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Impact of the COVID-19 Confinement on the Physics and Chemistry Didactic in High Schools

Elena Jiménez Sánchez [1,*], Estrella Montes-López [2] and María Jesús Santos Sánchez [1]

[1] Applied Physics Department, Faculty of Sciences, Universidad de Salamanca, 37008 Salamanca, Spain; smjesus@usal.es
[2] Department of Sociology and Communication, Faculty of Social Sciences, Universidad de Salamanca, 37007 Salamanca, Spain; estrellamontes@usal.es
* Correspondence: e.jimenezs@usal.es

Abstract: Online education due to COVID-19 confinement impacted the use of the Information and Communication Technology (ICT) in Spain, where it was poorly implemented. The aim of this paper was to inspect the methodological changes in Physics and Chemistry teaching during the confinement as well as in the ICT use and the lockdown impact afterwards. For this purpose, an online survey was administered by email to the Physics and Chemistry teachers of three provinces of Spain. Based on the analysis, the most widely used methodology was the traditional one. Still, during the lockdown, its use decreased, and others, such as the flipped classroom, increased significantly. Other adaptations included increasing the use of virtual simulations and self-learning by the student. It can be outlined the incorporation of new tools such as WebQuests, the smartphone, or online education platforms, whose use has continued. The ICT was used for new functionalities such as evaluation or answering student questions. According to the respondents, the lockdown had entailed that they strengthen implementation of ICT. In conclusion, there have been changes that have remained in the Physics and Chemistry didactic and in the ICT use due to the lockdown situation.

Keywords: educational technologies; digital technologies; teaching experiences; learning experiences; pedagogy

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1. Introduction

COVID-19 confinement caused an absolute rupture of the way life had been until then. Everyone was forced to remain at home and significant changes had to be implemented in order to minimize disruption on the economy and life. In this regard, education was one of the affected areas since there was a huge shift, especially in primary schools and high schools, from face-to-face teaching to online teaching.

Even if Information and Communication Technology (ICT) has a large presence in the classrooms, it has been proven that they are not really used during the lessons [1]. Nevertheless, due to the confinement, its implementation was imposed.

The aim of this article is to acquaint the changes in the Physics and Chemistry didactic due to the COVID-19 global confinement and its impact afterwards in the employed methodologies and in the use of ICT. For this purpose, an online survey was administered to the secondary teachers of Physics and Chemistry working in three provinces of Castille and Leon, Spain.

For this purpose, first, the situation of the ICT in high schools in Spain was analysed, as well as its main applications in the Physics and Chemistry didactic and the difficulties encountered to implement them in the classroom. In addition, the use of the ICT during the confinement is presented in the introduction. Next, the methodology employed is described. Then, the results are analysed, and last, we present the the discussion and the conclusions of the paper.

1.1. Situation of the ICT in Spain and in High Schools

The proportion of high schools with Internet access and computers was 100% in Spain in 2020. Moreover, 95.4% of households report to have an Internet connection and 91.3% of people used it frequently, at least once a week [2].

During the 2018–2019 academic year, the number of students per computer was 2.9 in high schools; 96.7% of the classrooms had an Internet connection, and 60.1% had interactive digital systems. Besides this, 89.1% of the educational centres counted with a website. Many centres, 45.4%, employed learning visual environments, which allow the interaction of the students so that they can continue with the learning process, and 59.2% supplied cloud services. Lastly, the mobile phone was used in 42.2% of high schools for younger students, and 50.2% for the older students [3].

Hence, high schools in Spain account to have a good supply of technology as well as Internet connection. Nevertheless, they were not that widely used, and the resources employed were very limited, as explained in the following section.

1.2. Causes of the Low Implementation of ICT in the Classrooms

The application of ICT in education is very limited [4–6]. ICT is barely used in comparison to the presence they have in high schools [7]. Moreover, the supply of ICT in the classroom has not meant almost any changes or adaptations in the teaching methodologies [5,8,9].

Some of the causes of this low use are the need of methodological changes in order to integrate ICT into the classes, which take time; the adaptability of educators to change, since they are comfortable with the methodologies they already know [10,11]; and the lack of knowledge on how to implement ICT in their classes [6]. Other causes are the poor formation of ICT tools and applications [9,11], together with the insecurities it generates or the frustration when the exercises implemented do not have the expected outcome.

Because of that, the ICT are mainly used by means of the traditional methodology for exposition or search purposes, and there is no real application of all the available resources [1].

1.3. Main Applications of ICT in Education and for the Physics and Chemistry Didactic

Even if not frequently implemented, some of the most common applications of ICT are short research on the Internet, and assignments and presentations with PowerPoint or the virtual classroom [9,11]. Interactive digital boards are also employed [12].

As for the Physics and Chemistry didactic, other applications are the use of simulators to illustrate phenomena, explanatory videos or measuring applications [11,13]. Nevertheless, there are a wide variety of methodologies or projects that could be implemented by means of the ICT but there is no real place for them in most of the classrooms. Some of them are the use of projects to research about everyday phenomena by implementing the scientific method and the ICT [8] or the use of WebQuest to guide the student in long projects [14].

Nonetheless, COVID-19 confinement necessitated the change from in-person to online education, forcing the use of ICT and a total rupture with classic high school education.

1.4. Ict Use and Didactic during Covid-19 Confinement

The COVID-19 confinement led to a complete shift from face-to-face teaching to fully online education in Spanish high schools from 12 March 2020 until the end of the academic year (30 June 2020). Because of this situation, teachers had to adapt and transform their didactic in order to perform online teaching [15]. Some of the taken measures were the use of online environments, the creation of online content and the implementation of online evaluation. It supposed a situation of huge learning of ICT tools by the educators. Online platforms, such as Zoom or Classroom, were used in order to interact with students; new materials, such as infographics, podcasts or applications, were also implemented, as well as new activities [15].

Besides these, there was a need to adapt the methodologies that had been employed until then, since technology as the main educational resource had never been used before [16–18]. In terms of online education, active methodologies are considered as the ideal ones. In them, the students are mainly responsible of their learning and they are more autonomous. These methodologies include project-based learning or the flipped classroom [19,20].

Thus, COVID-19 confinement entailed a completely new teaching situation, shifting from in-person to online education. Because of that, new resources, applications as well as methodologies should have been used during this period. Still, it demands the question whether physics and chemistry teaching was really adapted or if the methodology changed during that period.

1.5. Research Objectives

COVID-19 confinement should have led to a complete adaptation of the teaching methodology as well as to the adoption of new ICT resources. Before the lockdown, most educators implemented the traditional methodology with a very limited use of ICT in their classes [1]. Nevertheless, in terms of online education, active methodologies are recommended, and the education process must be implemented by means of the ICT resources.

Hence, the aim of this article was to learn about the changes that the confinement situation led to in the teaching methodologies and in the ICT tools being employed for teaching. Moreover, it was of interest to study if these tools have remained in education with the return of face-to-face education.

In more detail, the specific objectives were:

(i) Researching the methodologies that had been used for the didactic before, during and after lockdown.
(ii) Learning how ICT was used for the Physics and Chemistry didactic and how the lessons were taught during confinement.
(iii) Learning about the changes that there had been in the ICT implementation in the Physics and Chemistry didactic before, during and after confinement, as well as the ICT tools and resources that had been implemented.

Once the objectives were defined, the research technique was chosen as described in the methodology. For this purpose, an online survey was implemented and was answered by Physics and Chemistry teachers in some of the regions of Castile and Leon in Spain.

2. Materials and Methods

In this article, a social investigation was implemented. In order to achieve the research objectives, a self-administered online survey was designed and completed by secondary school Physics and Chemistry teachers in the regions of Salamanca, Avila and Zamora in Spain. This research technique was chosen so that the largest sample could be reached and to collect the maximum number of responses. Hence, for this purpose, first, the survey was created (Section 2.1), then, the data was collected by sending the survey access link to the teachers via email (Section 2.2), and last, the responses were analysed (Section 2.3). The phases of the whole research process are summarised in Figure 1.

2.1. Questionnaire Development

The questionnaire was designed based on the literature review and on the defined objectives. Some of the questions from the survey were directly extracted or adapted from similar questionnaires [4,11,21–25]. Besides this, the ICT tools, websites, platforms and so on, asked on the questionnaire were the ones that are used in the high schools based on the bibliography research.

The development of the questionnaire and the final drafting of the questions involved different stages of refinement and correction. First, the topics to be covered in the survey were determined. Then, the questions within each topic were drafted. Finally, the order of

each topic, and of the questions within it, in the questionnaire was decided. In the workflow of the questionnaire, which is depicted in Figure 2, the question grouping can be seen.

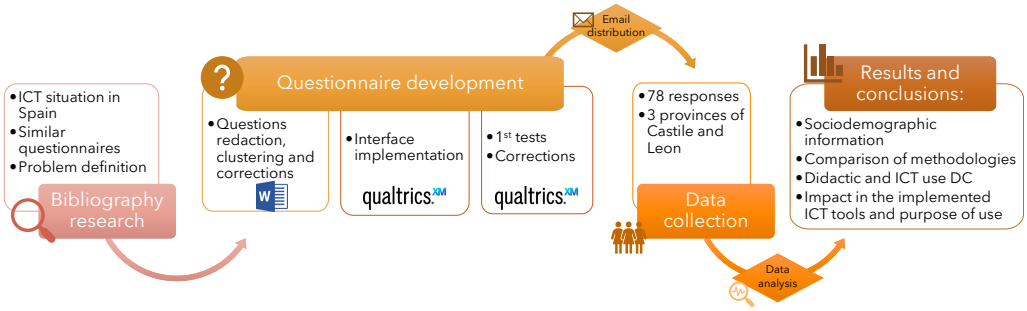

Figure 1. Phases of the research process. Abbreviations: DC, During Confinement; ICT, Information and Communication Technology.

The final structure of the questionnaire was as follows: firstly, socio-demographic variables (e.g., gender, age, years of teaching experience, professional category; size of the high school or province where the teacher worked, etc.) were included. Secondly, the questions related to the methodologies that the educators implemented were presented. Prior to this cluster, the methodologies were defined in order to ensure that all the respondents knew what each methodology implies. Thirdly, they were asked about the didactic experience during the confinement. This includes how the lessons had been implemented, what tools they had used, what modifications had been made and so on. Subsequently, questions related to changes in the use of ICTs—which ones they used and for what purpose—before, during and after confinement were included. Finally, respondents were given the opportunity to add additional comments on their experience during confinement. In contrast to the other, close-ended questions, this last question was drafted in an open-ended format.

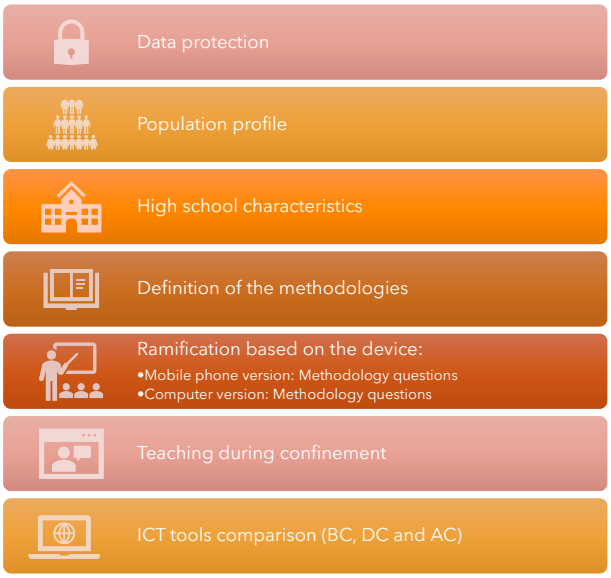

Figure 2. Questionnaire workflow and grouping of the questions that was done. Abbreviations: AC, After Confinement; BC, Before Confinement.

Once that they were completely clear, the survey was created in Qualtrics application [26], where different question formats, filters and logical conditions were implemented. Besides this, two versions with different formats were generated to provide enhanced visualisation depending on the device being used to response, either mobile phone, tablet or laptop. The differences in the two versions of the questions (one for computers and the other for mobile phones) that were created in the Qualtrics software are displayed in Figure 3;

both the version prior to the adaptation and after are shown. Once the questionnaire had been designed and implemented in the application, a pilot study was conducted. In this pilot study, respondents were fellow students from the masters program that qualifies for Secondary Education teaching in Spain [27].

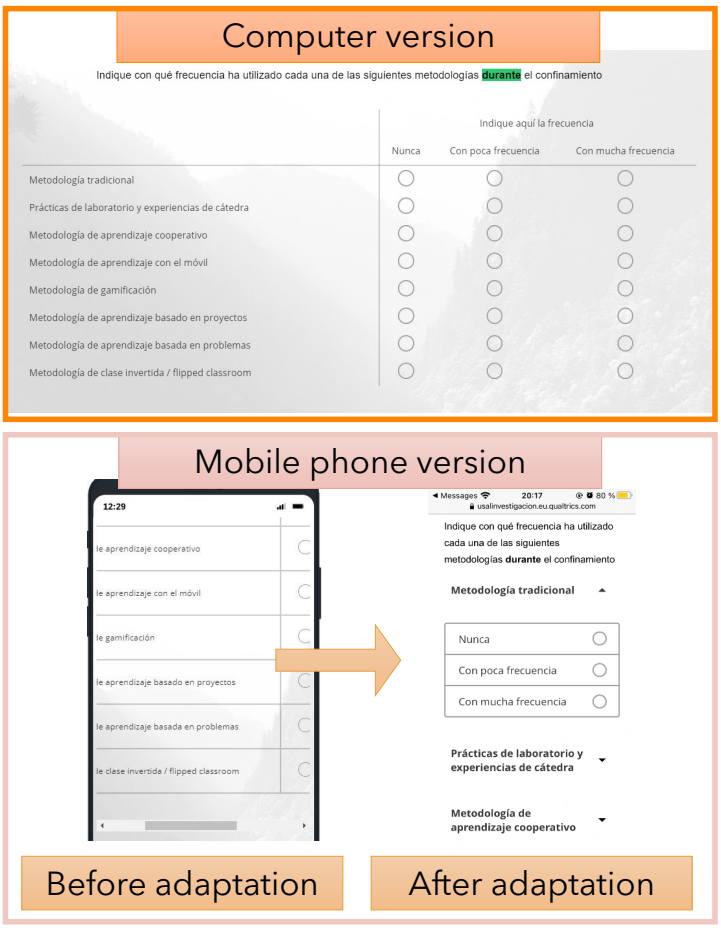

Figure 3. At the **top**, computer version of one question. At the **bottom**, mobile phone version of the same question: on the **left**, before adapting the questionnaire to the device; on the **right**, after adapting it to the device.

This pilot study allowed some questions to be revised and some response options to be completed. Hence, the average response time for the complete questionnaire was estimated to be 15 min, which was considered adequate. Once that the survey was completed and corrected, it was sent to the target population sample.

2.2. Data Collection and Sample

The final developed questionnaire was sent to high school Physics and Chemistry educators of the provinces of Ávila, Salamanca and Zamora (Spain) by electronic mail. It was also distributed to the high schools, asking for their collaboration in informing and requesting the responses of the teaching staff of that department. In addition, fellow students in the masters program were asked to send the questionnaire to their internship advisors and to other teachers, since they were doing their internships in high schools by that time. By doing so, it was aimed to reach the target population by several strategies in order to achieve a large sample.

Based on the Castile and Leon Resolution of 8 April 2021 [28], the estimated population of Physics and Chemistry teachers is 164 for the three provinces, counting private and public high schools. In order to answer the survey, some conditions were required: first, having been informed about their data being used only for the study; second, having

accepted the research conditions; and, third, being a Physics and Chemistry teacher in the provinces of Ávila, Salamanca and Zamora. Since the survey was completed by 78 teachers who accomplished the imposed conditions, and considering the population indicated in the aforementioned resolution [28], almost 50% of the total population was reached. However, not all teachers taught at all three points in time. Some people retired during this time and were replaced by others. It is not possible to calculate the achieved sample reliably as we have not been able to access a sample census that includes teachers who did teach at all three points in time.

2.3. Data Analysis

Data was registered in the Qualtrics platform. Afterwards, both the platform, with its reports tool, and Microsoft Excel were used to analyse the responses.

The conducted study of the results was mainly descriptive so as to inspect the changes in the methodology due to the confinement and its impact on the use of ICT.

3. Results

The results were clustered into four different categories: the first one referred to the population profile (Section 3.1); the second to the methodological changes implemented because of the confinement (Section 3.2); the third one about how the didactic was during confinement (Section 3.3); and the fourth one showing the evolution in the employed ICT tools and how they were used (Section 3.4).

3.1. Sociodemographic Information

There were in total 78 investigation respondents that continued until the end of the survey. Among them, most were women, accounting for 60.26%. In terms of age, only 6.41% were younger than 30 years old; 71.4% of the sample was older than 41 years, with the largest group of age being between 51 and 60 with 35.9% of the responses. Even if the sample was of advanced age, 25.32% accounted with less than 5 years in teaching. Hence, most of them started teaching after the age of 25.

A total of 58.23% of respondents taught in municipalities larger than 25,000 residents, so most of them worked in big areas rather than small villages. Then, 80.52% of the sample was employed by the public sector, with 69.35% having a permanent position. The centres accounted with 201 students or more in 74% of the cases; and in 62.47%, there were at least 401 students. Hence, the teachers taught in larger high schools. The most reduced class had less than 15 students for 61.54% of the respondents, and their largest class had between 16 and 25 students for 69.23%.

In terms of ICT media, most teachers (63.64%) taught in centres where there were 1 or 2 IT rooms, and 35.06% where there were 3 or more. Only in 1.30% of the centres were there no IT rooms. Besides this, in 71.9% of the cases all the classrooms had a projector and a computer; in 25.64% these were only available in some classrooms; and for 2.56% they did not have them available in the classrooms.

3.2. Comparison of the Methodologies Employed before, during and after the Confinement

The methodologies were compared in two different ways. Firstly, by asking the frequency in which they were used (never, little/low frequency or much frequency). Secondly, by the methodology that was employed the most during their lessons. In both cases, the question was posed for the three periods of time: before (BC), during (DC) and after confinement (AC). In Table the percentage of teachers and the frequency ("never" in the central column and "very frequently" in the right) at which they used each of the teaching methodologies is depicted for the three periods of time. This evolution can be observed graphically in Figure 4, which displays the percentage of teachers that "very frequently" employed each methodology before (BC), during (DC) and after (AC) the confinement, as well as in Figure 5, which shows the percentage of teachers who "never" used each methodology before (BC), during (DC) or after the confinement (AC).

For the first comparison, there was a significant change in the methodologies that were employed very frequently from before to during the confinement. More specifically, the traditional methodology passed from 90.4% of the teachers employing it very frequently (BC) to 47.2% (DC), as shown in Figure 4. The mobile learning methodology increased from 7.0% (BC) to 35.3% (DC) of the survey respondents that used it with much frequency before and during the lockdown. Moreover, the flipped classroom rose significantly from 1.4% (BC) to 33.8% (DC). The same observation can be made in terms of the methodologies that were never used before and during the confinement, since the percentage of respondents that never used the mobile learning and flipped classroom methodologies decreased from BC to DC.

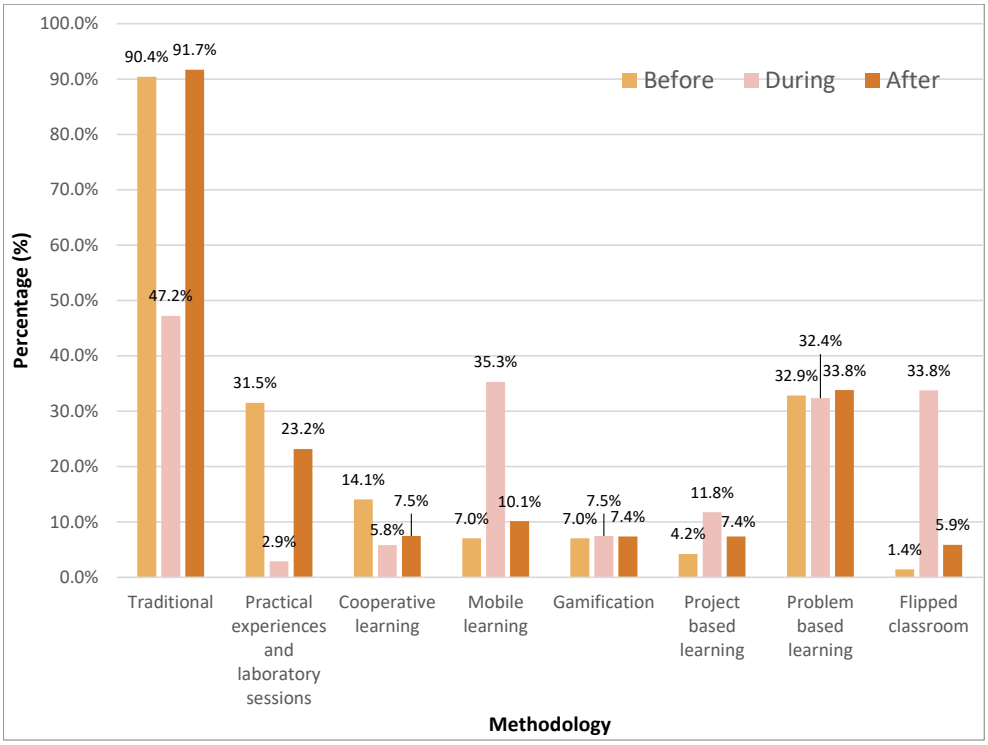

Figure 4. Percentage of teachers that employed very frequently each methodology before, during and after the confinement.

The fact that these methodologies (mobile learning and flipped classroom) started to be used during confinement had an impact for the period afterwards, since it decreased the percentage of teachers that never employed them from 57.7% (BC) to 44.9% (AC), and from 71.4% (BC) to 63.2% (AC), respectively, as depicted in Figure 5.

In terms of the most used methodology, from before, during and after the confinement, there were also some changes, as detailed in Figure 6, similar to the aforementioned. Hence, before confinement, the most used methodology was the traditional (83.8% of respondents). Then, during confinement, this methodology decreased to 37.3% of the teachers using it predominantly, and others, such as mobile learning and flipped classroom, increased to 22.4% (DC) and 20.9% (DC) of educators using it the most. After the confinement, the implementation of the new methodologies decreased again to their original values, and the traditional one was again the most employed methodology with 86.8% of the responses.

3.3. The Didactic of Physics and Chemistry during the Confinement and ICT Use

A total of 98.55% of the respondents considered that they had adapted the methodology during the lockdown. Besides this, 71.69% stated that they had kept these changes afterwards.

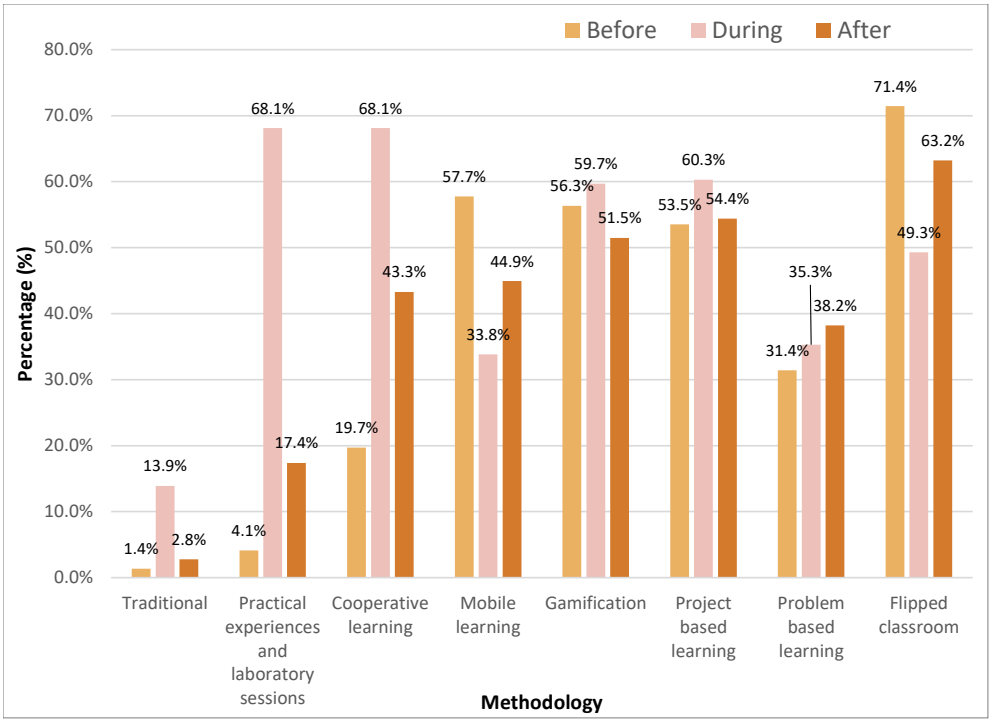

Figure 5. Percentage of teachers that never employed each methodology before, during and after the confinement.

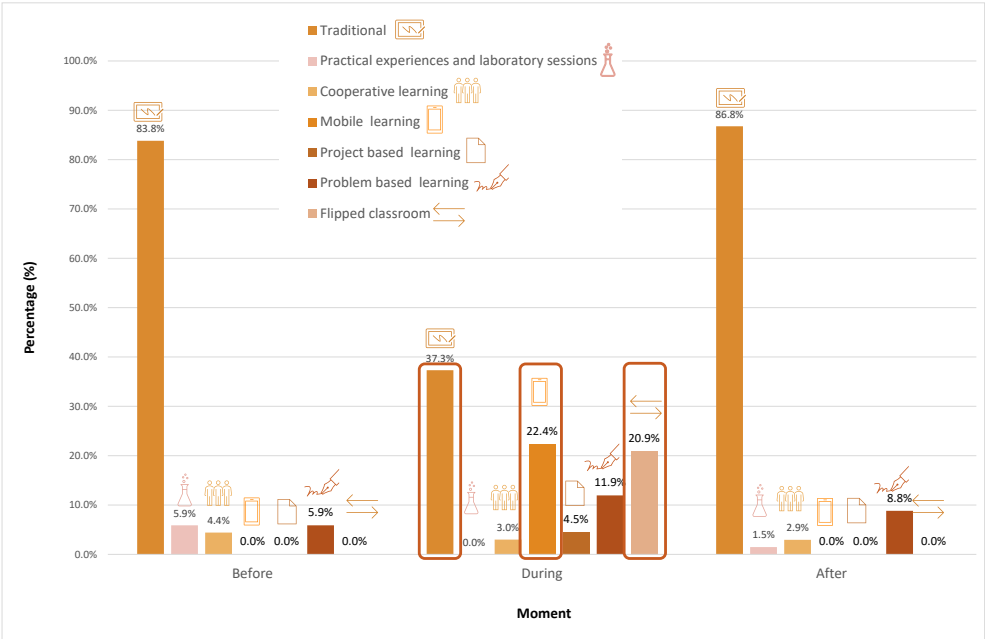

Figure 6. The most used methodologies before, during and after the confinement.

In Figure 7, some of the methodological changes that took place during confinement are shown, and presents if their implementation was decreased, increased or remained the same. Among the implemented changes, 56.72% increased the amount of student assignments, and 61.76% the student autonomous learning. Moreover, the use of virtual simulators and PowerPoint presentations increased for 65.67% and 64.71% of the respondents respectively. The participation of the students during classes was decreased for the case of 53.73% as

well as the number of exposition lessons by the teachers, for 42.65% of the educators. Still, there was 48.53% of them that kept the exposition as before confinement. The percentage of respondents that used the cooperative learning in the same proportion was 56.92%. All the detailed data can be found in Figure 7. Thus, the use of virtual simulators, PowerPoint presentations, autonomous learning and student assignments increased the most, and the participation of the students, the exposition lessons and the interaction with the students decreased the most.

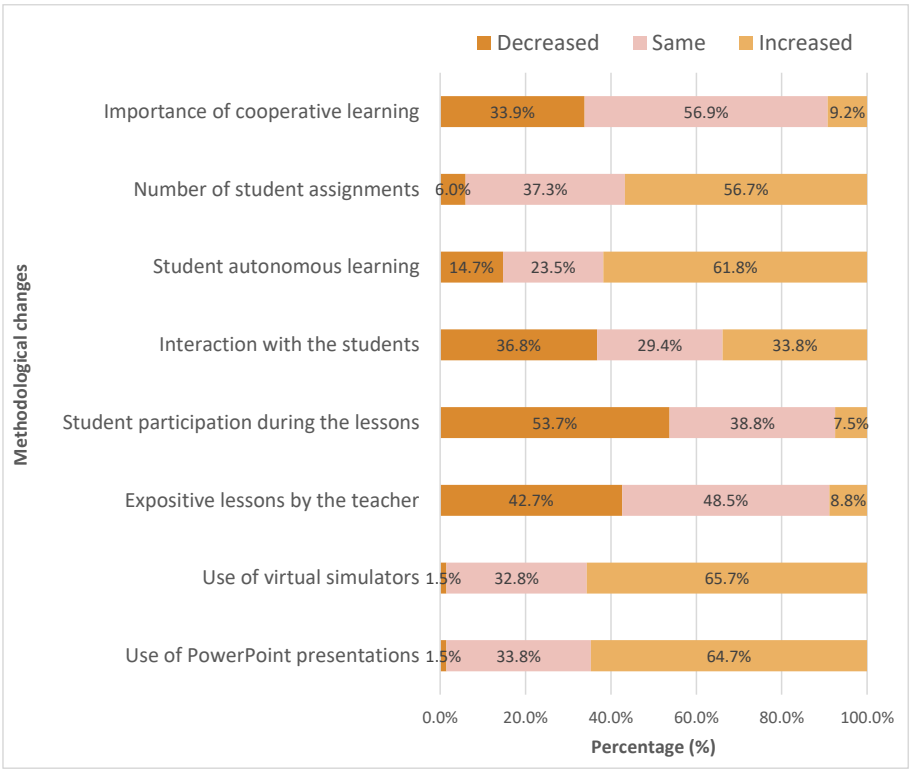

Figure 7. Methodological changes that took place during confinement, either their use was decreased, increased, or remained the same.

In terms of the exposition lessons, they were performed with spoken explanations in a virtual platform by a majority, 43.48%. A total of 20.29% used PowerPoint or similar tools, 18.94% uploaded notes to the platform, 7.25% employed their own videos and the 4.35% used mostly the book.

In order to solve exercises and problems, most of them did them virtually live, accounting for 47.83%; next, 36.23% of the teachers uploaded the solutions to the platform so that the students could ask questions; lastly, 13.04% gave the exercises with no solutions, so the students asked about the ones they did not manage to solve.

3.4. Evolution in ICT Tools Implementation before, during and after the Confinement and How They Were Used

In terms of the implementation of ICT, there was an increase in their use for each of the methodologies after the confinement, as shown in Figure 8.

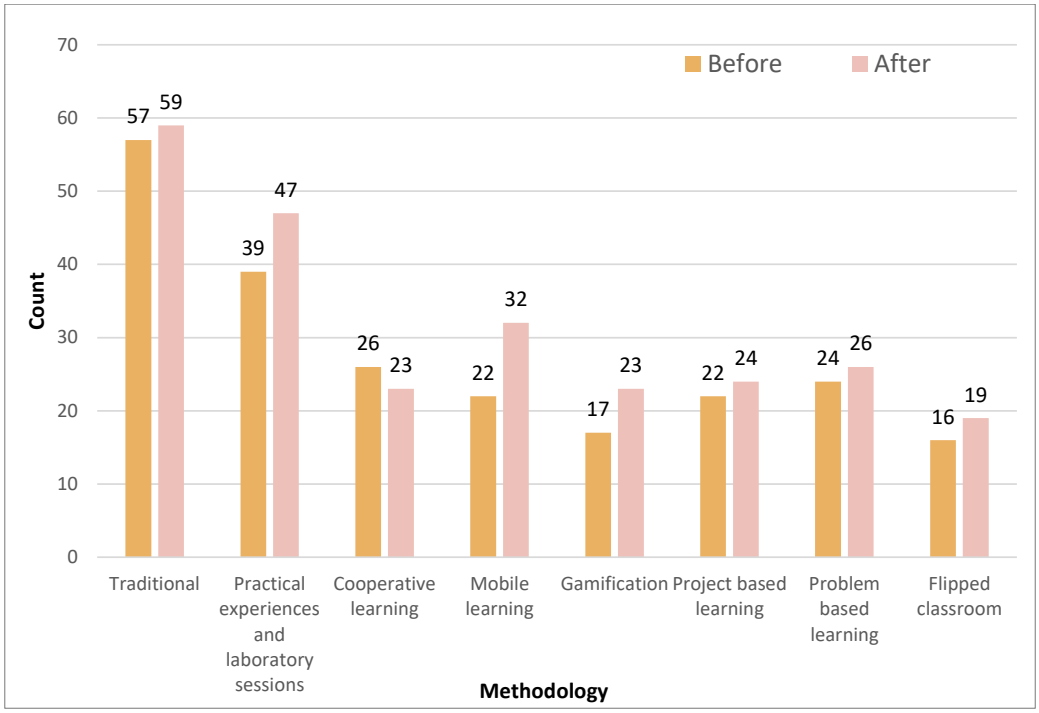

Figure 8. Number of teachers that used ICT for each methodology (from a total of 78 responses).

For this section, the respondents were asked to answer at which time period they had used any of the tools. These periods of time could be that they had implemented them before, during and/or after the confinement. Moreover, they could indicate if they had been using them for the three time periods: BC, DC and AC, as shown in Figure 9.

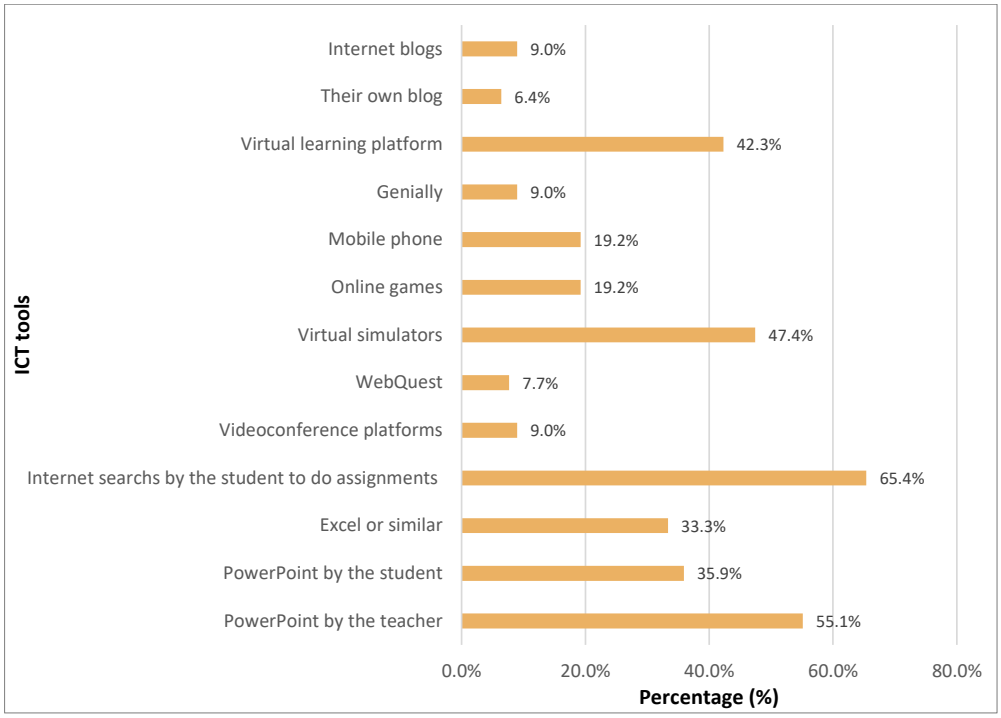

Figure 9. Percentage of teachers that employed these ICT tools before, after and during confinement (from a total of 78 responses).

The respondents had been using mostly Internet for students' research assignments, PowerPoint and virtual simulators, with more than 45% each. The least used were Genially, having their own blog, WebQuest and videoplatforms, as shown in Figure 9.

During quarantine, the largest differences in implementation were for the video platforms (almost 70% of the teachers), then the virtual education platform, the mobile phone and then WebQuests, with at least the 25% of the respondents starting to use them, as depicted in Figure 10. After confinement, the ones that continued to be implemented in the highest number were the video platforms, the virtual education platform and WebQuest. Their use continued after the lockdown but in lower proportion.

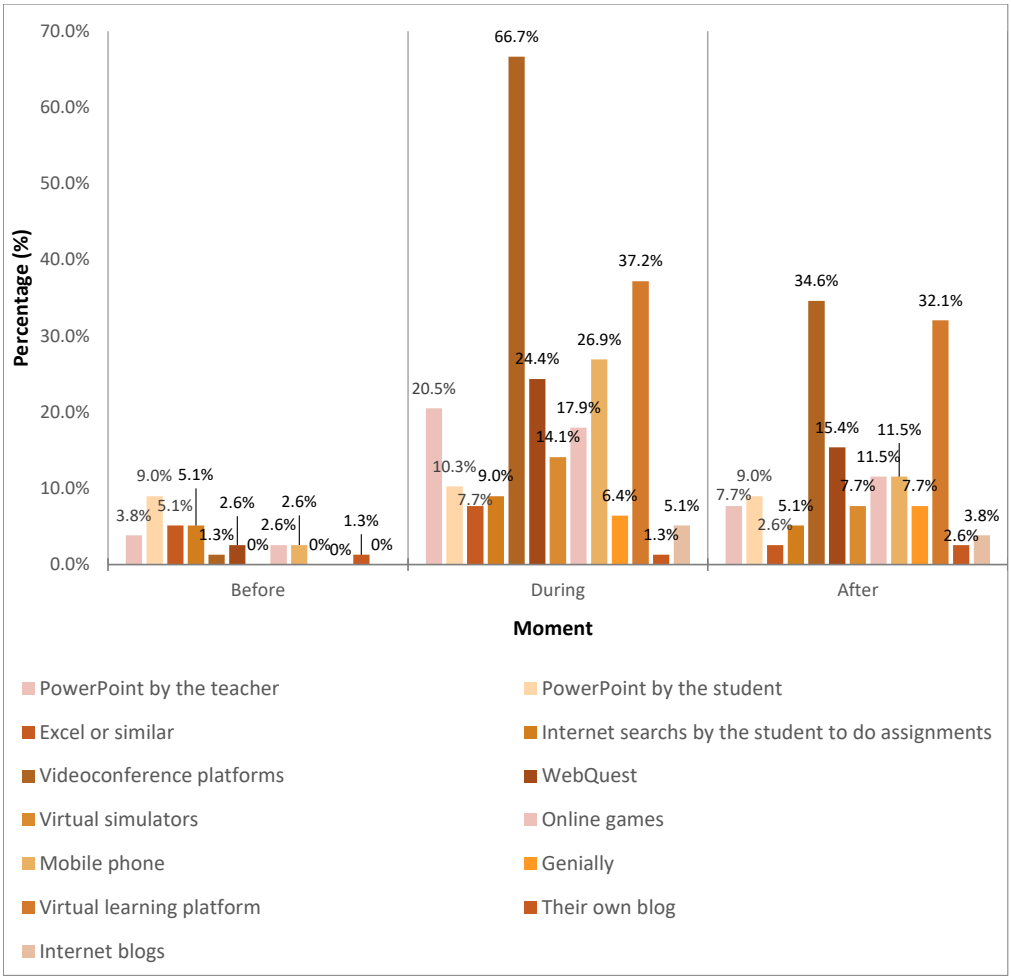

Figure 10. Percentage of teachers that employed the ICT tools at each time period: before, during or after confinement (from a total of 78 responses).

The simulators and websites that had been employed the most for the three time periods were Educacyl (Castile and Leon educational platform) [29], Educaplus [30] and Phet simulator [31] (both websites with educational simulators), with more than 30% of educators stating that they used these. During confinement, the most implemented website for new users was Educacyl (20% of the teachers), and most of them kept with it afterwards.

The most employed ICT resources during the whole period were the interactive resources and the YouTube videos, both with 55% of users. The least used was the Podcast. During confinement, 20% and 17% of respondents started using YouTube and the interactive resources, respectively, and most kept them afterwards.

In terms of the finality, the most common uses are depicted in Figure 11. It depicts the percentage of teachers and the purpose for which the ICT were used before, during

and after confinement. Hence, the ICT had been used at all times to present the lessons by means of PowerPoint and use of online resources, with 46% of responses. The least voted purposes were creating materials and online activities.

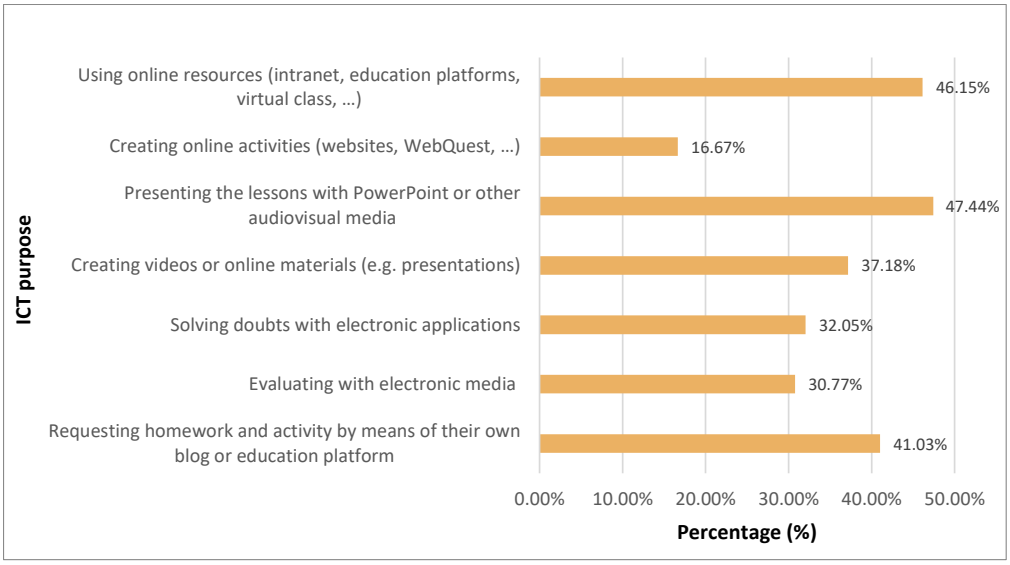

Figure 11. Percentage of teachers and the purpose for which the ICT were used before, during and after confinement (from a total of 78 responses).

During confinement, ICT started to be used for new functionalities and many of them continued. In Figure 10, it can be seen the number of teachers and the purpose for which the ICT were used BC, DC or AC. Some of them were resolving questions, evaluating, using online resources and asking for assignments with at least 32% of responses there.

During lockdown, the main implemented tools for video conference were Microsoft Teams (74.63% of the respondents); followed by Meet, with 14.93%; Zoom and Skype. Currently, 75% of respondents continued using them after confinement. In order to communicate with students, Microsoft Teams was again the favourite platform, with 50.75% of educators using it during confinement; then Moodle and email, with 20.90% for each during confinement. Their use was kept by 91.18% of respondents afterwards. To upload or send materials to the students during confinement, 44.12% employed mainly Microsoft Teams; 20.59% Moodle; and 19.12% via email. The two latter applications had been used at all time periods to upload materials and to communicate with the students, accounting with more than 40% users among the respondents. However, during lockdown, these tools started to be implemented as well for evaluation, delivery of assignments and exercises, communication with the students and uploading materials, ranging from 51% to 30% of the respondents respectively for the DC period. Many of them continued to use these tools for these purposes upon the return to classrooms.

A total of 89.39% of the respondents consider that the lockdown had entailed that they implement more the ICT afterwards. In terms of the main learning during this period, 46.27% responded that they learned new resources and ICT tools; 22.39% new methodologies and didactic options; and 22.39% that they improved their abilities with the ICT.

Last, some respondents stated that because of confinement, the differences in ICT resources in the centres were visible, since, while in many centres they were totally instituted, in others had not almost been used. Moreover, remarkable differences were appreciated between the rural and the city centres. In terms of the main difficulties encountered, they mentioned the students' low implication and the great effort they had to make, which led to new learnings. Others responded insisting on the importance of in-classroom education.

4. Discussion

The present article has allowed to analyse the methodological changes in the Physics and Chemistry didactic that were implemented because of the COVID-19 confinement and the situation afterwards. Besides this, the implemented ICT tools and the use made of them has also been inspected for the time periods before, during and after the confinement. Hence, this paper has permitted to compare the didactic for the three periods of time, including the impact on the use of the ICT after the confinement. This contrasts with many of the previously conducted research, since, to the authors' knowledge, investigation has focused on the experiences before and during lockdown, but the didactic situation afterwards has not been specifically inspected [32–34]. In addition, the specific employed methodologies have been assessed. Thus, by means of this research the truthful impact of the quarantine in the Physics and Chemistry didactic can be evaluated with the return to face-to-face education.

Based on the questionnaire, most of the high schools reported to have good ICT equipment, with 71.74% of them having a computer and a projector in each classroom. The most employed methodology is the traditional one; even if its use decreased during the confinement situation, it was again implemented with the return to classes. As seen, the presence of ICT has not led to significant changes on the didactic and the traditional methodology is still the most employed, as already exposed by [5,8,9]. Moreover, as shown in Figure 8, the ICT were mainly implemented by this methodology. This also stays in line with the European Commission Survey of schools [1], as it was stated that the ICT were mainly used by this methodology for exposition, search purposes or the use of the virtual platform [9,11]. This is also confirmed by the findings made on this survey (Figure 10). In addition, for the didactic of the Physics and Chemistry subject, other common uses of the ICT were virtual simulators or explanatory videos [11,13], which were also very common uses according to this survey.

Nonetheless, during the lockdown, there were some significant changes for the implemented methodologies as well as the ICT tools and functionalities being used.

During the lockdown, methodologies such as the mobile learning and the flipped classroom were favoured, and they started to be used at this period. Although the frequency of use decreased after the lockdown, it has risen in comparison to the situation before lockdown, as depicted in Figure 5. Hence, during confinement, more active methodologies were employed (Figures 4 and 6). The increase of the active methodologies and autonomous learning shown in this study matches other studies performed in terms of the didactic during confinement [35,36]. The fact that the autonomous learning of the student was favoured during this period can also be observed in Figure 7. As shown in Figure 5, the Practical experiences and laboratory sessions were very much affected DC, since they were never employed at much higher rates than BC or AC. This stays in line with other studies, where it was seen that the amount of experiences decreased DC, but the impact afterwards was not evaluated [32]. Still, there are papers where the teachers' effort to continue with the practical experiences are visible and their implementation DC is described [33,37–39].

Only 56% of the respondents were familiar with all the mentioned methodologies, remarking that there is a large lack of awareness on new methodologies. On the other hand, 99% considered that they adapted their methodology during confinement and 71.72% has kept these changes. Besides this, the number of teachers that use the ICT for each methodology has increased from before to after, as depicted in Figure 8.

During confinement, the theoretical lessons were taught mostly by verbal explanations in a virtual platform, by PowerPoint or by uploading notes. In order to solve exercises, most of them either solved them live online or gave the solutions. Furthermore, the use of virtual simulators, PowerPoint presentation, the autonomous learning of the students and the number of assignments increased. The participation of the students and the interaction with the students decreased as well as the amount of exposition lessons (by 42.65% of respondents); however, there was a high percentage that kept them the same (48.53%) as depicted in Figure 7. These results agree with previous studies, where the video conference

or the individual activities with live corrections played a role during confinement [35,40–42]. There have been other studies where the role of computer simulators and PowerPoint presentations during lockdown has been shown [34,42,43] as in this study.

Because of quarantine, some of the ICT tools incorporated and whose use has continued afterwards were video-conference platforms, education portal, the mobile phone and WebQuest, as shown in Figure 9. In addition, some of the new purposes for which ICT were used during confinement and that have continued were PowerPoint presentations, website materials, answering questions, evaluation, and homework assignment as depicted in Figure 12. According to the present study, the most used platform was Microsoft Teams, followed by Moodle. In this aspect, in terms of the preferred platforms, there is a wider variety of results over literature. According to some papers, the most used platforms were Moodle or Google Classroom in Spain [43], with Google Classroom being favoured if they were public employees, while others claimed it to be Classroom and Meet in Spain [44,45], or Zoom and Google Classroom as the most mentioned platforms according to a COVID-19 paper review [46]. In terms of communication with the students, there are again more dissimilar results. For instance, in Castile and Leon, the preferred platforms were Teams (by 50.75%), followed by Moodle and email (with 20.90%). Nevertheless, according to other studies, email [35,47] or Meet [44] were the most widely used tools for communication.

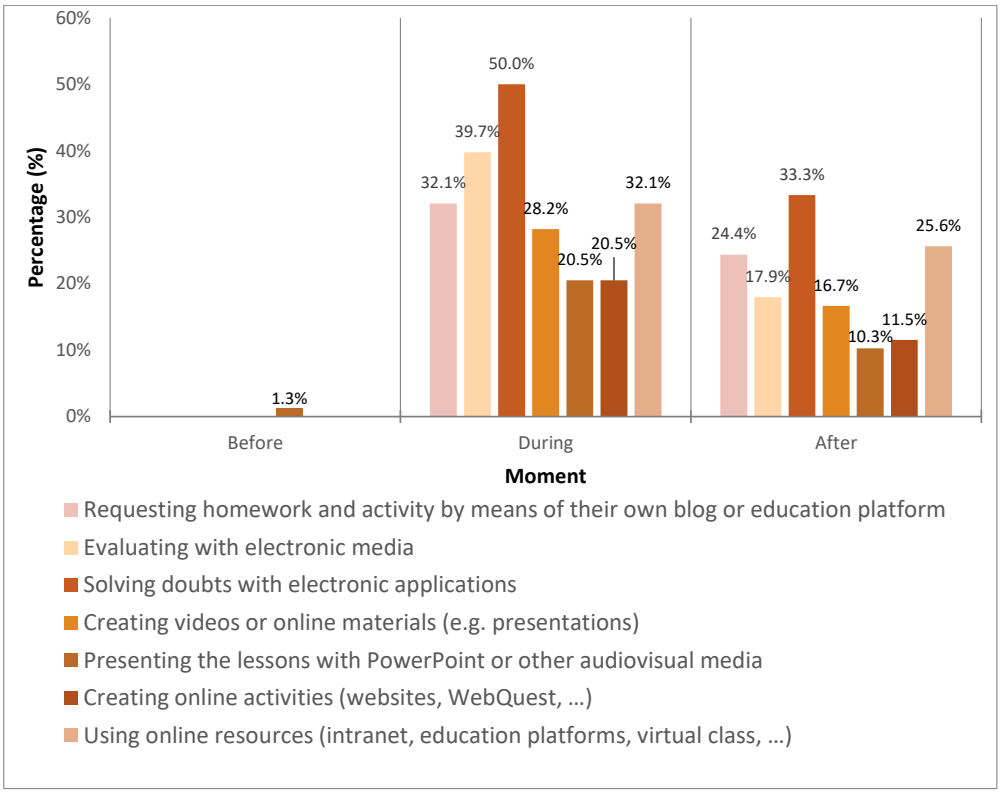

Figure 12. Percentage of teachers and the purpose for which the ICT were used before, during or after confinement (from a total of 78 responses).

It is remarkable that 89% of the respondents considered that, due to confinement, they currently employed more frequently the ICT. This was also the case in other studies where it was stated that the teachers were planning to continue with the ICT use [32,44,48]. Moreover, all of them had some learning because of the lockdown, either related to the methodologies, the ICT tools and possibilities or their ICT abilities. Many of them remarked that they acquired big learnings because of this situation. As stated by [6,9–11], some of the causes of the low use of the ICT in the classes were the teachers' low formation in ICT tools and applications, in how to implement them, and that they were comfortable in the

methodologies they used. Hence, thanks to these new learnings, the situation might be reverted in the coming years as the importance of being formed and prepared for the ICT implementation has been proven. According to literature, during confinement it has been seen that the teachers lack knowledge on the ICT use [32], whereas, in another study [49], the teachers claimed to have a medium level of knowledge in ICT according to their own perception. Other papers have also noted the learning of the educators with regard to this situation, and they have pointed out the need of formation plans and training for them in these technologies [40,42,43,47,50].

Moreover, by means of the last open-ended question, the respondents pointed out the noticeable differences between centres, the urban and rural areas, the low implication of the students, and the great effort they made. These differences must also be tackled since the digital divide can have a great impact on the education of the students as shown by several studies [48,51,52]. Other concerns reflected by the respondents (such as the low implication of the students) have already proven to have impacted on the students' results according to conducted research [53–55], where it has been shown the lower performance levels (with a decrease in Maths or Physics and Chemistry) as well as the influence of excessive parental participation during confinement.

Limitations and Future Work

The main limitation of the current study is the fact that the sample that responded the questionnaire was not very large since they had to accomplish the conditions that they had been teaching Physics and Chemistry before, during and after the confinement in specific provinces of Castile and Leon. Hence, they had to have been active for a period of time and to continue working by the time they responded. Consequently, only a descriptive analysis of the data collected has been carried out.

Future lines of work should include the extension of the study population and, therefore, of the sample. It could also be convenient to incorporate all the provinces of the selected Autonomous Community or even implement a nationwide study. Furthermore, it would be appropriate to carry out a bi-variate analyses that would allow to determine, for example, whether the location of the workplace in rural areas influences the implementation of ICT tools or not.

On the other hand, based on this and other analyses, recommendations could be made to improve the training of educators in ICT and methodologies. This could also be of special interest to the universities teaching the masters program that qualifies for Secondary Education teaching in Spain and that aims to adequately prepare students and future educators. In this aspect, there have already been papers making recommendations about how to evaluate, virtualise the lessons, train the teachers in ICT, or other pedagogical suggestions [50].

5. Conclusions

In conclusion, this study has allowed to inspect the changes that the confinement has supposed in the Physics and Chemistry methodology as well as in the ICT use and in the purpose for which they were employed. Moreover, how the lessons were implemented during the quarantine has been evaluated. Based on the results, recommendations and measures could be proposed for future situations. Thus, it has been concluded that, during the lockdown, the traditional methodology was less employed while others, such as the mobile learning and flipped classroom methodologies, were implemented more frequently. With the return to the classrooms, the traditional methodology increased again and, even if the implementation of the introduced methodologies decreased, it has increased in comparison to the initial situation. In terms of the ICT tools, it must be outlined the importance of the virtual platforms and education websites during and after lockdown, being Microsoft Teams the most widely used. Moreover, the ICT were applied for new purposes (such as evaluation). All the survey respondents considered that they had

acquired some knowledge and 89% stated that they had increased their use of the ICT due to the lockdown situation.

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Abbreviations

The following abbreviations are used in this manuscript:

AC	After confinement
BC	Before confinement
DC	During confinement
ICT	Information and Communication Technology

References

1. European Commission; European Schoolnet; University of Liege. *Survey of Schools: ICT in Education: Benchmarking Access, Use and Attitudes to Technology in Europe's Schools*; Publications Office: Luxembourg, 2013.
2. INE. Instituto Nacional de Estadística. Available online: https://www.ine.es/index.htm (accessed on 2 December 2021).
3. Ministerio de Educación y Formación Profesional. Ministerio de Educación y Formación Profesional. 2019. Available online: https://www.educacionyfp.gob.es/portada.html (accessed on 16 December 2021).
4. Fernández Cruz, F.J.; Fernández Díaz, M.J.; Rodríguez Mantilla, J.M. El proceso de integración y uso pedagógico de las TIC en los centros educativos madrileños. *Educ. XX1* **2018**, 21, 395–416. [CrossRef]
5. Grimalt-Álvaro, C.; Ametller, J.; Pintó, R. El uso del aula digital en las clases de ciencias de secundaria de Cataluña: Análisis del estado actual. Informe de la primera parte del proyecto ADIGIC. *Enseñ. Las Cienc. Rev. Investig. Exp. Didáct.* **2013**, *6*, 1657–1662.
6. Valverde-Crespo, D.; Pro-Bueno, A.J.; González-Sánchez, J. La competencia informacional-digital en la enseñanza y aprendizaje de las ciencias en la educación secundaria obligatoria actual: Una revisión teórica. *Rev. Eureka Sobre Enseñ. Divulg. Cienc.* **2018**, *15*, 1–15. [CrossRef]
7. Area-Moreira, M.; Hernández-Rivero, V.; Sosa-Alonso, J.J. Modelos de integración didáctica de las TIC en el aula. *Comunicar* **2016**, *24*, 79–87. [CrossRef]
8. Franco Mariscal, A.J. Competencias científicas en la enseñanza y el aprendizaje por investigación. Un estudio de caso sobre corrosión de metales en secundaria. *Enseñ. Cienc. Rev. Investig. Exp. Didáct.* **2015**, *33*, 231. [CrossRef]
9. Mármol, A.G.; de Chereguini, C.P. *Investigación e Innovación Educativa en el Siglo XXI*; Wanceulen Editorial: Sevilla, Spain, 2019.
10. Gabby, S.; Avargil, S.; Herscovitz, O.; Dori, Y.J. The Case of Middle and High School Chemistry Teachers Implementing Technology: Using the Concerns-Based Adoption Model to Assess Change Processes. *Chem. Educ. Res. Pract.* **2017**, *18*, 214–232. [CrossRef]
11. Gómez Crespo, M.A.; Cañas Cortazar, A.; Gutiérrez Julián, M.; Martín-Díaz, M. Ordenadores en el aula: ¿estamos preparados los profesores? *Enseñ. Cienc. Rev. Investig. Exp. Didáct.* **2014**, *32*, 239–250. [CrossRef]
12. Domingo-Coscollola, M.; Marquès-Graells, P. Classroom 2.0 Experiences and Building on the Use of ICT in Teaching. *Comunicar* **2011**, *19*, 169–175. [CrossRef]
13. Torres Climent, A.L.; Bañón García, D.; López Simó, V. Empleo de smartphones y apps en la enseñanza de la Física y Química. *Enseñ. Cienc. Rev. Investig. Exp. Didáct.* **2017**, *8*, 671–678.
14. Marzo Mas, A.; Monferrer Pons, L. Pregúntate, indaga y a la vez trabaja algunas competencias. *Rev. Eureka Sobre Enseñ. Divulg. Cienc.* **2015**, *12*, 14. [CrossRef]
15. García Martínez, D.M. Bendita Pandemia: Oportunidad de crecimiento y aprendizaje. *Educ. QuíMica* **2020**, *31*, 121–125. [CrossRef]

16. Bullón-Solís, O. Educación virtual interactiva como metodología para la educación: revisión de literatura. *Crescendo* **2020**, *11*, 14. [CrossRef]
17. Cabero-Almenara, J.; Palacios-Rodríguez, A. Marco Europeo de Competencia Digital Docente «DigCompEdu». Traducción y adaptación del cuestionario «DigCompEdu Check-In». *EDMETIC* **2020**, *9*, 213–234. [CrossRef]
18. Díaz-Arce, D.; Loyola-Illescas, E. Competencias digitales en el contexto COVID 19: una mirada desde la educación. *Rev. Innova Educ.* **2021**, *3*, 120–150. [CrossRef]
19. González, C.; Cañote, V. Aprendizaje basado en proyectos. *Colecc. Mater. Apoyo Docencia* **2017**, *1*, 1–17.
20. Albaladejo, C.B. Acerca de la utilidad del aula invertida o flipped classroom, In *XIV Jornadas de Redes de Investigación en Docencia Universitaria. Investigación, Innovación y Enseñanza Universitaria: Enfoques Pluridisciplinares*; Tortosa Ybáñez, M.T.; Grau Company, S., Álvarez Teruel, J.D., Eds.; Universidad de Alicante: Alicante, Spain, 2016; pp. 1466–1480.
21. Azorín Abellán, C.M. El método de aprendizaje cooperativo y su aplicación en las aulas. *Perfiles Educ.* **2018**, *40*, 181–194. [CrossRef]
22. Llobet, J.R.; Álvarez, M.R.; Velez, O.C. Aprendizaje Basado en Problemas, Estudio de Casos y Metodología Tradicional: Una Experiencia Concreta en el Grado en Enfermería. *Procedia-Soc. Behav. Sci.* **2015**, *196*, 163–170. [CrossRef]
23. Lozada Ávila, C.; Betancur Gómez, S. La gamificación en la educación superior: una revisión sistemática. *Rev. Ing. Univ. Medellin* **2017**, *16*, 97–124. [CrossRef]
24. Grund, F.B.; Gil, D.J.G. *Mobile Learning: Los Dispositivos Móviles Como Recurso Educativo*; Mad: Sevilla, Spain, 2011.
25. Martínez-Argüello, L.D.; Hinojo-Lucena, F.J.; Díaz, I.A. Aplicación de las Tecnologías de la Información y la Comunicación (TIC) en los Procesos de Enseñanza- Aprendizaje por parte de los Profesores de Química. *Inf. Tecnol.* **2018**, *29*, 41–52. [CrossRef]
26. Software de Gestión de la Experiencia. Available online: https://www.qualtrics.com/es/ (accessed on 22 March 2022).
27. Máster Universitario en Profesor de Educación Secundaria Obligatoria y Bachillerato, Formación Profesional y Enseñanzas de Idiomas | Universidad de Salamanca. Available online: https://www.usal.es/master-profesor-de-educacion-secundaria-obligatoria-y-bachillerato-formacion-profesional-y-ensenanzas (accessed on 15 December 2021).
28. Consejería de Educación de la Junta de Castilla y León. Resolución de 8 de abril de 2021, BOCYL de 12-04-2021, 2021. Available online: https://bocyl.jcyl.es/html/2021/04/19/html/BOCYL-D-19042021-8.do (accessed on 2 December 2021).
29. Portal de Educación de la Junta de Castilla y León. Available online: https://www.educa.jcyl.es/es (accessed on 31 March 2022).
30. Educaplus-Recursos Educativos Para la Enseñanza de las Ciencias. Available online: https://www.educaplus.org (accessed on 31 March 2022).
31. PhET: Simulaciones Gratuitas en Línea de Física, Química, Biología, Ciencias de la Tierra y Matemáticas. Available online: https://phet.colorado.edu/es (accessed on 31 March 2022).
32. Štibi, I.; Pavlin, J.; Čepič, M. Physics Teaching in Croatian Elementary and High Schools during the Covid-19 Pandemic. *Cent. Educ. Policy Stud. J.* **2021**, *11*, 335–360. [CrossRef]
33. Chans, G.M.; Bravo-Gutiérrez, M.E.; Orona-Navar, A.; Sánchez-Rodríguez, E.P. Compilation of Chemistry Experiments for an Online Laboratory Course: Student's Perception and Learning Outcomes in the Context of COVID-19. *Sustainability* **2022**, *14*, 2539. [CrossRef]
34. Coman, T.B.; Cazacu, M.M.; Radinschi, I. Teaching strategy based on interactive use of computer simulations during COVID-19 pandemic. In Proceedings of the INTED2021 Proceedings, 15th International Technology, Education and Development Conference, Online, 8–9 March 2021; pp. 10485–10490. [CrossRef]
35. Torres Martín, C.; Acal, C.; El Homrani, M.; Mingorance Estrada, Á.C. Impact on the Virtual Learning Environment Due to COVID-19. *Sustainability* **2021**, *13*, 582. [CrossRef]
36. 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**, *18*, 189–204. [CrossRef]
37. Babinčáková, M.; Bernard, P. Online Experimentation during COVID-19 Secondary School Closures: Teaching Methods and Student Perceptions. *J. Chem. Educ.* **2020**, *97*, 3295–3300. [CrossRef] [PubMed]
38. E. Obaya Valdivia, A.; Montaño Osorio, C.; Marina Vargas Rodríguez, Y.; Gerardo Ponce Pérez, R. Experimentation in Times of COVID 19. Didactic Sequence "*Influence of pH on plant irrigation*" for a High School Chemistry Course. *Am. J. Educ. Res.* **2021**, *9*, 746–754. [CrossRef]
39. Pinto, G.; Moreno, L. Una iniciativa para destacar la labor del profesorado en una etapa histórica singular. *An. Quím.* **2021**, *7* .
40. Garavaglia, A.; Petti, L. Sudden Shift to Distance Learning: Analysis of the Didactic Choices Made by Italian Secondary School Teachers in the First COVID-19 Lockdown. *Res. Educ. Media* **2020**, *12*, 19–28. [CrossRef]
41. Baladrón Pazos, A.J.; Correyero Ruiz, B.; Manchado Pérez, B. La transformación digital de la docencia universitaria en comunicación durante la crisis de la COVID-19 en España: una aproximación desde la perspectiva del alumnado. *Rev. Lat. Comun. Soc.* **2020**, *78*, 265–287. [CrossRef]
42. OECD. *The impact of COVID-19 on Education-Insights from Education at a Glance 2021*; OECD Publishing: Paris, France, 2021. [CrossRef]
43. García Martín, J.; García Martín, S. Uso de herramientas digitales para la docencia en España durante la pandemia COVID-19. *Rev. Esp. Educ. Comp.* **2021**, *38*, 151–173. [CrossRef]

44. Pratsobrerroca Pujol, M. Didactic Adaptations Needed to Successfully Teach EFL in a Pandemic Context: Teaching Speaking. In *Trabajo fin de Máster*; Universidad de Vic: Barcelona, Spain, 2021. Available online: http://hdl.handle.net/10854/6868 (accessed on 31 March 2022).
45. Rodríguez-Rodríguez, E.; Sánchez-Paniagua, M.; Sanz-Landaluze, J.; Moreno-Guzmán, M. Analytical Chemistry Teaching Adaptation in the COVID-19 Period: Experiences and Students' Opinion. *J. Chem. Educ.* **2020**, *97*, 2556–2564. [CrossRef]
46. Bond, M. Schools and emergency remote education during the COVID-19 pandemic: A living rapid systematic review. *Asian J. Distance Educ.* **2020**, *15*, 191–247.
47. Hernández-Ortega, J.; Álvarez Herrero, J.F. Gestión educativa del confinamiento por COVID-19: percepción del docente en España. *Rev. Esp. Educ. Comp.* **2021**, *38*, 129–150. [CrossRef]
48. Mseleku, Z. A Literature Review of E-Learning and E-Teaching in the Era of Covid-19 Pandemic. *Int. J. Innov. Sci. Res. Technol.* **2020**, *5*, 588–597.
49. Prieto-Ballester, J.M.; Revuelta-Domínguez, F.I.; Pedrera-Rodríguez, M.I. Secondary School Teachers Self-Perception of Digital Teaching Competence in Spain Following COVID-19 Confinement. *Educ. Sci.* **2021**, *11*, 407. [CrossRef]
50. Rodgríguez, C.L.; Mula-Falcón, J.; Segovia, J.D. The Effects of Covid-19 on Science Education: A Thematic Review of International Research. *J. Turk. Sci. Educ.* **2021**, *18*, 20.
51. Ballesta Pagán, F.J.; Lozano Martínez, J.; Cerezo Máiquez, M.C. Internet Use by Secondary School Students: A Digital Divide in Sustainable Societies? *Sustainability* **2018**, *10*, 3703. [CrossRef]
52. European Commission; Joint Research Centre. *The Likely Impact of COVID-19 on Education: Reflections Based on the Existing Literature and Recent International Datasets*; Publications Office: Luxembourg, 2020.
53. Kuhfeld, M.; Soland, J.; Tarasawa, B.; Johnson, A.; Ruzek, E.; Liu, J. Projecting the Potential Impact of COVID-19 School Closures on Academic Achievement. *Educ. Res.* **2020**, *49*, 549–565. [CrossRef]
54. Retnawati, H. The Influence of Online Learning on Physics Learning Outcomes during the Covid-19 Pandemic. *Radiasi J. Berk. Pendidik. Fis.* **2022**, *15*, 35–42.
55. Goyal, N.; Abdulahad, A.I.; Privett, J.A.; Verma, A.; Foroozesh, M.; Coston, T.S. Student Grade Evaluation, Survey Feedback, and Lessons Learned during the COVID-19 Pandemic: A Comparative Study of Virtual vs. In-Person Offering of a Freshman-Level General Chemistry II Course in Summer at Xavier University of Louisiana. *Educ. Sci.* **2022**, *12*, 226. [CrossRef]