education sciences

MDPI

Article

Some Web-Based Experiences from Flipped Classroom Techniques in AEC Modules during the COVID-19 Lockdown

Juan Carlos Mosquera Feijóo [1], Fernando Suárez [2], Isabel Chiyón [3] and Marcos García Alberti [4,*]

[1] Departamento de Mecánica de Medios Continuos y Teoría de Estructuras, Universidad Politécnica de Madrid, 28040 Madrid, Spain; juancarlos.mosquera@upm.es
[2] Departamento de Ingeniería Mecánica y Minera, Campus Científico-Tecnológico de Linares, Universidad de Jaén, 23700 Linares, Spain; fsuarez@ujaen.es
[3] Facultad de Ingeniería, Universidad de Piura, Piura 20009, Peru; isabel.chiyon@udep.edu.pe
[4] Departamento de Ingeniería Civil-Construcción, Universidad Politécnica de Madrid, 28040 Madrid, Spain
* Correspondence: marcos.garcia@upm.es

Abstract: The classroom closure during the first semester of 2020 entailed decisive changes in higher education. Universities have become more digital in both the availability of e-resources and pervasive devices and how students communicate with lecturers and classmates. Learners adapted their study habits with a growing role of self-paced, internet-based strategies. Some flipped learning approaches have proven their efficacy under the remote-teaching physical constraints. This study aimed to appraise the outcomes from the implementation of various web-based, learning-aid tools on flipped teaching approaches in engineering modules. The open educational resources (OER) performed satisfactorily during the lockdown period in three universities from two countries with similar higher education models. Such resources encompassed classroom response systems and web-based exercise repositories, designed for diverse purposes such as autonomous learning, self-correction, flipped classroom, peer assessment, and guided study. The acquired experiences reveal that OER helped students to enhance their engagement, reach the deeper levels of the cone of learning, and widen their range of learning abilities. This procedure is easily attainable for architecture, engineering, and construction (AEC) courses and lifelong learning settings. Feedback from students, instructors' perceptions, and learning outcomes show the suitability and effectiveness of the web-based learning assistant procedure presented here.

Keywords: web-based learning; COVID-19 lockdown; flipped classroom; architecture-engineering and construction (AEC); blended learning; lifelong learning; meaningful learning

Citation: Mosquera Feijóo, J.C.; Suárez, F.; Chiyón, I.; Alberti, M.G. Some Web-Based Experiences from Flipped Classroom Techniques in AEC Modules during the COVID-19 Lockdown. *Educ. Sci.* **2021**, *11*, 211. https://doi.org/10.3390/educsci11050211

Academic Editor: James Albright

Received: 27 March 2021
Accepted: 27 April 2021
Published: 29 April 2021

1. Introduction

During the first months of 2020, universities all around the world had to face a sudden shift to online learning, due to lockdown, as a consequence of the COVID-19 global pandemic. Since this situation overcame with no time for preparing, the teaching resources, nor the technological means that online teaching implies, it can be argued that, in general, universities were not prepared to face this challenge and a huge effort had to be made by institutions and lecturers in order to handle teaching in the most satisfactory way.

Moore and Kearsley [1] defined online teaching as a planned learning that takes place in a different location where it is taught and other authors [2–4] made a distinction between the online synchronous teaching (real-time interaction) and the online asynchronous teaching (no real-time interaction). It is clear, nowadays, that the World Wide Web (WWW) not only facilitates asynchronous learning, allowing anytime and anywhere learning, but it also makes synchronous teaching by means of virtual meetings using video-calls easier [5]. The WWW provides a wide range of teaching possibilities that have been exploited intensely during more than two decades [6,7], and nowadays, it is hard to imagine higher education without its use [8]. Nevertheless, these tools are usually combined with other traditional teaching methods, such as master classes and problem-focused sessions, which are particularly relevant in the context of many engineering courses. For example, it is worth mentioning the work by Manseur and Zohra that analyzed the performance of synchronous distance programs in Electric Engineering and Mathematics at West Florida University [9]. In the context of the global pandemic motivated by COVID-19, the use of online tools has sharply increased for obvious reasons, pushing lecturers to adapt their teaching strategies from one day to the next.

There is a wide variety of published research on the factors that influence learning achievement, ranging from physical parameters, such as classroom design, lighting, air quality, and temperature [10], to instruments or techniques that affect advanced levels of the learning pyramid [11]. The debate is even more complex about the advantages and disadvantages, benefits and weaknesses of the use of digital resources in higher education. Considering that electronic resources have undergone a transformation in university teaching and management [12,13]. These include learning management systems, mobile devices, and multimedia and interactive digital resources [14–16]. In this sense, educational websites are an effective way to achieve learning results such as checking, applying, putting into practice, analyzing, and even evaluating [17]. On the one hand, they facilitate students to learn at their own pace through electronic devices that they usually handle daily and with great dexterity [18,19]. On the other hand, they contribute to collaboration among universities as an internationalization effort [20,21].

Higher education has performed such a significant effort to implement Open CourseWare (OCW) or Massive Open Online Courses (MOOC) that has led to an attractive alternative for autonomous learning in webpages such as miriadax.net or coursera.org. However, most of the students leave courses after the first two or three lessons [22–24]. In addition, web-based learning has shown several advantages such as economics of scale, novel instructional methods, or flexible scheduling [25]. Among them, the possibility of overcoming barriers of distance has been of special interest during the COVID-19 pandemic situation [26]. Moreover, web-based learning became an attractive alternative for training during several months in most of the developed countries. During this period, the use of online means became essential for education, and a large number of materials, mainly videos and documentation, have been created and submitted to the internet. Thus, web-based learning materials have helped students and professionals to make the best use of their possibilities and improve their lifelong learning resources. In addition, web-based learning provides the learner with greater control over the learning process, schedules, and environment, allowing them to select multiple and varied learning opportunities. This individual learning could be of higher impact in the long term, given that self-motivation is the starting point of the learning process. Nevertheless, in order to achieve meaningful learning, some interaction is needed, and several drawbacks must be considered such as social isolation, responding to the real individual need, cost associated with developing, poor institutional programs, and the use of technology for the sake of technology [25,27]. Some other questions, such as the comparison of face-to-face learning, will always remain in the grey area, though there is no doubt that web-based learning has become relevant in these pandemic days and that the study of the best performance of the use of these methods is of great interest for lecturers and institutions [28].

The global sanitary crisis has boosted the digital transformation in many organizations, ranging from the sanitary field and industry to higher education [29]. Some digital transformation goals are to better serve customers and increase efficiency in processes. Thus, the migration of all paper and manual record-keeping into electronic files is still an ongoing process. Indeed, university policies are struggling to maintain a competitive edge, which is even more concerning when looking at the declining figures of incoming students. The closure of classrooms also entailed a large variety of changes in teaching strategies all around the world. The pandemic disrupted some assumptions of the teaching-learning process in higher education. Some higher education teaching frameworks previously established are not guaranteed to function from now. The pure lecture model may no longer be an acceptable teaching pedagogy, as the rise of technology has arrived to stay [30].

The impact of the pandemic on higher education is still open for debate, and guidelines, experiences, and recommendations are increasingly emerging [31,32]. Web-based learning frameworks have gained presence during the development of digital transformation of universities [28,33]. As students are digital natives, it appears necessary to identify their perspective on the use of technology in the academic context, as well as with what purpose and operations students use the technologies, and to understand what their expectations are [26,34]. At the same time, it seems attainable to harness the benefits of digital media to communicate with them and guide their training. One interesting technique is the inquiry-based learning by using the so-called Immediate Response Systems (IRS)—or Student Response Systems (SRS) or Classroom Response Systems (CRS) [35–37]. These include elements such as the development of a positive relation with failure, objectivity, and continuous assessment as usual targets. They also introduce breakpoints during impartations to recall student attention and focus on key aspects of the lessons [38,39].

Diverse studies focused on evaluating the readiness of lecturers and the feasibility of LMS [40,41], others on collecting students' perceptions [42–44], on analyzing the impact of the online format on studying at home [44,45], on learning achievements [46,47], and on the efficiency of flipped teaching methods [44,48–52]. It appears that blended learning methods have suffered less than other teaching approaches during this sudden shift to remote teaching [51]. However, lecturers had to harness the best of flipped teaching and adapt it to a completely virtual context [44,49–52]. Other studies addressed the social impact of the pandemic crisis on the professional careers [53] and the lecturer's role [54], as well as the relationship between lecturers and learners [55]. Nevertheless, these are currently open fields for debate [56].

This study aims to appraise the outcomes from implementing various web-based learning-aid tools on flipped teaching approaches in engineering modules: the use of CRS, web-based repositories of problems and exercises, pre-recorded videos, and a problem-based learning approach for technological Master's engineering courses.

This study collects both lecturers' and students' perceptions and feedback with the aim of implementing further teaching measures. The information gathered comprises lecturers' perceptions, final grades, learning outcomes, feedback from online questionnaires delivered to students, as well as individual and group interviews.

2. Methodology

This study belongs to a collaborative project carried out by professors of the Universidad Politécnica de Madrid (UPM, Madrid, Spain), Universidad de Jaén (UJA, Linares, Spain) and Universidad de Piura (UDEP, Piura, Perú). The scope was to share techniques, methods, resources, and strategies for home and classroom learning in accordance with the United Nations Educational, Scientific and Cultural Organization (UNESCO) recommendation in promoting and reinforcing international cooperation in open educational resources (OER) [33]. The project focuses on applying innovative methods in higher education since digital technology and remote instruction are stepping ahead of face-to-face teaching [57]. The methodology aims at helping students to improve their learning of some key concepts of structural analysis, construction management, and operations research, although it is easily implementable in courses of other AEC disciplines.

This work builds on a renewed boost of a merged learning technique under the convergence between distance and face-to-face learning for undergraduate students of fundamental subjects in civil engineering [58]. It focuses on the use of digital resources for integrating their autonomous homework with classroom involvement and aims to swap passive class time for just-in-time teaching, give quality time classes, improve achievements, and enhance the instructor's role [28]. Thus, the application of OER contributes to increasing the number of e-resources available to the community following the current digital transformation trend undertaken by universities [33,59]. Some essential features of the OER described are scalability, third-party availability, and transferability. In this regard, other AEC teaching units holding these modules can either use or adapt these contents as needed. Such a repository can also be reshaped as an e-resource for lifelong learning experiences, through which alumni can refresh or update some technical concepts over the years [60].

Learning Management Systems (LMS) have been increasingly used in higher education, albeit played a noticeable role during the lockdown period. Furthermore, some tools such as CRS—also called Immediate Response Systems (IRS)—, repositories of web-based interactive problems and videos have proven effective for calling student engagement and prompting them for active learning [37].

On the one hand, formative assessment is admitted to enhancing learners' achievement based on seeking success through failure [61–63]. Nevertheless, this methodology must address three well spotted challenges: (1) how to be effective in promoting meaningful learning, (2) how to tailor grading practices that promote personal improvement rather than competition, and (3) assessment feedback may cause a negative impact on low-achieving students, who are prone to seem to be unable to learn and may become discouraged [59,60]. In this regard, the CRS approach allows an instructor to collect feedback immediately and relies on the individual discretion, as most students are reluctant to speak up and engage in large groups. CRS may become a useful ingredient of the question-driven instruction (QDI) approach, occasionally used together with traditional teaching practice, instead of the classical transmit-and-test classroom model [64,65].

The methodology applied in this project aims at leveraging students' digital skills, boosting their active participation in remote teaching and assessing their learning. The target is to improve learning outcomes for both undergraduate and graduate engineering students. This study explores some results from the application of various student response systems in the classroom (SRS, IRS or CRS), namely Kahoot!, Socrative and Mentimeter.

On the other hand, the web-based tools aim to boost students' receptive and productive skills while learning the principles and the elusive concepts of construction-related subjects. A large percentage of students encounter difficulties in acquiring the knowledge of the basic principles of behavior of some usual structural typologies related to civil engineering constructions.

The OER described here were intended to enhance students' capabilities and spatial reasoning skills for envisaging the physical meaning of some intricate underlying concepts. The learning aid approach presented here encompasses a repository of interactive exercises and problems, written in HTML5, CSS and JavaScript, and is based on a problem-solving strategy. This tool is also adequate for self-correction, self-assessment, flipped teaching, guided study, and peer assessment, among other features [66,67]. This e-learning tool boasted good performance and acceptance during the confinement period at both UPM and UJA.

The indicators considered include the students' perception of the usefulness and benefits of the system employed, the agreement between expectation and system performance, satisfaction upon using the web-based systems, and the users' readiness to continue using the system in future courses.

This study also handled diverse control variables such as the teaching modality (synchronous or asynchronous), the course type (fundamental or technological, undergraduate or graduate), the instructor's predisposition and readiness to innovate, and previous experience with educational innovation, among others.

The students were surveyed twice during the semester and invited to participate in either individual or group interviews. Survey results provided quantitative data about student usage of digital technology, their purposes, the ways they did, and for what tasks. The interviews and observed classes provided valuable information around their reasons to do so.

2.1. Classroom Response Systems (CRS, SRS or IRS)

The changes in higher education have involved significant changes in the learning-teaching system, starting from the lecturer and reaching the students. Universities have encouraged the teaching staff to introduce modifications in the traditional teaching techniques. One of the main issues in AEC and science, technology, engineering, and mathematics (STEM) disciplines is the use of new methodologies and technology in the evaluation tasks, seeking to enhance the motivation of the students. This is a key aspect because there is a direct relation between the motivation of the students and their results. Since the 2017–2018 academic year, the assessment of Construction Management combined both the traditional methodology with some gamification approach based on Kahoot, Socrative, and others. These apps allow performing questionnaires in the classroom in real time. Moreover, the answers of the students can also be evaluated in real time, and after each question, a ranking of the students is shown. This permits the lecturer to focus on the main points of the lesson as well as breaking the monotony of the lecture at any time the lecture considers. In order to promote the daily study of the modules, a certain percentage of the final mark was obtained through the analysis of the Kahoot! tests. The influence of introducing such techniques, in the motivation towards the modules, was assessed by a test whose results can be seen in Figure 1.

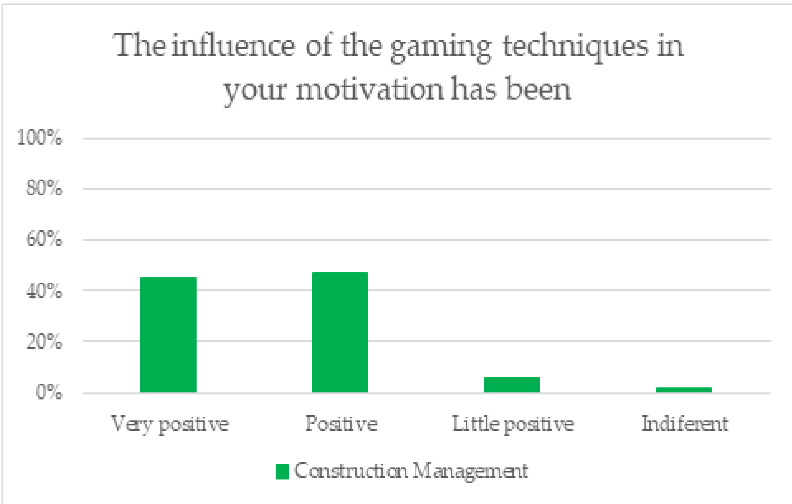

Figure 1. Results of the final survey regarding the influence of inquiry-based learning techniques introduced.

Therefore, some gamification methods were used before the COVID-19 lockdown and these previous experiences served as an approach to what was needed after the pandemic situation. At the time of writing, many implementations have been included in the modules Construction Management in the Bachelor's degree in Civil Engineering and Smart Construction: BIM in the Master's degree in Civil Engineering. However, the perception is that Kahoot! was already known and several new options, such as Socrative and Mentimeter, helped to improve the motivation during the lockdown. Mentimeter works in a similar way, although it features several new options such as the one shown in Figure 2 that help lecturers to promote student participation.

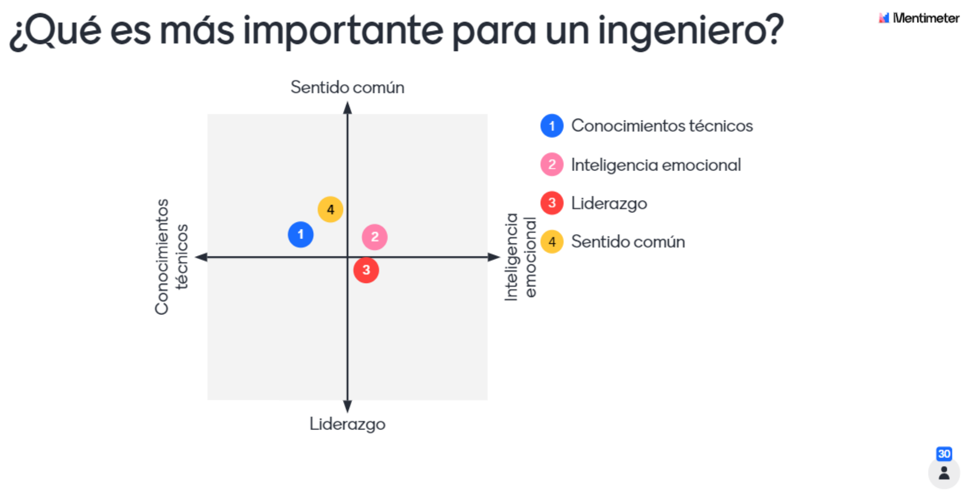

Figure 2. Mentimeter slide with 30 participants in Spanish with the open question: What skill is the most important for a Civil Engineer? and the answers: 1 Technical knowledge, 2 Emotional intelligence, 3 Leadership skills, 4 Common sense.

Some other tools were implemented during the lockdown given that there was not any possibility of student visits to construction sites. This activity was performed twice during the semester every academic year. Thus, this activity was substituted by the use of videos related to the construction processes and the management. In the same sense, Computer Laboratory activities in which the students learn how to use construction related software were also substituted by video-lectures. The main problem that the teaching staff had to face was that it was difficult to follow the assessment and the student could not see all the videos prepared for that aim. In such a sense, the use of Edpuzzle was of special interest as it permits inserting questions in the video sequentially. Thus, the students had to answer all the questions and the lecturer could see if they had seen it completely. After that, some exercises to put in practice, and the content of the video, were also proposed and marked for each of the activities.

2.2. Problem-Based Learning (PBL) and Classroom Response Systems (CRS) Strategies

PBL and CRS strategies were also designed with the aim of getting students to participate in knowledge reworking activities, as well as allowing them to get involved in real situations. Engineers use mathematics to describe and interpret situations, but find it difficult to identify, in the context of their work, the mathematics they have learned and envisage their physical implications.

The modules included in this study focus on practical and professional issues that students need to attain. This justifies that most classes are technologically oriented so students should achieve a variety of competences by means of a sequence of problems, projects, and challenges with increasing complexity. In this regard, the web tools presented can be properly applied in problem-based teaching practices [8]. Pre-recorded videos and the repositories of both online quizzes and interactive problems on Strength of materials, Structural analysis, Construction management and Operations research are intended to be used with the problem-based model.

2.3. Web-Based Strategies

This line of action aims to boost students' receptive and productive skills while learning the fundamentals of Structural Analysis. It draws on the difficulties encountered by a large percentage of the students in understanding the implications of the principles that govern the response of some simple structures with widespread application in civil engineering constructions.

The formal object encompasses the combination of web-based tools with other open educational resources (OER), which altogether contribute to enlarging the availability of the so-called e-textbooks [14], necessary for the blended learning models implemented at these teaching units. The web-based material focuses on enhancing students' spatial reasoning skills for envisaging the actual response of simple structures. This entails mastering concepts such as equilibrium, bending stiffness, force transmission, support conditions, moving loads, worst load combinations, and envelopes of response features. As a result, learners become able to identify the critical sections of a given structure and envisage the most unfavorable loading for a given structure.

The resource is freely available through any web browser. It encompasses a collection of pre-recorded videos with classes given by lecturers, a collection of pre-set Socrative tests and a repository of interactive problems and exercises written in HTML and JavaScript to be accessed through any web browser.

The pre-recorded videos harness the availability of the digital tablets as a modern version of the classical blackboard [68,69]. It is useful for both on-campus and remote teaching [70]. Figure 3 shows a snapshot of a screen during a class. Teaching with a tablet allows the lecturer to add colors and images easily, save the successive screens and voice, export them to digital format, and generate new e-resources. Tablets facilitate instructors the benefits of an attractive electronic lecture presentation and the ability to signal and jot down directly on the screen, remark relevant aspects, or respond to student queries. These are enormous advantages compared with the classical blackboard sessions. Besides, the tablet has proven to be a useful and effective device during the lockdown period for both tutorials and student follow-up. It has changed the classroom interaction and communication between students as well as collaborative work [71]. At the same time, it has become highly adequate for ubiquitous teaching [13].

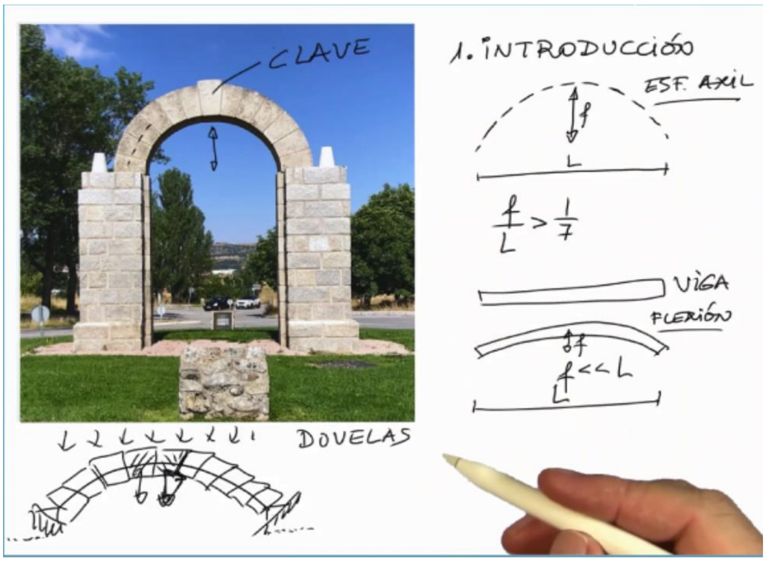

Figure 3. Snapshot of a class taught with a tablet and the digital pencil.

The collection of web-based problems and exercises has increased the OER available to learners and has been conceived for a multitasking purpose: autonomous learning, self-correction, flipped teaching, peer assessment and guided study. Its topic sequence follows the course syllabus development. Once the user has accessed, chosen the preferred language (Spanish or English) and topic, and selected an interactive exercise, they begin an interactive exercise. Then, a sequence starts, consisting of the statement, solving triggering, solution, rubric, and feedback provided by the system. The user can set the desired data values for physical and mechanical properties of the structural system, i.e., the span lengths, support conditions, load types and values, and flexural stiffness. Then the structural system is plotted on the screen.

After setting the problem data, upon clicking a "calculate" button, the system returns the numerical results and graphic output for the user-defined data. The latter draws on the advanced features of JavaScript and jQuery.

The user can browse back and forth throughout the diverse parts of the exercise, which includes a help context providing hints, remarks and comments at each solving step. Besides, these web pages may include some links to complementary short videos. In this way, the users can take ownership of his/her learning. To date, students have found them useful to understand the spatial impact of loading and support conditions on the structural response. In this regard, outcomes indicate that this collection of interactive problems and exercises is a helpful tool for autonomous learning.

Scalability is one advantage of this repository with interactive exercises and problems, either with increasing complexity or with the number of examples included of which a sample is shown in Figures 4 and 5.

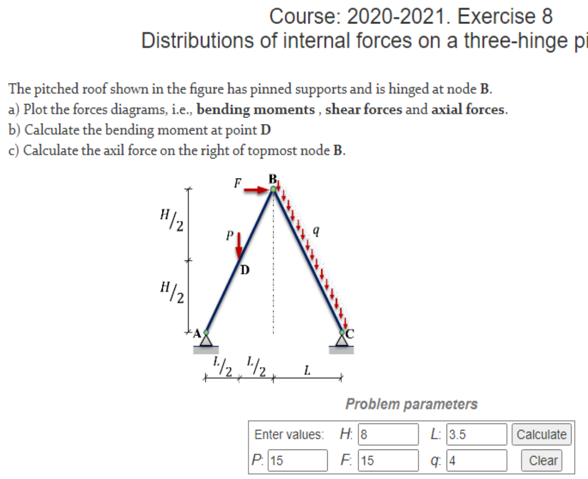

Figure 4. The statement of an interactive exercise on Structural analysis. The user can assign values to diverse parameters. Upon clicking the "Calculate" button, the web system shows the numerical and graphical output, partly shown in Figure 5.

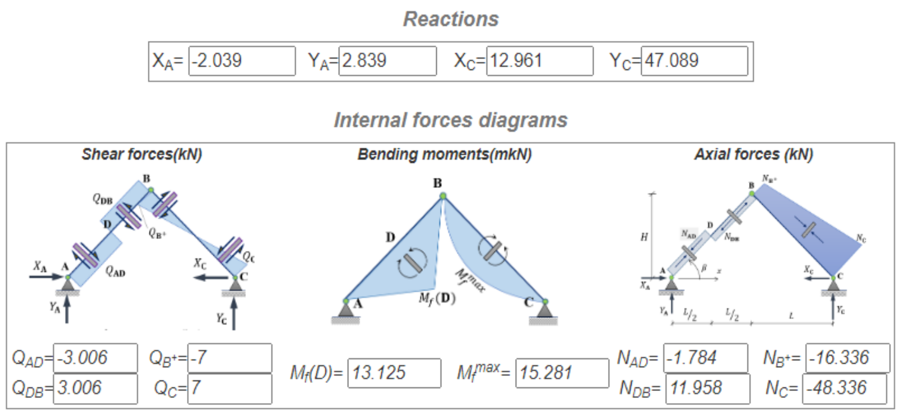

Figure 5. Immediate responses to the interactive exercise on Structural Analysis. When used for self-correction, the user can check his/her own handwritten procedure and results with those from the web.

3. Teaching-Learning Experiences during COVID-19 Lockdown

A summary of the experiences carried out during the lockdown period in engineering modules of the above mentioned three universities is described in this section. Such experiences deal with flipped classroom techniques under the physical constraints of remote teaching and evaluation. The experiences described here correspond to courses including Strength of materials, Smart construction: BIM, Construction management, Elasticity and Strength of materials II, Operations research I and II, and Dynamic and seismic analysis of structures. These semester modules were taught remotely and engaged 671 registered students.

Some sets of pre-recorded videos with teachings played a core role among the e-resources used in the accomplished flipped-teaching model. Indeed, they constituted a remarkable resource for the autonomous learning stage. Each subject has its own growing collection, which is reviewed on a semester basis. Lecturers prompt students to visualize some videos and do some homework, mainly exercises and problems. To ensure their viewing and comprehension of these multimedia files available for individual study, the pre-recorded videos included short questions sparsely inserted (Edpuzzle) so that students could only continue watching them after replying. Learners highly valued this feature as a motivating feature.

The first class time after the homework study stage was devoted to both testing the at-home individual learning and just-in-time teaching. The former included performing online quizzes through the CRS or responding to an on-the-fly exercise, which resembled the assigned homework, as a way to encourage students in their active learning. The latter helps to promote the use of class time for intensifying active learning [64,72,73]. The underlying purpose of this blended learning approach comprised four ingredients:

- Encouraging open discussion, giving more dynamic classes and lessons more interactively.
- Using technology properly to enhance engagement.
- Keeping, when possible, concise sessions within class time, diversifying activities to avoid boring one or two-hour passive sessions.
- Integrating some type of entertainment and professional perspectives in training.

3.1. Classroom Response Systems

In order to assess their individual learning in the fundamental degree subjects, students were prompted to solve at-home weekly exercises delivered through the LMS and to make short online quizzes with the IRS at least once a week during class time. The digital tools employed were Kahoot, Socrative, and Mentimeter. Figure 6 shows a snapshot of a Socrative item.

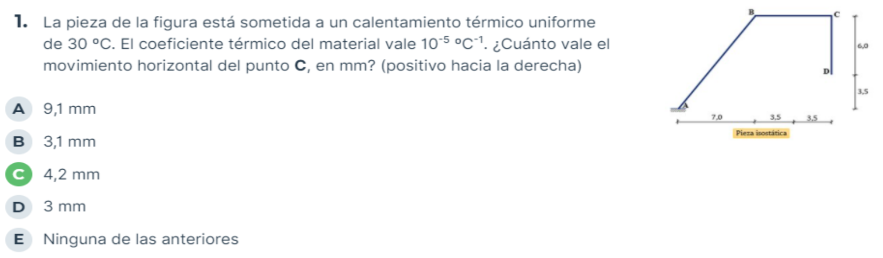

Figure 6. A question from a Socrative quiz on Strength of materials (from the instructor side).

During class time and after closing the online quiz, the lecturer solves the problem or exercise on the tablet and responds to queries or difficulties raised by the students.

Survey results indicate that students highly appreciate the use of IRS in their learning process, as this helps them to make the pedagogical practice more dynamic and point out the relevant issues of a subject.

3.2. Web-Based Parameterized Problems (UJA and UPM)

The use of flipped-learning techniques is starting to be introduced in several courses of Civil and Mechanical Engineering at University of Jaén (UJA). In these courses, mainly dealing with Strength of Materials, it is of paramount importance to help students to master the most relevant aspects regarding the way the beams behave under different loading scenarios, how they modify their bending moment and shear stresses diagrams, as well as their deformation. These abilities are fundamental for the students to understand more complex structures that are covered in later courses of these degrees.

In this case, the use of web-based problems is focused on flipped-learning experiences where the teacher guides students through a specific problem to make them think and question their knowledge about key aspects regarding the behavior of a beam under loading. The main goal is to stimulate students and deepen their knowledge, so they acquire a certain intuitive understanding of how structures work.

The experience is carried out as follows: at the end of a class, the students are presented a new problem to solve, which has several parameters that can adopt different values (Figure 3 shows one of the proposed problems). This problem can be solved by means of a web page where students can experiment by modifying the values and observing the results in an interactive way (they see the resulting bending moment and shear stresses diagrams, the deflection of point D). The main goal of this problem is not to solve it, which can be easily done with the web page, but thinking of several key issues that the students must try to guess by intuition and, then, check with the help of the web-based problem. To this end, the students are given a set of questions to answer regarding the proposed problem. In the case of the problem shown in Figure 7, for example, they were questioned about how load P affects deflection of point D (does increasing P make D move upward or downward?) and whether load q induces a positive or negative moment in A. Before the next class, the students must use the web page to solve these questions and check if their intuition is correct about them. Finally, at the beginning of the next class, the teacher opens a debate where students talk about their findings. This debate takes no longer than fifteen minutes, but it is extremely rich, since it helps students to connect their knowledge and better understand how structures work. They must be able to solve problems by using specific methods taught in class. They also have the chance to understand them better, often connecting some concepts with others, finding out that what they have learned in different courses are not isolated boxes, but related. The lecturer conducts this debate to help them to find the correct conclusions.

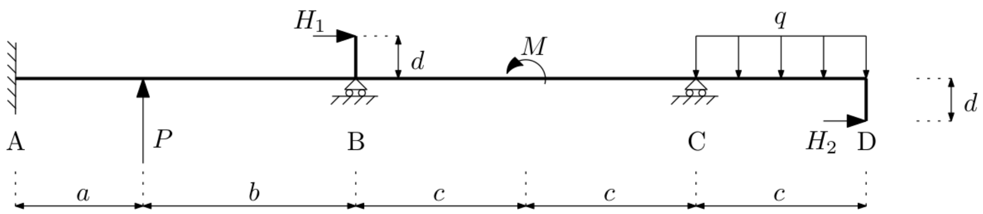

Figure 7. Parameterized problem used in one of the web-based flipped learning experiences proposed at the Universidad de Jaén (UJA).

During these experiences, only about 25% of the students proved to work properly on the problem, the rest only used the web-based problem occasionally but did not think much about the proposed questions. This can be because this was a new experience to them, and they were not used to it. Nevertheless, the experience was interesting for all the students, since all of them were present in the debate, which helped them find the same conclusions as the rest.

The web repository of parameterized exercises and problems also proved to be an adequate resource for guided-study class sessions. The lecturer hands out an online exercise and explains the basic guidelines to solve it. No two data sets are alike, since the statement data (spatial layouts, stiffness, loads, etc.) are functions of the registration number of learners. They attempt to solve each one's exercise and hand it in to the LMS. Then, the lecturer unlocks the URL with the interactive problem so that students can check their corresponding numerical results and find complementary hints. Besides, they can raise queries and arguments, thus converting this part of the class in quality time.

3.3. *Web-Based Parameterized Problems (UDEP)*

The undergraduate third-year students to whom UDEP allocated the experience featured organizational skills, teamwork ability and responsibility still in the making. Besides, given their work context (social isolation, very large classes, and extensive syllabi), the teachers conducted the research, raised the problems and targets, provided the bibliography and resources, and performed activities to ensure that the students developed the necessary work and achieved the expected knowledge.

The PBL-CRS strategies used in the Operations Research dictation experience encompassed the autonomous study of the theoretical framework and the ex-post resolution of problems assigned to the students, either individually or in teams. The achievement indicators included the application of an algorithm, the ability to introduce a new concept or procedure, to deepen its meaning or usefulness, and/or problem aspects that raised learning difficulties.

With this PBL-CRS strategy, students must argue their answers, thus avoiding random or improvised responses. Unlike the traditional teaching practice consisting of asking questions throughout the session, which involves only a few motivated students, the employed strategy includes a structured questioning process, what requires the participation of the entire class. The autonomous homework stage comprises studying the theoretical background, doing exercises, responding to short quizzes, and designing brief projects. In this regard, they have available the support material and e-resources on the LMS (UDEP Virtual), which constitutes a program of activities that can be carried out either individually or in teams. Thus, they can demonstrate competence achievement for each stage by advancing in the resolution of problematic situations. Figure 8 shows the students' satisfaction survey on the comparison between remotely oriented work and traditional teaching on Operations Research at UDEP.

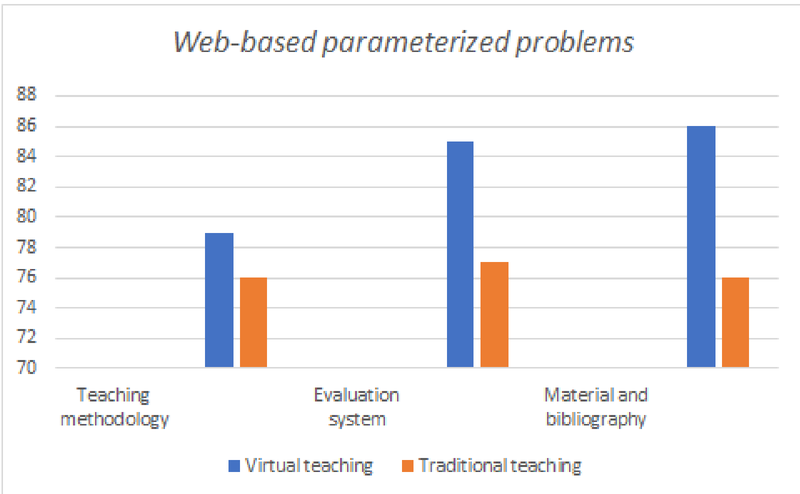

Figure 8. Survey feedback: remotely oriented teamwork with the PBL-CRS strategy versus traditional teaching at UDEP. Ordinates indicate students' degree of satisfaction.

4. Results and Discussion

The web-based resources used for flipped-learning techniques, where the teacher guides the students through some key aspects of the behavior of structures, proved to be of great interest, particularly during the lockdown period. A correctly designed and guided experience by the teacher provides students with a valuable opportunity to think about some general structural aspects that can be eluded by only solving problems using specific methods taught in class [19,25].

The students' participation was somewhat limited, but the final debates that led to highlight the main conclusions took place in front of all the students, so any could follow the most meaningful aspects of the problems.

In this experience, an alternative to traditional engineering teaching has been implemented, developing activities based on the PBL model and adopting a CRS to improve communication in the classroom. The design of the activities took into consideration some learning difficulties and the related teaching proposals and advice identified by the research on the field [34,49–52]. In this regard, noticeable differences resulted in the suitability of web-based methods between undergraduate courses and Master's courses, and between fundamental and technological modules.

Some of the items included in the surveys were:

(1) Degree of satisfaction with the individual learning experience.
(2) Usefulness of such implementation in class time.
(3) Applicability of this procedure to other units in this module.
(4) Fulfilment of learning expectations.
(5) Initial individual readiness to perform the task.
(6) Current readiness after having performed the task.
(7) Readiness to perform the task in groups.

Table 1 shows the results from 220 survey respondents for an undergraduate module taught during the confinement period.

Table 1. Students' perceptions on the use of CRS for assessing learning in a flipped teaching model in Strength of materials at UPM.

Item	Highly Agree	Agree	Neutral	Disagree	Highly Disagree	Mean	Standard Deviation
(1)	20.7%	51.7%	24.1%	16.7%	0%	3.90	0.76
(2)	17.2%	72.4%	6.9%	20.0%	0%	4.03	0.61
(3)	36.7%	26.7%	33.3%	9.1%	0%	3.97	0.91
(4)	26.7%	53.3%	16.7%	12.5%	0%	4.03	0.75
(5)	16.7%	46.7%	33.3%	20.0%	0%	3.77	0.76
(6)	50.0%	36.7%	10.0%	6.7%	0%	4.33	0.79
(7)	71.0%	25.8%	0.0%	4.5%	0%	4.65	0.65

Students were also surveyed about the exams, the usefulness and adequacy of OER. Table 2 shows feedback for technological modules at UPM and UDEP for the following questions:

(1) The ease of last exams: (5) very difficult; (1) very easy.
(2) Adequacy of exams to the subject syllabus.
(3) Preference about onsite exams vs. online.
(4) The usefulness of CRS on your learning achievements.
(5) The usefulness of LMS on your self-paced learning and learning achievements.
(6) How do you value your PBL learning achievement during the pandemic?
(7) Degree of satisfaction with the OER delivered by the instructors of the subject during the lockdown period.
(8) Certainty on having mastered the key concepts taught in the subject.

Table 2. Survey feedback on the adequacy of exams and the usefulness of the OER provided within the flipped teaching model at UPM and UDEP.

Item	Highly Agree	Agree	Neutral	Disagree	Highly Disagree	Mean	Standard Deviation
(1)	0.0%	2.9%	42.9%	45.7%	8.6%	2.40	1.24
(2)	17.1%	54.3%	20.0%	8.6%	0.0%	3.80	1.26
(3)	42.9%	34.3%	8.6%	11.4%	2.9%	4.03	1.51
(4)	5.9%	38.2%	29.4%	14.7%	11.8%	3.12	1.64
(5)	5.9%	47.1%	14.7%	26.5%	5.9%	3.21	1.61
(6)	17.3%	28.8%	34.6%	17.3%	1.9%	3.42	1.57
(7)	36.5%	36.5%	23.1%	3.8%	0.0%	4.06	1.29
(8)	11.5%	36.5%	42.3%	9.6%	0.0%	3.50	1.38

Some achievement indicators are worth mentioning:

- What lessons have been more beneficial in the use of the web-based resources? Around 65% of students witnessed that those interactive exercises associated with the first few chapters ranked at the top because they were helpful to grasp the principles and fundamentals of the module.
- Which are the most complex problems of the repository? Half of survey takers pointed at those of the second half of the course, associated with more advanced concepts.
- Which improvement opportunities are the users demanding? Around 25% of students' suggestions or comments were fair enough to be considered for improving either the content or the structure of the repository.
- Which other lessons or concepts are eligible for inclusion in the repository? Answers ranged from preliminary concepts and theoretical background to advanced topics that belong to subsequent modules.
- The ease and usability of the web-based tools: the mean value was 3.65 in a scale from one up to five.
- Other comments: 48% of surveyed students stated that they lacked the fundamentals needed to properly achieve the subject skills and learning.
- The dropout rate in fundamental subjects reached 22%, which was notably higher than in technological modules, which was lower than 10%.

Feedback from surveys, outcomes, and interviews indicate that the use of CRS promoted a mind shift in students: more than 50% have increased attendance and improved their achievements. More than 35% swapped shyness for active participation in the classroom, along with transferable skills. In exchange, they demand some reward for accomplishing these tasks. On the lecturer side, CRS become helpful instruments provided that they may make the classroom pedagogical practice more dynamic. Besides, CRS tasks yield a rapid assessment, which can become motivating for students and useful and low-effort demanding for teachers [74–77].

Two major forces have affected higher education during the lockdown period caused by the global sanitary crisis: digital technology for remote teaching and the policies and structures of higher educational entities. The former issues have increased the access, inclusion, and efficiency of some processes, albeit the outcomes seem to highly depend on its implementation [28] and monitoring [67]. Another remarkable benefit is that, when combined with some blended learning models, students can take ownership of their active learning [78–80]. Indeed, more than a few universities are boosting vice-rectorates of Strategy and Digital transformation. This passes through the modernization of equipment, facilities and digital media, but it must involve a widespread set of measures to tackle three pending tasks: the digital divide, inclusion, and the quality standards. The former entails that lecturers acquire digital competences accordingly [81]. The term inclusion refers to the ongoing, and transformative, process of improving education systems to meet all learners' needs, especially focusing on low-achieving students or students from low-income families.

Likewise, there is wide concern that universities are lowering the bar and dropping the standards, so student training is becoming poorer. Module requirements have lessened and the implicitly assumed levels of reading and writing are cutting off [82,83]. This entails that the students devote less and less time to their studies and fail to develop productive skills such as critical thinking, spatial reasoning, or argument abilities, among others [84]. As a result, some grade inflation seems to have appeared [85–88]. Many classes are still designed as passive lectures with few applications and scarce active engagement, which limits skill development and competence acquisition [89–91]. Conversely, achievement is directly linked to the stimulation of meaningful learning by delivering information in a clear and alluring way, relating it to the learners, and using conceptually demanding learning tasks [92]. This, indeed, involves the use of digital technology. In this regard, the authors witness that web-based, learning-aid resources can be valuable tools for engagement and active learning.

Research on flipped learning, understood in terms of peer-reviewed journal articles, books, and conference proceedings, is soaring from these last years on. A variety of experiences and studies can be found elsewhere with regard to the switch to online teaching and examinations because of the pandemic. Online higher education has taken a step forward, and, somehow, most lecturers are increasingly teaching online on a regular basis [50,52,56]. Instructors and administrators realized that physical attendance to classes is not linked to learning outcomes [46,48].

Some studies reflect students' dissatisfaction with online learning in general during the lockdown period, and particularly with the communication and Q&A in online classes whereas the combination of online teaching with flipped learning model has improved students' learning, attention, and evaluation of modules [44,48]. Conversely, this study has not detected such degree of dissatisfaction among students in view of the results [26,43,54]. The teaching experience acquired from the pandemic sheds light about strategies and practices to be kept after COVID times, since they are suitable to switch between blended and online classroom models [26,46,52]. Other studies show a high agreement among students that flipped teaching has promoted the development of valuable skills for their personal and professional future. These include character building, collaboration, communication, citizenship, critical thinking, leadership abilities, digital competences, and creativity [50,53].

The higher education landscape has abruptly changed as a consequence of the 2020 pandemic. Since then, students are intensifying their daily activities with technology. They have assimilated, more deeply than instructors, the key role of technology in academic life. Back to classrooms, the authors have verified the bigger presence of diversity of digital devices in face-to-face sessions, which call learners' attention even more than the blackboard or the screen. Furthermore, attendance has lessened, not strictly attributable to sanitary issues. Even more, students from a large set of universities are claiming for pre-recorded classes and online exams, rather than for remote online teaching. Thus, the authors state that Internet-based tools are becoming increasingly necessary to communicate with students and to achieve more intense student follow-up: Learning Management Systems, online meeting software, e-textbooks, immediate response systems, blogs, multimedia content and repositories of web-based interactive tools, among others. These mixed tools should be designed for multipurpose activities, either face-to-face, remote, or blended, including autonomous learning.

Lastly, one remark about eventual online exams: as students are currently displaying preference and claiming for sitting online exams, it becomes mandatory for higher education authorities to issue policies and measures to tackle the difficulty of ensuring the fair assessment of learning.

5. Conclusions

The recent lockdown period has emerged as a chance to value the efficacy of teaching modes. The flipped teaching methods implemented by the authors during this sudden shift to remote teaching have suffered less than other classical teaching approaches, not only with regard to lectures but also to the outcomes. Lecturers struggled to take advantage of the best of the former to adapt them to a virtual context.

The procedure presented here is a suitable strategy to find a trade-off between using digital technology in engineering courses and keeping the rhythm, the quality time of classes, communicating with students and teaching staff, as well as ensuring meaningful learning. Some of the strategies and practices implemented during the lockdown period have entailed such a positive impact on the teaching practice that they have arrived to stay for the future: the tablet as a teaching instrument, pre-recorded videos with queries-to-go, repositories with questions for on-the-fly quizzes, the ability to hold online meetings among teaching unit members, among others.

Hence, an increasing concern on how to address the pervasive use of technology to achieve the effectiveness of the training system has emerged. There is a wide range for action, not only in technology but also from an ethical and holistic perspective.

The authors agree that physical attendance to classes is not linked to learning outcomes. The slight differences in passing students percentages with respect to the ordinary face-to-face teaching, their feedback on satisfaction, figures of learning outcomes, and the given step forward to digitalization in higher education can be highlighted as benefits of the actions undertaken by stakeholders. Conversely, the experience from the lockdown physical constraints has raised some controversial aspects that require further research:

- Students and lecturers' readiness to adapt to the digital transformation of higher education.
- The confidence in technology and the efficient use of digital devices to promote active learning and effective training settings.
- Digital technology has influenced students' attitude, readiness, and treatment with instructors. It seems worth investigating the moments and ways students communicate among them and with lecturers during the course.
- Assessment of whether higher education is lowering the standards or not.
- How to design appropriate remote evaluation procedures to measure goal achievements while ensuring honesty, ethics, and fairness.

Author Contributions: Conceptualization, F.S.; J.C.M.F. and M.G.A.; methodology, F.S.; I.C.; M.G.A. and J.C.M.F.; validation, J.C.M.F.; F.S.; I.C.; and M.G.A.; formal analysis, J.C.M.F., F.S.; I.C.; and M.G.A.; investigation, F.S.; I.C.; M.G.A. and J.C.M.F.; resources, M.G.A. and I.C.; data curation, F.S. and I.C.; writing—original draft preparation, F.S. and J.C.M.F.; writing—review and editing, J.C.M.F.; F.S.; I.C.; and M.G.A.; visualization, F.S.; I.C.; M.G.A. and J.C.M.F.; supervision, M.G.A. and I.C.; project administration, M.G.A. and F.S.; funding acquisition, F.S. and J.C.M.F. All authors have read and agreed to the published version of the manuscript.

Funding: This work was funded by Universidad Politécnica de Madrid through the Educational Innovative Programme 2019–2020, Project code IE1920-0405, and by Universidad de Jaén through the Educational Innovative Project PIMED06_201921.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available from the authors on request.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Moore, M.G.; Kearsley, G. *Distance Education: A Systems View of Online Learning*; Cengage Learning: Boston, MA, USA, 2011; pp. 10–15.

2. Graves, W.H. “Free Trade” in Higher Education. *Meta Univ. J. Asynchronous Learn. Netw.* **1997**, *1*, 1–13.
3. Beagle, D. Web-based learning environments: Do libraries matter? *Coll. Res. Libr.* **2000**, *61*, 367–379. [CrossRef]
4. Garcia Aretio, L. *La Educación a Distancia. De la Teoría a la Práctica*; Ariel: Barcelona, Spain, 2001.
5. Singh, V.; Khasawneh, M.T.; Bowling, S.R.; Kaewkuekool, S.; Jiang, X.; Gramopadhye, A.K. The evaluation of alternate learning systems in an industrial engineering course: Asynchronous, synchronous and classroom. *Int. J. Ind. Ergon.* **2004**, *33*, 495–505. [CrossRef]
6. Ibrahim, B.; Franklin, S.D. Advanced educational uses of the World-Wide Web. *Comput. Netw. ISDN Syst.* **1995**, *27*, 871–877. [CrossRef]
7. Boaz, C.; Ravinder, N. Asynchronous learning environments: An empirical study. In Proceedings of the 1997 Annual Meeting of the Decision Sciences Institute, Part 1 (of 3), San Diego, CA, USA, 22–25 November 1997.
8. Fhea, O.B. Web-Based Learning Environments. In *Higher Education Management and Operational Research*; Bell, G., Warwick, J., Galbraith, P., Eds.; Educational Futures (Rethinking Theory and Practice); Sense Publishers: Rotterdam, The Netherlands, 2012; Volume 54. [CrossRef]
9. Manseur, R.; Manseur, Z. A synchronous distance learning program implementation in Engineering and Mathematics. In Proceedings of the 39th ASEE/IEEE Frontiers in Education Conference W1C-1, San Antonio, TX, USA, 18–21 October 2009.
10. Barrett, P.; Davies, F.; Zhang, Y.; Barrett, L. The impact of classroom design on pupils’ learning: Final results of a holistic, multi-level analysis. *Build. Environ.* **2015**, *89*, 118–133. [CrossRef]
11. Lord, T. Revisiting the Cone of Learning. Is it a Reliable Way to Link Instruction Method with Knowledge Recall? *J. Coll. Sci. Teach.* **2007**, *37*, 14.
12. Bulman, G.; Fairlie, R.W. Technology and education: Computers, software, and the internet. In *Handbook of the Economics of Education*; Elsevier: Amsterdam, The Netherlands, 2016; Volume 5, pp. 239–280. [CrossRef]
13. Espinel, B.I.; Sevillano García, M.L.; Monterrosa Castro, I.J.; Pascual Moscoso, C. El auge del aprendizaje universitario ubicuo. Uso de las tabletas en la apropiación del conocimiento. *Educ. Siglo XXI* **2019**, *37*, 183–204. [CrossRef]
14. Dutkiewicz, A.; Kołodziejczak, B.; Leszczyński, P.; Mokwa-Tarnowska, I.; Topol, P.; Kupczyk, B.; Siatkowski, I. Online Interactivity—A Shift towards E-textbook-based Medical Education. *Stud. Log. Gramm. Rhetor* **2018**, *56*, 177–192. [CrossRef]
15. Mynbayeva, A.; Sadvakassova, Z.; Akshalova, B. Pedagogy of the Twenty-First Century: Innovative Teaching Methods. In *New Pedagogical Challenges in the 21st Century: Contributions of Research in Education*; Cavero, O.B., Llevot-Calvet, N., Eds.; IntechOpen: London, UK, 2018; pp. 3–20.
16. Pavón, R.M.; Arcos Alvarez, A.A.; Alberti, M.G. BIM-Based Educational and Facility Management of Large University Venues. *Appl. Sci.* **2020**, *10*, 7976. [CrossRef]
17. Mirete, A.B.; García-Sánchez, A.; Maquilón, J.J. Webs didácticas en educación superior: Análisis de su contenido y valoración del estudiante. *Rev. Interuniv. De Form. Del Profr.* **2014**, *28*, 95–114.
18. Mirete, A.B.; García-Sánchez, F.A.; Sánchez-López, M.C. Implicación del alumnado en la valoración de su satisfacción con las webs didácticas. *Edutec. Rev. Electrónica De Tecnol. Educ.* **2011**, *37*, 1–13.
19. El-Sawy, K.M.; Sweedan, A. Innovative use of computer tools in teaching structural engineering applications. *Australas. J. Eng. Educ.* **2010**, *16*, 35–54. [CrossRef]
20. Ministerio de Educación, Cultura y Deporte. Estrategia Para la Internacionalización de las Universidades Españolas 2015–2020. 2014. Available online: http://www.mecd.gob.es/educacion-mecd/dms/mecd/educacion-mecd/areas-educacion/universidades/politica-internacional/estrategia-internacionalizacion/EstrategiaInternacionalizaci-n-Final.pdf (accessed on 10 March 2021).
21. UNESCO. ICT Competency Framework for Teachers. 2015. Available online: https://teachertaskforce.org/sites/default/files/2020-07/ict_framework.pdf (accessed on 3 March 2021).
22. Goel, Y.; Goyal, R. On the Effectiveness of Self-Training in MOOC Dropout Prediction. *Open Comput. Sci.* **2020**, *10*, 246–258. [CrossRef]
23. Gregori, P.; Martínez, V.; Moyano-Fernández, J.J. Basic actions to reduce dropout rates in distance learning. *Eval. Program Plan.* **2018**, *66*, 48–52. [CrossRef]
24. Morales, M.; Rizzardini, R.H.; Gütl, C. Telescope, a MOOCs initiative in latin America: Infrastructure, best practices, completion and dropout analysis. In Proceedings of the 2014 IEEE Frontiers in Education Conference (FIE) Proceedings, Madrid, Spain, 22–25 October 2014.
25. Cook, D.A. Web-based learning: Pros, cons and controversies. *Clin. Med.* **2007**, *7*, 37. [CrossRef]
26. García-Alberti, M.; Suárez, F.; Chiyón, I.; Mosquera Feijoo, J.C. Challenges and Experiences of Online Evaluation in Courses of Civil Engineering during the Lockdown Learning due to the COVID-19 Pandemic. *Educ. Sci.* **2021**, *11*, 59. [CrossRef]
27. Woo, Y.; Reeves, T.C. Meaningful interaction in web-based learning: A social constructivist interpretation. *Internet High. Educ.* **2007**, *10*, 15–25. [CrossRef]
28. Siemens, G.; Gasevic, D.; Dawson, S. Preparing for the digital university: A review of the history and current state of distance, blended, and online learning. *MOOC Res. Initiat.* **2015**. Available online: https://www.pure.ed.ac.uk/ws/portalfiles/portal/21130003/PreparingDigitalUniversity.pdf (accessed on 12 March 2021).
29. Solis, B.; Littleton, A. The 2017 State of Digital Transformation. Altimeter. Available online: https://issuu.com/bjarn/docs/the_state_of_digital_transformation (accessed on 12 March 2021).

30. Talbert, R. Flipped Learning Can Be a Key to Transforming Teaching and Learning Post-Pandemic. 2021. Available online: https://www.edsurge.com/news/2021-04-02-flipped-learning-can-be-a-key-to-transforming-teaching-and-learning-post-pandemic (accessed on 10 April 2021).
31. IESALC; UNESCO. COVID-19 and Higher Education: Today and Tomorrow. Impact Analysis, Policy Responses and Recommendations. 2020. Available online: http://www.iesalc.unesco.org/en/wp-content/uploads/2020/04/COVID-19-EN-090420-2.pdf (accessed on 10 April 2021).
32. Schleicher, A. The Impact of Covid-19 on Education Insights from Education at a Glance 2020. 2020. Available online: https://www.oecd.org/education/the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf (accessed on 10 April 2021).
33. UNESCO. Open Educational Resources (OER). 2012. Available online: https://en.unesco.org/themes/building-knowledge-societies/oer (accessed on 12 March 2021).
34. Santos, H.; Batista, J.; Marques, R.P. Digital transformation in higher education: The use of communication technologies by students. *Procedia Comput. Sci.* **2019**, *164*, 123–130. [CrossRef]
35. Fies, C.; Marshall, J. Classroom response systems: A review of the literature. *J. Sci. Educ. Technol.* **2006**, *15*, 101–109. [CrossRef]
36. Kogan, M.; Laursen, S.L. Assessing long-term effects of inquiry-based learning: A case study from college mathematics. *Innov. High. Educ.* **2014**, *39*, 183–199. [CrossRef]
37. Buckley, P.; Doyle, E. Gamification and student motivation. *Interact. Learn. Environ.* **2016**, *24*, 1162–1175. [CrossRef]
38. García-Alberti, M.; Moreno Bazán, A.; González-Rodrigo, B.; Mosquera-Feijoo, J.C. Gamification and question-driven learning aided with immediate response systems. Some experiences from civil engineering students. In Proceedings of the 12th annual International Conference of Education, Research and Innovation (ICERI 2019), Seville, Spain, 11–13 November 2019; p. 6315. [CrossRef]
39. Wu, Y.C.J.; Wu, T.; Li, Y. Impact of using classroom response systems on students' entrepreneurship learning experience. *Comput. Hum. Behav.* **2019**, *92*, 634–645. [CrossRef]
40. Junus, K.; Santoso, H.B.; Putra, P.O.H.; Gandhi, A.; Siswantining, T. Lecturer Readiness for Online Classes during the Pandemic: A Survey Research. *Educ. Sci.* **2021**, *11*, 139. [CrossRef]
41. Revilla-Cuesta, V.; Skaf, M.; Varona, J.M.; Ortega-López, V. The Outbreak of the COVID-19 Pandemic and its Social Impact on Education: Were Engineering Teachers Ready to Teach Online? *Int. J. Environ. Res. Public Health* **2021**, *18*, 2127. [CrossRef] [PubMed]
42. Coman, C.; Țîru, L.G.; Meseșan-Schmitz, L.; Stanciu, C.; Bularca, M.C. Online Teaching and Learning in Higher Education during the Coronavirus Pandemic: Students' Perspective. *Sustainability* **2020**, *12*, 10367. [CrossRef]
43. Mosquera Feijoo, J.C.; Baeza Brotons, F.J.; Galao, O.; García-Alberti, M. On student perceptions about e-textbooks and digital resources for online teaching: Lessons learned from confinement. In Proceedings of the 13th annual International Conference of Education, Research and Innovation (ICERI 2020), Seville, Spain, 9–11 November 2020; pp. 3642–3647. [CrossRef]
44. Tang, T.; Abuhmaid, A.M.; Olaimat, M.; Oudat, D.M.; Aldhaeebi, M.; Bamanger, E. Efficiency of flipped classroom with online-based teaching under COVID-19. *Interact. Learn. Environ.* **2020**, 1–12. [CrossRef]
45. Lewis, M.M.; Markey, M.K. From Study-Abroad to Study-at-Home: Teaching Cross-Cultural Design Thinking During COVID-19. *Biomed. Eng. Educ.* **2021**, *1*, 121–125. [CrossRef]
46. Fung, F.M.; Lam, Y. How COVID-19 disrupted our "flipped" freshman organic chemistry course: Insights gained from Singapore. *J. Chem. Educ.* **2020**, *97*, 2573–2580. [CrossRef]
47. Schuck, R.K.; Lambert, R. "Am I Doing Enough?" Special Educators' Experiences with Emergency Remote Teaching in Spring 2020. *Educ. Sci.* **2020**, *10*, 320. [CrossRef]
48. Izagirre-Olaizola, J.; Morandeira-Arca, J. Business Management Teaching-Learning Processes in Times of Pandemic: Flipped Classroom at A Distance. *Sustainability* **2020**, *12*, 10137. [CrossRef]
49. Jia, C.; Hew, K.F.; Bai, S.; Huang, W. Adaptation of a conventional flipped course to an online flipped format during the Covid-19 pandemic: Student learning performance and engagement. *J. Res. Technol. Educ.* **2020**, 1–21. [CrossRef]
50. Latorre-Cosculluela, C.; Suárez, C.; Quiroga, S.; Sobradiel-Sierra, N.; Lozano-Blasco, R.; Rodríguez-Martínez, A. Flipped Classroom model before and during COVID-19: Using technology to develop 21st century skills. *Interact. Technol. Smart Educ.* **2021**. ahead of print. [CrossRef]
51. Ferlazzo, L. Blended Learning in the Age of COVID-19. 2020. Available online: https://www.edweek.org/teaching-learning/opinion-blended-learning-in-the-age-of-covid-19/2020/08 (accessed on 10 April 2021).
52. Nerantzi, C. The use of peer instruction and flipped learning to support flexible blended learning during and after the COVID-19 Pandemic. *Int. J. Manag. Appl. Res.* **2020**, *7*, 184–195. [CrossRef]
53. Salas-Provance, M.B.; Arriola, M.E.; Arrunátegui, P.M.T. Managing in a Crisis: American and Peruvian Professionals' Experiences During COVID-19. *Perspect. ASHA Spec. Interest Groups* **2020**, *5*, 1785–1788. [CrossRef]
54. García Alberti, M.; Suárez Guerra, F.; Chiyón Carrasco, I.; Mosquera Feijoo, J.C. The sudden shift from face-to-face to online teaching: The social and educational role of lecturers during confinement. In Proceedings of the 13th annual International Conference of Education, Research and Innovation (ICERI 2020), Seville, Spain, 9–11 November 2020; pp. 3655–3659. [CrossRef]
55. Sederevičiūtė-Pačiauskienė, Ž.; Valantinaitė, I.; Kliukas, R. Communion, Care, and Leadership in Computer-Mediated Learning during the Early Stage of COVID-19. *Sustainability* **2021**, *13*, 4234. [CrossRef]

56. UNESCO. Education: From Disruption to Recovery. Available online: https://en.unesco.org/covid19/educationresponse (accessed on 15 April 2021).
57. García Aretio, L. Educación a distancia y virtual: Calidad, disrupción, aprendizajes adaptativo y móvil. RIED. *Rev. Iberoam. De Educ. A Distancia* **2017**, *20*, 9–25. [CrossRef]
58. García Aretio, L. Blended learning y la convergencia entre la educación presencial y a distancia. RIED. *Rev. Iberoam. De Educ. A Distancia* **2018**, *21*, 9–22, ISSN 1390-3306. Available online: http://revistas.uned.es/index.php/ried/article/view/19683 (accessed on 8 March 2021). [CrossRef]
59. Hilton, J. Open educational resources and college textbook choices: A review of research on efficacy and perceptions. *Educ. Technol. Res. Dev.* **2016**, *64*, 573–590. [CrossRef]
60. Abramovic, S. Open Educational Resources. 2020. Available online: http://www.buffalo.edu/ubcei/enhance/teaching/open.html (accessed on 12 March 2021).
61. Black, P.; Wiliam, D. Assessment and classroom learning. *Assess. Educ. Princ. Policy Pract.* **1998**, *5*, 7–74. [CrossRef]
62. Black, P.; Harrison, C.; Lee, C.; Marshall, B.; Wiliam, D. Working inside the black box: Assessment for learning in the classroom. *Phi Delta Kappan* **2004**, *86*, 8–21. [CrossRef]
63. Talanquer, V. La importancia de la evaluación formativa. *Educ. Quími.* **2015**, *26*, 177–179. [CrossRef]
64. Cashman, E.M.; Eschenbach, E.A. Using on-line quizzes outside the classroom to increase student engagement inside the classroom. In Proceedings of the American Society for Engineering Education, Pacific Southwest Section, Spring 2003 Conference. Developing Tomorrow's Workforce, Los Angeles, CA, USA, 20–21 March 2003; pp. 20–21.
65. Mosquera, J.C.; Baeza, F.; Santillán, D.; Garcia-Alberti, M. Exploring some problem-based learning approaches with the classroom response systems for undergraduate engineering students. In Proceedings of the 12th annual International Conference of Education, Research and Innovation (ICERI 2019), Seville, Spain, 11–13 November 2019; pp. 4231–4238.
66. Mosquera-Feijoo, J.C.; Chiyón, I.; Cueto-Felgueroso, L.; Muñoz, I. Un método para aprendizaje de problemas elusivos de Resistencia de Materiales mediante técnicas web. In *La innovación Docente Como Misión del Profesorado. Actas del IV Congreso Internacional Sobre Aprendizaje, Innovación y Competitividad (CINAIC 2017)*; Universidad de Zaragoza: Zaragoza, Spain, 2017; pp. 321–325. ISBN 978-84-16723-41-6.
67. García-Cabrero, B.; Luna-Serrano, E.; Ponce-Ceballos, S.; Cisneros-Cohenour, E.; Cordero-Arroyo, G.; Espinoza-Díaz, Y.; García-Vigil, M.H. Las competencias docentes en entornos virtuales: Un modelo para su evaluación. *Rev. Iberoam. De Educ. A Distancia* **2018**, *21*, 343–365.
68. van Oostveen, R.; Muirhead, W.; Goodman, W.M. Tablet PCs and reconceptualizing learning with technology: A case study in higher education. *Interact. Technol. Smart Educ.* **2011**, *8*, 78–93. [CrossRef]
69. Fischer, N.; Smolnik, S.; Galletta, D.F. Examining the Potential for Tablet Use in a Higher Education Context. In *Wirtschaftsinformatik Proceedings 2013 (1)*. Available online: http://aisel.aisnet.org/wi2013/1?utm_source=aisel.aisnet.org%2Fwi2013%2F1&utm_medium=PDF&utm_campaign=PDFCoverPages (accessed on 13 March 2021).
70. Aiyegbayo, O. How and why academics do and do not use iPads for academic teaching? *Br. J. Educ. Technol.* **2014**, *46*, 1324–1332. [CrossRef]
71. Wakefield, J.; Frawley, J.K.; Tyler, J.; Dyson, L.E. The impact of an iPad-supported annotation and sharing technology on university students' learning. *Comput. Educ.* **2018**, *122*, 243–259. [CrossRef]
72. Carrington, A.; Green, I. Just in time teaching revisited: Using e-assessment and rapid e- learning to empower face to face teaching. In Proceedings of the ICT: Providing Choices for Learners and Learning. Proceedings Ascilite Singapore, Singapore, 2–5 December 2007.
73. Brame, C. Just-in-Time Teaching (JiTT). Vanderbilt University Center for Teaching. 2013. Available online: https://cft.vanderbilt.edu/guides-sub-pages/just-in-time-teaching-jitt/ (accessed on 10 March 2021).
74. Beatty, I.D.; Gerace, W.J. Technology-enhanced formative assessment: A research-based pedagogy for teaching science with classroom response technology. *J. Sci. Educ. Technol.* **2009**, *18*, 146–162. [CrossRef]
75. Lee, H.; Feldman, A.; Beatty, I.D. Factors that affect science and mathematics teachers' initial implementation of technology-enhanced formative assessment using a classroom response system. *J. Sci. Educ. Technol.* **2012**, *21*, 523–539. [CrossRef]
76. Gould, S.M. Potential use of classroom response systems (CRS, Clickers) in foods, nutrition, and dietetics higher education. *J. Nutr. Educ. Behav.* **2016**, *48*, 669–674. [CrossRef] [PubMed]
77. Decman, M. Factors That Increase Active Participation by Higher Education Students, and Predict the Acceptance and Use of Classroom Response Systems. *Int. J. High. Educ.* **2020**, *9*, 84–98. [CrossRef]
78. Freeman, S.; Eddy, S.L.; McDonough, M.; Smith, M.K.; Okoroafor, N.; Jordt, H.; Wenderoth, M.P. Active learning increases student performance in science, engineering, and mathematics. *Proc. Natl. Acad. Sci. USA* **2014**, *111*, 8410–8415. [CrossRef] [PubMed]
79. Eddy, S.L.; Hogan, K.A. Getting under the hood: How and for whom does increasing course structure work? *CBE Life Sci. Educ.* **2014**, *13*, 453–468. [CrossRef] [PubMed]
80. DeLozier, S.J.; Rhodes, M.G. Flipped classrooms: A review of key ideas and recommendations for practice. *Educ. Psychol. Rev.* **2017**, *29*, 141–151. [CrossRef]
81. Mirete Ruiz, A.B. El profesorado universitario y las TIC. Análisis de su competencia digital. *Ens. Rev. De La Fac. De Educ. De Albacete* **2016**, *31*, 133–147.
82. Arum, R.; Josipa, R. *Academically Adrift: Limited Learning on College Campuses*; University of Chicago Press: Chicago, IL, USA, 2011.

83. Law, S.; Baer, A. Using technology and structured peer reviews to enhance students' writing. *Act. Learn. High. Educ.* **2020**, *21*, 23–38. [CrossRef]
84. Kim, K.; Sharma, P.; Land, S.M.; Furlong, K.P. Effects of active learning on enhancing student critical thinking in an undergraduate general science course. *Innov. High. Educ.* **2013**, *38*, 223–235. [CrossRef]
85. Jewell, R.T.; McPherson, M.A.; Tieslau, M.A. Whose fault is it? Assigning blame for grade inflation in higher education. *Appl. Econ.* **2013**, *45*, 1185–1200. [CrossRef]
86. Bachan, R. Grade inflation in UK higher education. *Stud. High. Educ.* **2015**, *42*, 1580–1600. [CrossRef]
87. Stroebe, W. Why good teaching evaluations may reward bad teaching: On grade inflation and other unintended consequences of student evaluations. *Perspect. Psychol. Sci.* **2016**, *11*, 800–816. [CrossRef] [PubMed]
88. Stroebe, W. Student Evaluations of Teaching Encourages Poor Teaching and Contributes to Grade Inflation: A Theoretical and Empirical Analysis. *Basic Appl. Soc. Psychol.* **2020**, *42*, 276–294. [CrossRef]
89. Haak, D.C.; HilleRisLambers, J.; Pitre, E.; Freeman, S. Increased structure and active learning reduce the achievement gap in introductory biology. *Science* **2011**, *332*, 1213–1216. [CrossRef] [PubMed]
90. Ruiz-Primo, M.A.; Briggs, D.; Iverson, H.; Talbot, R.; Shepard, L.A. Impact of undergraduate science course innovations on learning. *Science* **2011**, *331*, 1269–1270. [CrossRef] [PubMed]
91. Abeysekera, L.; Dawson, P. Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. *High. Educ. Res. Dev.* **2015**, *34*, 1–14. [CrossRef]
92. Schneider, M.; Preckel, F. Variables associated with achievement in higher education: A systematic review of meta-analyses. *Psychol. Bull.* **2017**, *143*, 565–600. [CrossRef]