of Minho in Portugal. The study was applied in the first semester of the 2021/2022 academic year to third-year students, who entered in higher education in the 2019/2020 academic year. The data sample covered 142 students evaluated in DEDMS of 162 enrolled. The evaluation of the curricular unit consisted of an exam and a practical project, in which 136 students were approved. Of the students enrolled in the subject, 109 were male and 52 were female. In addition, the average age of students was 21, with a minimum age of 19 and a maximum age of 44.

Two questionnaires were prepared using Google forms, one applied at the beginning of the semester in order to understand the students' expectations with the new curricular unit, and another at the end of the semester to verify if the students' expectations were met. The structure of the questionnaires was similar, with a total of 8 questions of different types, such as multiple choice and free text. The questionnaire was anonymous and did not aim to identify the students. The questions focused on understanding the students' motivation towards the project, their perception of the communication created between the students and the teaching team, their opinion about the learning contents and about the structure of the practical project, and finally free text for suggestions and comments. The extraction of data from the questionnaires was done manually, using data analysis tools such as Excel and Tableau.

Therefore, it was intended to discuss the evolution of students in DEDMS class in a post-pandemic phase. In addition, it was also intended to observe the performance of students in relation to a new curricular unit that emerged due to the reformulation of the course, which does not contain previous records for comparison.

4.2   Findings

At the beginning of the semester, a questionnaire was made available in order to understand the expectations of students with DEDMS curricular unit. This questionnaire obtained 71 responses. As shown in Figure 1 a), 58% of students responded that their expectations

were normal and 32% had high expectations. The second question was related to student communication with teachers, with a rating from 0 to 5. 46% of students rated the work environment created as good (4), 28% as normal (3) and 14% as very good (5). Graph c) corresponds to the students' understanding of the learning content, with 51% saying yes, 9% partially recording and 4% recording no. In general, students at the beginning showed motivation to learn and curiosity about the subject studied.
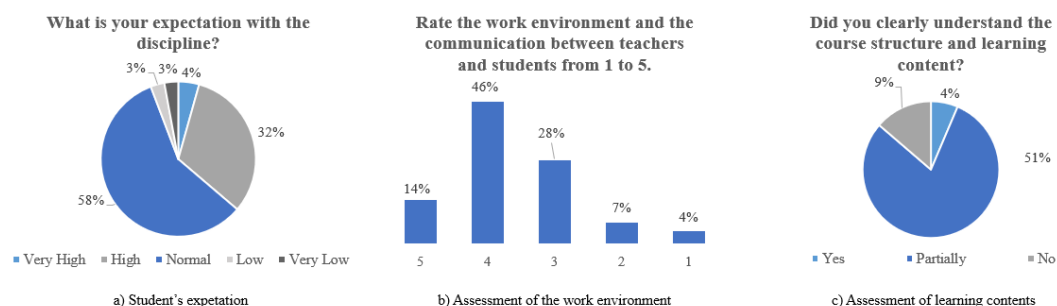
Figure 1 Results obtained from the first questionnaire.

At the end of the semester, a second questionnaire was made available, obtaining 39 responses. Unfortunately, the number of student responses in the second questionnaire decreased by almost 50% compared to the first questionnaire. A specific reason for this reduction was not identified, but we believe that the questionnaire should have been applied a little before the students' assessment, and not at the end of the semester as it was done. The interpretation of results was not greatly affected by this reduction, however a larger sample would be better to compare the results of the two questionnaires. It is also noted that it is not possible to know whether the audience of the two questionnaires was the same, but we believe that a large part was.

The first question in Figure 2 a), refers to the learning contents, where 61% of students reported that the learning contents were clearly presented, 34% classified it as partially and 5% as not. Question b) refers to the functioning of DEDMS, where 37% of students classified it as good (4), 29% classified it as normal (3), and 21% as very good (5). Graph c) corresponds to the general evaluation of DEDMS, where 61% evaluated the course unit as positive, 34% as very positive, 5% negative and no rating very negative.
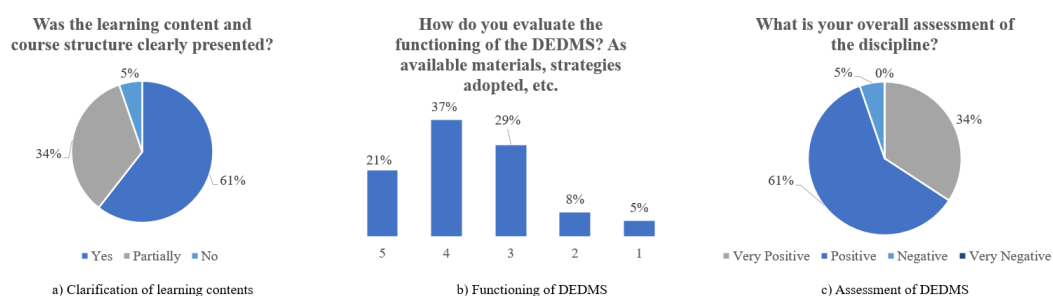
Figure 2 Results obtained from the second questionnaire.

Furthermore, some questions were applied in both questionnaires, which served to compare the results. The graph in Figure 3 a), analyzes the students' motivation towards the DEDMS curricular unit. There was a greater motivation of students at the end of the semester, and a

decrease in those who registered "no" in the initial questionnaire. The graph in Figure 3 b) demonstrates the students' opinion towards technologies, where 54% of students at the beginning thought that technologies were a good bet and only 39% at the end. 36% at the beginning fount it partially and 47% at the end. In the first questionnaire 10% think the technologies use were not a good bet and 13% at the second questionnaire. The students' difficulties with the tools used for the development of the practical project were noticed during the classes.
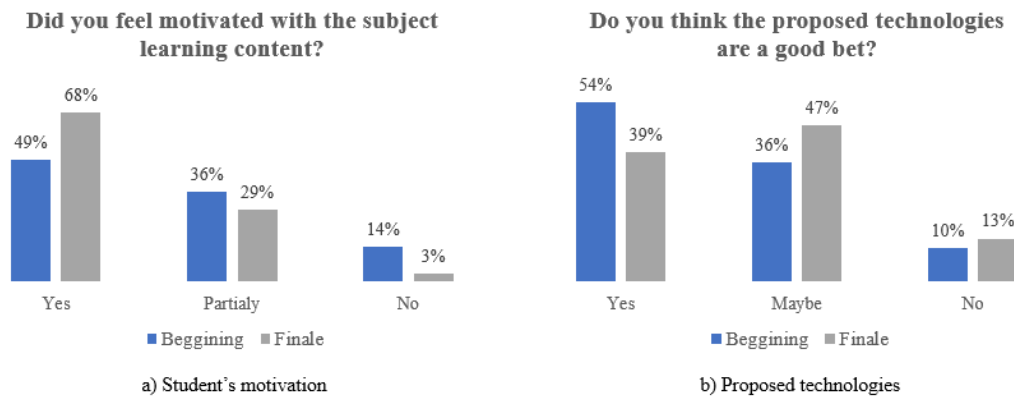
Figure 3 Combination of results obtained from the two forms.

In addition to these questions, the second questionnaire contained a free text field for suggestions and comments that students wished to place. Some comments referred to the tools chosen for the project, where some students pointed out some difficulties in their use. On the other hand, most students highlighted the difficulty of teamwork and stated that the DEDMS project should be more individual and not so much a group. These comments caught the attention of the teachers, because during the classes it was noticed that students had a lot of difficulty in team work, as they did not know how to communicate as a team and ended up creating rivalry between the members of the group itself. In addition to this behavior being perceived during the practical classes, the questionnaires also confirmed the fact that students did not know how to work as a team in the face-to-face format.

As DEDMS is a project-oriented course, teamwork is essential. On the one hand, the results showed that students felt motivated with the DEDMS curricular unit and that they had high expectations regarding the activity contents. On the other hand, the greatest difficulties encountered were in the choice of tools and in the performance of team work. The results of the questionnaires allowed to highlight a difficulty in teamwork on the part of the students, which sometimes generated a certain rivalry between the members of the group itself. The lack of communication between the members made group work a hard task. We believe this was due to students not knowing each other and not being used to working face to face. The social component in an academic environment is essential for students to get to know each other, stimulate conversation and also help each other with academic work.

Based on the difficulties encountered, the teachers needed to take certain measures that promoted continuous monitoring in the exercise of developing the practical project. To this end, the search for answers to questions that were not fully understood or that should be deepened was encouraged; Involvement of students in the assessment process in order to respond to answers from other students; recognition of mistakes made by students; Remembering the evaluation criteria; Promote future performance against established criteria; Promote students' critical thinking; Promote team work and student interaction independently.

5 Conclusion

The Covid-19 pandemic changed format of higher education, contributing to an Emergency Remote Teaching. This case study aims to analyze the performance of students who entered university in the 2019/2020 school year and who are now in the third year after two years of classes in remote format. This school year is in the 3rd year and with face-to-face classes. The study focused on DEDMS, a new curricular unit from the EMIS course. This 10 ECTS curricular unit requires students to work as a team to develop a practical project.

During the practical classes of the DEDMS project, the teaching staff realized that students were not working properly as a team, as they lacked communication, organization, and critical and judgmental capacity. Two questionnaires were applied to understand the general functioning of the DEDMS curricular unit. However, through free answers and in the practical classes, it was found that students had difficulty working as a team because they had not worked face-to-face before. This led to the teaching staff of the practical DEDMS classes having to take steps so that students could work better as a team, namely the definition of well-defined roles for each student, for example, defining a project manager, documentary, responsible for communication, and others; the concrete definition of the expectations of each team member; the preparation of meetings with well-defined objectives; the reporting of meetings; planning and implementation rigorous work to be carried out; among other measures. These recommendations allowed students to be able to bring the DEDMS curriculum unit to a full term. Thus, of the 162 students enrolled, 20 were not evaluated, and of the 142 students evaluated, 136 were approved, making only 6 students not obtained performance and the average of the classifications (0 to 20) in DEDMS was 16 values, which is a good result.

Colleges and universities are trying to decide the ideal way to continue learning. However, although the online format has its advantages, on the other hand it can compromise the social life and can harm the development of personal skills. For students entering university, aged 17 or 18, in addition to the specialization they will get through the course they have chosen, they will also develop and form their social personality. ERT has eliminated this prospect of training. It is therefore appropriate that when choosing the remote format, there is a concern to strengthen the social aspects to overcome the difficulties experienced by these students. Furthermore, it is expected that this sudden change will serve as a lesson for us to be prepared for situations of change and to have the necessary resources to do so.

─── **References** ───────────────────────────────

1 Tianhua Chen and Mike Lucock. The mental health of university students during the covid-19 pandemic: An online survey in the uk. *PLoS ONE*, 17, 2022. `doi:10.1371/journal.pone.0262562`.

2 Kristen Fox, Gates Bryant, Nicole Lin, and Nandini Srinivasan. Time for class covid-19 edition: part 1: a national survey of faculty during covid-19 | vocedplus, the international tertiary education and research database. *Tyton Partners and Every Learner Everywhere*, 2020. URL: `https://www.voced.edu.au/content/ngv:88359`.

3 Regan A. R. Gurung and Arianna M. Stone. You can't always get what you want and it hurts: Learning during the pandemic. *Scholarship of Teaching and Learning in Psychology*, October 2020. `doi:10.1037/STL0000236`.

4 Madona Kekelia, Eliso Kereselidze, and Ina Shanava. The covid-19 pandemic and the mental health of students. *Vectors of Social Sciences*, 1, 2021. URL: `https://jlaw.tsu.ge/index.php/vss/article/view/3639`.

5   Barbara Means and Julie Neisler. Suddenly online: A national survey of undergraduates during the covid-19 pandemic, July 2020. `doi:10.51388/20.500.12265/98`.

6   Madeleine Pownall, Richard Harris, and Pam Blundell-Birtill. Supporting students during the transition to university in covid-19: Five key considerations and recommendations for educators:. *Psychology Learning & Teaching*, 21:3–18, July 2021. `doi:10.1177/14757257211032486`.

7   Shannon Riggs, Kathryn E. Linder, and Penny Ralston-Berg. *Thrive online: a new approach to building expertise and confidence as an online educator*. STYLUS PUB LLC, 2019.

8   Katerina Salta, Katerina Paschalidou, Maria Tsetseri, and Dionysios Koulougliotis. Students' engagement and interactions in four university-based science learning communities during a shift from a traditional to a distance learning environment imposed by the covid-19 pandemic. *Science & Education*, 31:93–122, 2022. `doi:10.1007/s11191-021-00234-x`.

9   Klaus Zierer. Effects of pandemic-related school closures on pupils' performance and learning in selected countries: A rapid review. *Education Sciences*, 11:252, May 2021. `doi:10.3390/EDUCSCI11060252`.