Online-Teaching Environment with Gamification – A real Case Study

Filipe Portela
Algoritmi Research Centre, University of Minho, Braga, Portugal
IOTech – Innovation on Technology, Trofa, Portugal

Abstract

Teaching processes are changing, and Higher Education is not an exception. Professors are adapting their teaching methods to b-learning classes. They are looking for innovative approaches and tools that allow engaging students in the classrooms. This paper presents the results of a teaching and challenging experience. The TeachTeach paradigm was used in a fully online environment. Professors explored several methods/approaches during the semester, and the students were faced-off with a new reality of learning. They attested students skills like programming, resilience, innovation and entrepreneur capabilities during the development of a project with an actual web application. The results show that the efforts were tremendous but beneficial for all the stakeholders. At the end of the case study, a few numbers should be highlighted: 11,173 Downloads, 15,224 Messages, 200,000 Sessions and 208 online hour classes. Comparing this approach with other curricular units (CUnit) online strategies, 96,53% of the students considered it equal or better.

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1 Introduction

Nowadays, Education is facing a significant digital transformation process. Universities are experiencing a set of essential changes induced by technological and social trends towards digitisation. These changes were aggravated by Coronavirus disease (COVID-19) [1]. COVID-19 brought new challenges to Education where professors and schools had to take the lead of this unexpected digital transformation without being prepared for it [12]. Higher Education is not an exception and, unfortunately, most professors migrated their presential classes to an online schema without them being transformed/adapted. Several techniques and approaches are being explored, but the teaching and assessment methods are not accompanying the changes, and professors limited their action to transpose their teaching mechanisms to distance classes.

Conscientious of this fact, a new and innovative teaching approach was proposed. TechTeach is a disruptive approach in which the focus is the students and their motivation. This approach was designed for several years and showed good results in a presential contact environment; however, two critical questions arise now: "Is TeachTeach ready or adapted to classes 100% online?". "What is the effort needed? Is it worth it?"

This paper will answer both questions after dissecting the experience performed during a semester. All the classes and assessment methods were conducted online, using sync and async activities. This experience was a challenge for everyone, and the results were promising. This article also shows some ideas about converting presential classes to B-Learning approaches with sync and async tasks. In fact, this paper presents a proof of concept of a case study on a Programming Curricular Unit (CUnit) with ten (10) European

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Credit Transfer and Accumulation System (ECTS) with almost one hundred and seventy (170) students. Innovation and entrepreneur skills are applied through the development of a real-life case project and exploration of soft-skills.

The paper is divided into six sections: after a brief introduction, the paper background is explained. Then, section three presents all the methods and tools used in this case study. The case study is described in section four, and the achieved results are analysed in the discussion section. Finally, a conclusion of the work is provided.

2 Background

This section helps to understand the case study theoretical context better by reviewing some concepts.

2.1 Online Classes

Online learning has several characteristics that impact faculty implementation and CUnit progress [9]. One of the most significant changes in Education is the classroom converting from presential to online. According to a study [2], online and remote learning in higher education institutes are a necessity in times of COVID. Wahab Ali [2] also mentioned that the massive technology advance represents a shift in educational goals and aspirations. Online classes can have better results with bigger classes [16]; however, the typical conversion of teaching environments is not the best solution.

2.2 Digital Transformation at Classrooms

Digital transformation can bring new knowledge and practices of teaching, learning, communicating, and organising schoolwork [18]. A study [14] showed that the ability to have a digital competence is identified by someone who can use laptops and various digital learning resources in a positive way. In this aspect, the same study highlighted that the context/environment determine professors' digital competences. Their decisions are based on their own value frameworks and approaches.

2.3 Related Works

This work's main goal is to do a proof concept of TeachTeach and not address or compare it to other teaching methods. Even though there are other similar works in this area, none was considered.

3 Material and Methods

This case study explored TechTeach and all the related approaches.

3.1 TechTeach

TechTeach uses Blended-Learning, Gamification, Soft-skills, Quiz and Surveys, Flipped classrooms and Project Base Learning to proportionate the best learning environment for the students [20]. According to the author [21], TechTeach can be adapted to different lessons and environments. The case study explores this method in a non presential space and proves its adequacy for online teaching environments.

3.1.1 Project Based Learning

Project-based learning (PBL) is an approach to learning [4] and explores the use of exercises to proportionate practical learning. PBL is a student-centred pedagogy [10] and involves a dynamic classroom approach. Professors use the active exploration of real-world challenges and problems to stimulate students to achieve new knowledge [10].

3.1.2 Gamification

According to Kapp et al. [13], Gamification consists of "using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems". Learning environments with gamification activities can have a positive impact on the learning outcome [7]. In Education, Gamification is being used to encourage students to perform specific tasks; however, the lack of a narrative makes it difficult to measure the engagement influence [15].

3.1.3 Flipped Classes

Flipped learning is an instructional approach used to support teaching [7]. This type of learning allows students to have their own learning environments outside school [22]. The classes using this method are different and more practical because professors can use the contact time to discuss the most relevant topics and clarify students doubts instead of having monotonous exposing classes.

3.1.4 Skills

Skills achievement is a natural process of human being development [3]. The constant changes in the modern world require more flexibility and more vital adapting skills [17]. According to Araujo [3], this concept is also developed in the educational scope and elevates the cognitive and constructionist pedagogical perspectives to the detriment of behaviourism. In the case study, the two types of skills were trained: technical (web programming and derivates) and soft (resilience, innovation, argumentation, communication, leadership, entrepreneurship, among others).

3.2 Tools

This subsection does a brief overview of the tools used in this case study used to apply TechTeach.

3.2.1 Teach Supporting

ioEduc is an owner tool of IOTech and arises due to the increasing use of mobile devices at the classroom [23]. This platform was designed to support teachers and students in their tasks during classes [23]. Its web-based features (e.g. attendances, chat, slides, quizzes, surveys, drive, FAQs, peer-assessment) make it an excellent tool to support online classes.

ioChat arised as an internal communication platform of IOTech. Its success near the costumers motivated the Team to explore it in a different context such as Education. ioChat is based on an open-source software – RocketChat. It is fully customised and has many features like messages/conversations (text, audio and video), rooms (grouped, private, public or discussion), notifications (online, email, push), plugins (drive, calendar, polls), among others.

Zoom is currently one of the most used video-conferencing platforms. Their robustness allows people to maintain high-quality meetings with a vast number of participants. Zoom allows creating an online teaching environment due to its functionalities. It can connect long-distance participants across rooms systems, desktops and mobile devices to seamlessly bring together from various places [25].

3.2.2 Collaborative and Competitive

Kahoot! is characterised as a response system that engages participants through game-like pre-made or impromptu quizzes, discussions, and surveys [8]. Its game-based learning allows professors to support their education activities [5]. According to Carolina et al. [19], "Instructional games are gaining acceptance in the classroom as the eLearning merits of student engagement, and immediate feedback is recognised."

HackerRank [11] can be classified as a classic competitive programming platform [6] with several different types of exercises (e.g. problem-solving or challenges).

3.2.3 Data Analytics

Google Analytics is a web analytical tool that helps to analyse websites' traffic [24]. This tool is essential to understand the tools/websites' impact/usage.

4 Case Study

The following subsections characterise the case study – Application of TeachTeach on a computer programming unit at the University of Minho to create an entire online learning environment.

4.1 Context

To better understand the case study, it is essential to analyse the context/environment of this Curricular Unit (CUnit):

- Integrated Master degree;
- 2nd year of study plan;
- Ten European Credit Transfer and Accumulation System (ECTS);
- Online from 5 of October 2020 and 29 of January 2021;
- One hundred and sixty-eight students registered (90% participants);
- Five professors;
- Three types of classes: Theoretical (T), Theoretical-practice (TP), laboratory practices (LP);
- Fifteen weeks of work;
- Thirteen weeks of contact classes;
- Fourteen hours of work by week/student;
- Six hours of contact by week;
- Two Hours of Tutorial Working Time (OT).

Before the CUnit starts, the coordinator professor defined two mains goals according to the TechTeach paradigm:

1. To Innovate and guarantee the success of a 100% Online CUnit;
2. To use a set of concepts/trends: Gamification, PBL, Quizzes, and Flipped Classes and emerging tools to provide students' best online learning environment.

The working/teaching plan of Web Programming CUnit was based on the following assumptions:

- Full online classes (100%);
- Gamification mechanisms to assess students' performance;
- Online communication platform that allows simulating the classroom environment;
- Tests and assessments – dynamic, inclusive and online;
- Preparation of learning content/tutorials to be carried out outside of classes (OT);
- Online repository (drive) with complementary information (books, articles, videos or tutorials);
- FAQs with the most common issues;
- Recording of theoretical classes;
- Project-based learning with the application of a real case;
- Room for doubts and online chat;
- Continuous assessment of the CUnit – direct contact with the class delegates;
- Exploration of soft-skills (e.g. entrepreneurship, cross-learning, communication, adaptability, resilience and leadership).

4.2 Approach

TechTeach was designed to be used by any teacher who wants to innovate and have a different teaching view. This CUnit has a strong focus on the project component. So, to ensure the correct implementation of this mechanism, professors used several approaches.

4.2.1 Classes

All the classes ran online, and three tools were used:

Zoom – At the beginning of each theoretical class, the professor started the recording and shared the ioEduc live system (containing the slides and other features) in Zoom. After a brief explanation of the week's main topics, the professor created several breakout rooms, and the students were randomly distributed. Students were faced with solving some challenges in a group according to the topics addressed in this phase. They can ask for support here or in ioChat, and professors were jumping between each room. Each room was an average of 5-6 students, i.e., each class had 20 rooms on average. Before classes ending, all the students returned to the main room, and the professor performed a raffle among the attendees to determine which students have a bonus in the weekly quiz.

ioChat – ioChat was the main communication tool. The professor created several conversation rooms according to classes, teams and groups. All the students and professors were registered in ioEduc and had access to this communication tool. At the beginning of each class (TP and LP), the professor started a video-call with all of the students. The Professor used this first video call to talk a little about the class goals. Then, all the students went to their particular room and initiated another video-call. Professor visited each room to explain possible doubts and to give support in the project development. This tool allowed professors to have parallel classes on the same platform. In the TP classes, students were grouped by Team according to their role (front-end, back-end and full-stack). In the LP classes, the students were organised by group, following the allocation of figure 2 1. ioChat also had a set of creation rules (rooms name, username, photo, among other details) to quickly identify students, groups, projects, and professors. This tool was also used to promote and facilitate the communication inside and outside of the classes between all the stakeholders.

ioEduc – ioEduc was the centre of everything. All the slides were available in this platform; students can, for example, ask questions, answer the quizzes, consult FAQs or perform a peer-assessment. In all classes the attendances are registered at ioEduc through the attendances system. ioEduc' drive had T recorded classes and many books, tutorials, and videos to support the OT work. Regarding the professors, the attribution of cards was done here as well. ioEduc also has a connection to many complementary tools useful to help the classes (e.g. Cloud 9 AWS, GitHub or Heroku).

4.2.2 Project

The project developed in this CUnit tried to bring some innovation and entrepreneurship to the entire process and asked students to propose a solution to a real case. In a brief overview of the project statement, it is important to mention the following points:

1. The company "Secure4All" is responsible for the coordination of operations. It needs a web application that helps managing each of the occurrences received, and a web / mobile application that allows the interaction of operations on the field with their occurrences.
2. The intention was to develop a web/mobile application/system (PWA) that supports a public intervention unit's management.
3. In an initial phase, Secure4All defined a strategy to digitise processes for some of its intervention units, namely: Firefighters (Fire), PJ (Cyber-Attack), GNR (Events), Municipal Police (Assaults), ASAE (Food Inspection), INEM (Accident), Maritime Police (Drowning), and PSP (Disturbances).
4. The teams selected the project themes, and each Team was composed by three groups. Each group was responsible for developing a set of features/components.
5. The Team gathered and defined the components for each group. Then, each group was responsible for developing the entire Front-end (visual) and Back-end (Server) layer of the assigned component solution.
6. ioChat was the communication platform between all the stakeholders.

Regarding the team, the distribution was the following:

Group I – Operations Center;

Group II – Operations manager / Administrators;

Group III – Field Operations Officer;

Group IV – Audit (external entity).

To better comprehend students distributions by each class type, figure 1 presents how the teams and groups were organised.

The teams were constituted according to the TPs shifts. Each TP shift had two teams with a specific theme, and each Team had three or four groups. The groups were composed by 6 six elements (+/- 1 depending on the number of students in the shift).Each group was composed by at least 2 Front-End students, 2 Back-End students, and 1 Full-Stack student. Each element was responsible for the development of a set of functionalities/interactions. Each group' functionalities was divided between front-office (without login) and back-office (with login). Each Team created the terms of reference plan at the begin of the project. This document included project requirements, distribution of roles and tasks by the group and members, and a projected project cost (i.e., the grade that they want to achieve if they meet all the requirements).The terms of reference represents their commitment to the client (teaching team) and must show their innovative and entrepreneurial vision to the project.

Figure 1 Teams and Groups distribution retrieved from [21].

4.2.3 Assessment

This CUnit has a transversal and continuous assessment method that evaluates students, professors, and the respective unit. The students' assessment was divided into three types:

- A weekly quiz with a bonus to award motivation, work, and participation;
- Project with the cards system to value skills;
- Mini-tests with three synchronised methods to assess different parts of knowledge (Front-end, Back-end and Full-stack).

The CUnit and professors were also evaluated in two moments in the middle and the end of the semester. This assessment was used to assess several factors like professors knowledge, teaching skills, CUnit plan, and classes.

4.2.4 Gamification

Gamification was applied in several moments of the CUnit, and professors attributed positive and negative points during the classes. A narrative was designed for each method, and students knew from the beginning what they had to do in order to achieve specific goals. Gamification was applied in the following exercises/contexts:

- MT1 and MT3 – Grades were calculated using a metric based on the student knowledge, questions weight, and answering time according to the average time of respondents (3rd quartile).
- MT2 – Exercise 1 had code gaps, and students must complete it with their personal data. Then students had to use their skills/knowledge to unlock exercise 2.2. In the end, students achieved one of three possible grades:
  - -1 Student does not know the basics and should reprove to this component – 0%;
  - 0 Student knows the basic and can advance – 100%;
  - 1 Student knows the basics and overcomes all the challenges (e.g. unlock the 2nd part of the exercise) and must advance – 110%.
- The final grade of MT was achieved by the formula avg(MT1, MT3) * MT2.
- Quiz with bonus – The students had the opportunity to duplicate their weekly quizzes results. The Professor performed every T classes a selection of 10 to 15 students. The rules were simple: only the attendants of that T class were eligible, and no one could be selected more than two times without all the students being selected at least one time.

In the end, the student with the most points without a bonus (K) had a grade of 20. All the students with points with a bonus higher than the K had also 20; then all the other students had a relative grade regarding K. The goal of this exercise was to motivate and award students who could hit more questions.

- Cards System – The card system was applied during the project. Team leaders and professors attributed yellow (negative) or white cards (positive) to the students.
- Rescue System – This system was only available in MT2 to the students who had -1 grade and considered it unfair. In this situation, professors analysed the student case and, in case of acceptance, they allowed him to continue with a penalty of fifteen per cent (15%) in the final MT grade (i.e., MT2 equal to 85%).

4.3 Numbers

The following numbers help to understand the impact and the effort needed to have a CUnit with a complete online-learning environment:

- 13 shifts (1T, 4TP, 8LP);
- 1 Real project with three evaluation phases;
- 8 teams (+/- 20 students) and 27 groups (+/- 6 students);
- 3 synchronous Mini-Tests (2 Kahoot, 1 HackerRank);
- 2 CUnit and professors evaluations (middle and end);
- 115 was the average number of responses in CUnit final evaluation;
- 85% of students approved the CUnit gamification system;
- 80% was the minimum attendance of T Classes;
- 144 was the number of bonus attributed;
- 21 cards (Blue, White, Yellow and Red) were attributed;
- 3 students activated the rescue system.

In this analysis, it is essential to highlight some of the achieved online results:

- 208 (two hundred and eight) hours online classes with parallel sessions, in a total of 338 (three hundred and thirty eight) hours;
- 80 (eighty) chat rooms;
- $\sim$ 220k page views;
- $\sim$ 25k access to the CUnit support platform (sessions);
- $\sim$ 16k access to the chat (sessions);
- $\sim$ 15k messages exchanged in the chat;
- $\sim$ 11k file downloads;
- $\sim$ 106 uninterrupted days online (sum of all active sessions time).

A visual analysis of the CUnit impact on the students' online usage and assessments is presented in figures 2 to 8. Figures 2 to 5 resume some of the numbers that are possible to achieve from ioEduc and ioChat (such as page views, events, sessions, among others). Regarding Figures 6 to 8, students evaluated TechTeach approach and their Gamification and online component. These figures prove the results mentioned in the before list and sustain the assumptions taken with this study.

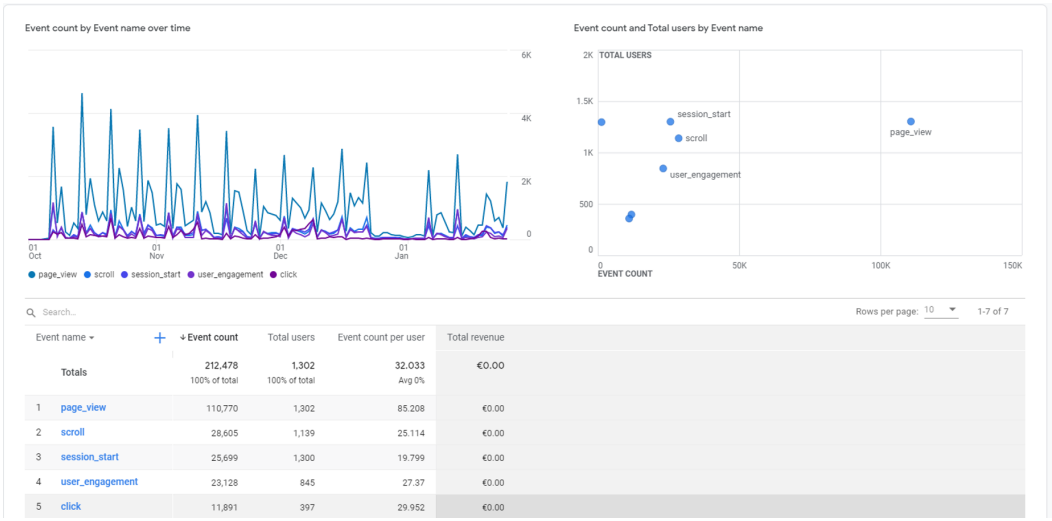

Figure 2 ioEduc – Session and Events.

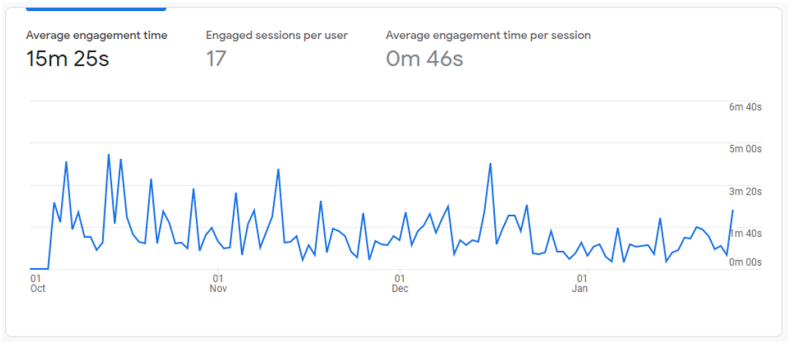

Figure 3 ioEduc – Session Average Time.

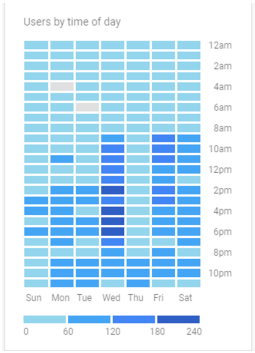

Figure 4 ioEduc – Users work/time.

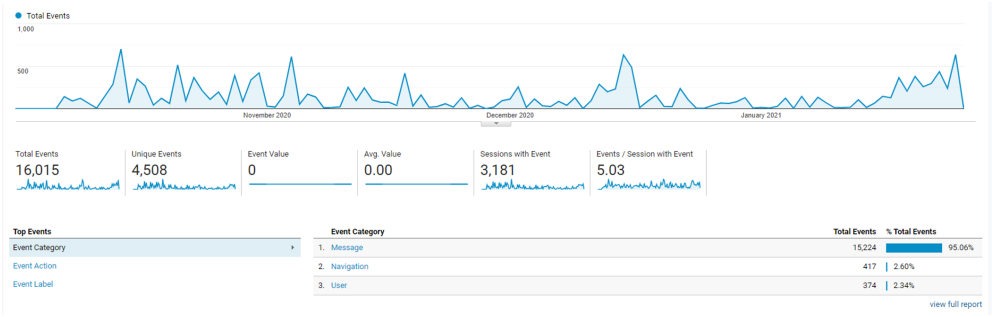

Figure 5 ioChat – Events.

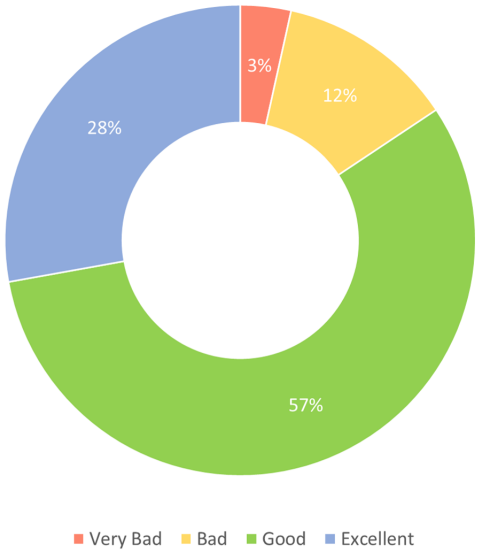

Figure 6 How was the gamification approach?

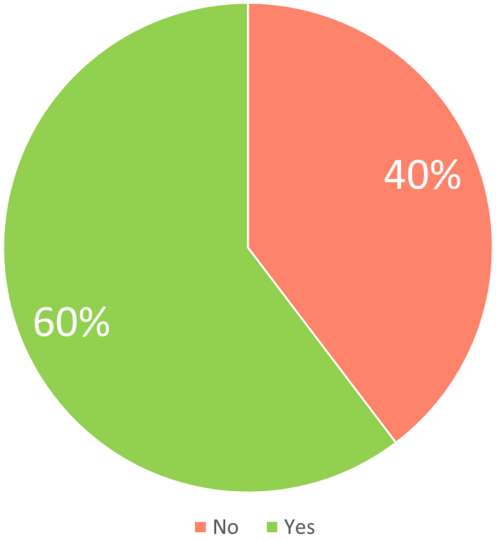

Figure 7 Did you like having online classes?

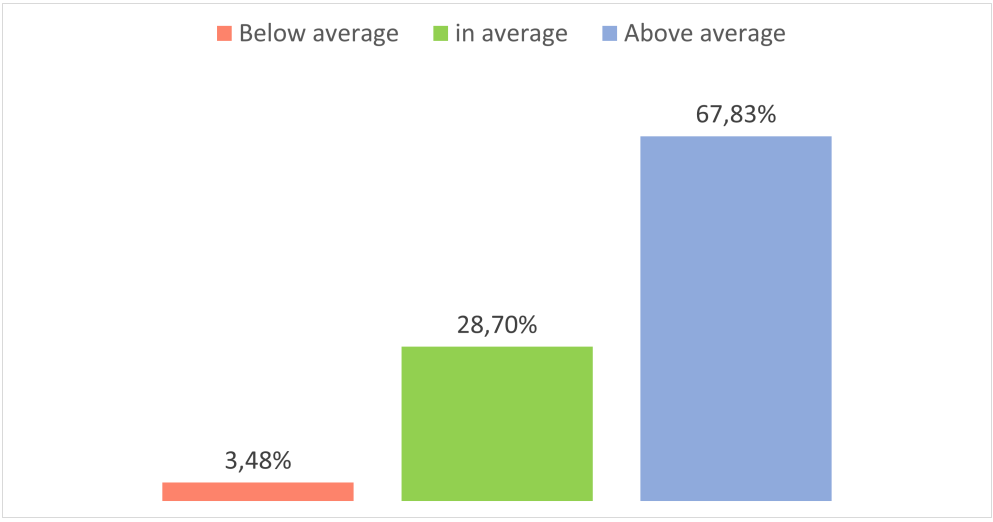

Figure 8 How do you classify this approach (TechTeach) when comparing it with other CUnit?

4.4 Word Cloud

The bag of words is an excellent technique to present students' opinions. After receiving the students' comments, the most positive words figure (9) – dynamic classes and professors – and negative aspects figure (10) – much mater and materials – were identified, as can be observed in the figures.

Figure 9 Positive aspects of CUnit.

Figure 10 Negative aspects of CUnit.

5 Discussion

After concluding this case study, the achieved numbers can give a detailed overview of the students and professors interactions and engagement. There were more than two hundred thousand (232,433) page views, and the average session time was approximately fifteen minutes (15m25s). Users exchanged more than fifteen thousand messages (15,224), and eleven thousand (11,173) downloads were made. A particular fact to mention is the working time: only two periods of time did not have anyone online – Monday from 4 am to 5 pm, and Tuesday from 5 am to 6 am. In all the other hours/day, at least one user was online. Both platforms have at least fifteen thousand accesses during the semester.

In terms of the mini-tests, the strategy used was to have simple exercises under pressure (without much time to think), and questions containing personal attributes that contributed to making each exercise unique. Generally, students liked the MT1 & MT3 (62.39 % approved the model) but disliked MT2. Both results showed the success of the strategy. MT1 and MT3 were easy and allowed to understand the basics, and MT2 was challenging to do copy or thinking; because of that, the students did not liked it.

Finally, and regarding the CUnit, students' opinion was very positive and motivating. More than ninety-five per cent of students (96,53%) considered this CUnit on the average or higher than average compared with other CUnits in this time of COVID-19. In terms of the online class question, it is essential to mention that, although most of the students (60%) liked it, 40% answered "no" The negative answer was essentially due to working conditions (e.g. one computer at home to many users/students or lousy internet).

On the positive side is the Teaching Team and CUnit and TechTeach as one whole, focusing on the professors' availability and dynamism. On the negative side, many answers were "nothing" to mention; however, students indicate some negative aspects related to the quantity of matter and materials taught in the Theoretical classes. Unfortunately, this issue has years and happens because this CUnit is the only one that addresses this thematic in the entire course. So the time is not enough to address all topics, but it is not possible to reduce more because it is crucial to give the students a global overview of Web Programming.

6 Conclusion

This work was used as proof of concept and the case study explored allowed professors to obtain an answer to the research question: "Is TeachTeach ready or adapted to classes 100% online?". The answer is Yes. Both stakeholders (students and professors) considered this approach a success (>80% positive answers). Although good results achieved – more than 220k page views, 40k sessions, 11k downloads of files and 15k messages – it is vital to highlight the effort need to put into practice, for example, the coordinator' effort was $\sim$ 250% multiplied by their teaching hours (8) in an average of 20h a week. With this study, it was also possible to conclude that it is essential to have some "free" time to apply this methodology and keep students engaged. It is necessary to make an extra effort, a good teaching team and, as the word cloud shows, many availabilities to help the students. TechTeach is adequate to the constantly changing teaching system; it brings fresh air to this type of classes and has a favourable acceptance. Unfortunately, this study also showed a considerable gap. In some cases, and although the results are motivating, students fear and distrust online classes. On the other side, the limitations are notorious and, from the 40% of students who did not liked to have online classes, 80% considered that they do not have the correct conditions to do so.

Making a balance and after analysing students opinion (in a time of COVID-19, >95% of students considered this CUnit equal or better than the others online CUnit) and their grades (95% of the active students were approved), the results are much rewarding and offset the effort. As the main contributions of this work are:

- A guide of strategies/tools needed to have an entire online class;
- An idea of the effort needed to have this type of classes;
- Case study results and the receptivity of students to the TechTeach approach.

With this case study, it was possible to prove that the TechTeach approach can motivate students skills and promote innovation and entrepreneurship of them at a distance (online).

As future work, all the data will be dissected, and a Web Mining process will be applied to try to correlate the students' performance with their activity.

References

1 Emilio Abad-Segura, Mariana-Daniela González-Zamar, Juan C. Infante-Moro, and Germán Ruipérez García. Sustainable management of digital transformation in higher education: Global research trends. *Sustainability*, 12(5), 2020. doi:10.3390/su12052107.

2 Wahab Ali. Online and remote learning in higher education institutes: A necessity in light of covid-19 pandemic. *Higher Education Studies*, 10(3):16–25, 2020.

3 C.V. Araújo. The bologna process and curricular changes at higher education: what are skills for? *Educação e Pesquisa*, 44, 2018.

4 Stephanie Bell. Project-based learning for the 21st century: Skills for the future. *The clearing house*, 83(2):39–43, 2010.

5 Marisa Correia and Raquel Santos. Game-based learning: The use of kahoot in teacher education. In *2017 International Symposium on Computers in Education (SIIE)*, pages 1–4. IEEE, 2017.

6 Alexandru Dan and Ass Pr PhD Iftene Adrian. Computer science platform, 2018. BACHELOR THESIS.

7 C. Davis. Flipped or inverted learning: Strategies for course design. In *Enhancing Instruction with Visual Media: Utilizing Video and Lecture Capture*, page 25. Information Science Reference, 2013.

8 Ryan Dellos. Kahoot! a digital game resource for learning. *International Journal of Instructional technology and distance learning*, 12(4):49–52, 2015.

9 Amber D Dumford and Angie L Miller. Online learning in higher education: exploring advantages and disadvantages for engagement. *Journal of Computing in Higher Education*, 30(3):452–465, 2018.

10 Glavin. Examples of project-based learning | k12 academics. `https://www.k12academics.com/Educational%20Practices/Project-Based%20Learning/examples-project-based-learning`, 2019. (Accessed on 03/09/2021).

11 HackerRank. Hackerrank. `https://www.hackerrank.com/`. (Accessed on 03/15/2021).

12 Netta Iivari, Sumita Sharma, and Leena Ventä-Olkkonen. Digital transformation of everyday life – how covid-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management*, 55:102183, 2020. Impact of COVID-19 Pandemic on Information Management Research and Practice: Editorial Perspectives. `doi:10.1016/j.ijinfomgt.2020.102183`.

13 K.M. Kapp. . *The gamification of learning and instruction: Game-based methods and strategies for training and education*. John Wiley & Sons, 2012.

14 Anders D Olofsson, Göran Fransson, and J Ola Lindberg. A study of the use of digital technology and its conditions with a view to understanding what 'adequate digital competence'may mean in a national policy initiative. *Educational studies*, 46(6):727–743, 2020.

15 Paula Toledo Palomino, Armando M Toda, Wilk Oliveira, Alexandra I Cristea, and Seiji Isotani. Narrative for gamification in education: why should you care? In *2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT)*, volume 2161, pages 97–99. IEEE, 2019.

16 Marc Parry. Online, bigger classes may be better classes. *Chronicle of Higher Education*, 57(2):A1–A22, 2010.

17 C. Partenie. The bologna process: Between past reforms and the innovative future. In *Conference: International Multidisciplinary Scientific Conferences on Social Sciences and Arts*, Bulgaria, 2014. Albena.

18 Fanny Pettersson. Understanding digitalization and educational change in school by means of activity theory and the levels of learning concept. *Education and Information Technologies*, 26(1):187–204, 2021.

19 Carolyn M Plump and Julia LaRosa. Using kahoot! in the classroom to create engagement and active learning: A game-based technology solution for elearning novices. *Management Teaching Review*, 2(2):151–158, 2017.

20 Filipe Portela. A new and interactive teaching approach with gamification for motivating students in computer science classrooms. In *First International Computer Programming Education Conference (ICPEC 2020)*. Schloss Dagstuhl-Leibniz-Zentrum für Informatik, 2020.

21 Filipe Portela. Techteach—an innovative method to increase the students engagement at classrooms. *Information*, 11(10):483, 2020.

22 M.S. Ramírez-Montoya. Inverted learning environments with technology, innovation and flexibility: Student experiences and meanings. *Journal of Information Technology Research (JITR*, 9(1):18–33, 2016.

23 Miguel Silva, Diogo Ferreira, and Filipe Portela. Ioeduc - bring your own device to the classroom. In Ricardo Queirós, Filipe Portela, Mário Pinto, and Alberto Simões, editors, *First International Computer Programming Education Conference, ICPEC 2020, June 25-26, 2020, ESMAD, Vila do Conde, Portugal (Virtual Conference)*, volume 81 of *OASIcs*, pages 23:1–23:9. Schloss Dagstuhl - Leibniz-Zentrum für Informatik, 2020. `doi:10.4230/OASIcs.ICPEC.2020.23`.

24 Bill Su. What is google analytics, and why is it important to my business? | by bill su | analytics for humans | medium. `https://medium.com/analytics-for-humans/what-is-google-analytics-and-why-is-it-important-to-my-business-8c083a9f81be#`, 2017. (Accessed on 03/16/2021).

25 Jane Sutterlin. Learning is social with zoom video conferencing in your classroom. *ELearn*, 2018(12), 2018.