mathematics

MDPI

Article

Technological Factors That Influence the Mathematics Performance of Secondary School Students

Melchor Gómez-García [1], Hassan Hossein-Mohand [1,*], Juan Manuel Trujillo-Torres [2], Hossein Hossein-Mohand [1] and Inmaculada Aznar-Díaz [2]

1 Department of Pedagogy, Faculty of Teacher Training and Education, Universidad Autónoma de Madrid (UAM), 28049 Madrid, Spain; melchor.gomez@uam.es (M.G.-G.); hossein.hossein@estudiante.uam.es (H.H.-M.)
2 Department of Didactics and School Organization, Faculty of Educational Sciences, Universidad de Granada (UGR), 18071 Granada, Spain; jttorres@ugr.es (J.M.T.-T.); iaznar@ugr.es (I.A.-D.)
* Correspondence: hassan.hossein@estudiante.uam.es

Received: 23 September 2020; Accepted: 19 October 2020; Published: 3 November 2020

Abstract: Although the value of information and communication technology (ICT) is positive and its use is widespread, its potential as a teaching tool in mathematics is not optimized and its methodological integration is rare. In addition, the availability of ICT resources in schools is positively associated with the academic success of students, and the availability of ICT resources at home is negatively associated with their success. To determine the relationships among academic performance, uses, and available ICT resources, a total of 2018 secondary school students participated in the present study. The uses and available ICT resources, and the learning of mathematics and ICT, were evaluated using a validated 11-item questionnaire. Statistical analysis reveals that, of the secondary education levels, the lowest results are observed in the third year. A total of 64% of students affirm that they use ICT at home to study mathematics. In addition, 33.61% of the students affirm that they use their mobile phones frequently while studying at home. However, it should be noted that between 23.80% and 28.44% affirm that they dedicate more than 4 h per day to phone calls. Educational level is a predictor of academic performance in mathematics associated with students' uses of ICT. The scores indicate that the computer is generally used for Internet searches, thus, limiting the use of ICT for educational purposes. Furthermore, there is a difference regarding gender.

Keywords: ICT; secondary education; academic performance; learning; mathematics

1. Introduction

Technology has expanded to all levels of our society, as shown by data from the Office for National Statistics (INE). In their report on Equipment and Use of ICT in Spanish homes in 2019, it was observed that 90.7% of homes had Internet access, 80.9% had a computer at home, and 99.6% had at least one mobile phone [1]. Moreover, in terms of gender, daily average Internet use was 78.2% for women and 77.0% for men. In addition, it was observed that students were the most active on social media, with 91.1% active; in particular, 90.6% of students were young people between 16 and 24 years of age. Regarding digital competences, 65.0% focused on copying and pasting folders, 63.2% focused on installing applications, and 60.1% focused on transferring files between different devices [1].

Moreover, the INE report on information and communication technology (ICT) in non-university educational centers in the academic year of 2018/2019 showed that the average number of students per computer was 2.9. In addition, it highlighted that more than 90% of classrooms had cable or wireless Internet connections. Laptops and tablets represented 50% of available devices and interactive digital systems (SDI) made up 60.1%. Furthermore, 50.5% of secondary school and public vocational training (FP) centers participated in educational technological projects. Finally, mobile phones were used for educational purposes in 43.0% of compulsory secondary education (ESO) centers and in 51.3% of centers for post-16 education. Regarding academic years, values increased to 41.7% at the basic professional training (FP) grade, 53.5% at the medium grade, and 58.6% at the advanced grade. Thus, the Autonomous City of Melilla, the area of our sample, showed the highest percentages of mobile phone use, with 80.0% at the medium grade and 100% at the advanced grade [2].

In spite of the accessibility of technology and online connectivity, it is notable that students' technological skills are distant from the educational framework and more focused on social skills [3]. As a result, young people's non-controlled use of ICT could directly impact their academic performance [3]. Thus, this new study analyzes educational performance and examines the correlations among the associated technological variables. For this purpose, indicators related to ICT resources and their uses, which may influence performance in the area of mathematics, are identified.

1.1. Information and Communication Technology (ICT) in Education

In 2018, the European Commission adopted a Digital Education Action Plan to promote the use of ICT and the improvement of digital competences for educational purposes. This plan was structured into the following three priorities: (1) to improve the use of ICT for teaching and learning, (2) to develop digital competences and skills, and (3) to modernize education through data analysis [4]. The use of technology in education assists students with digital content, supports methodological resources, and facilitates academic management [5].

Although the value of ICT is deemed to be positive and its use is generalized, its potential as an educational tool is not optimized and its methodological integration is infrequent [6]. In addition, a digital divide exists that affects vulnerable groups of disadvantaged students, students of a foreign origin, and those with special educational needs [7]. Similarly, the use of mobile devices is also promoted among secondary students [8]. However, their application for teaching and research for educational purposes remains to be limited [9].

Furthermore, the existence of a significant correlation between age and the frequency of connection via a mobile device, and between the starting age and the positive perceptions of students, is evident among teenage students [10]. Moreover, another recent study suggested a significant association among age, gender, ICT education received, and the free time which students dedicate to using technology [11]. Excessive use of mobile devices can lead to addiction, for which a higher impact is observed in urban areas than in rural areas [12].

Related to the aforementioned factors, video games or online game addiction is related to an increase in attention deficit in young people [13]. This addiction has a direct negative impact on students' physical and psychological health, and indirectly on their academic performance [14]. Similarly, it is observed that the profile of the addict in secondary students is that of an obese male online player or multiplayer [15].

1.2. The Influence of ICT on Educational Performance

Evaluation of the degree of association between the use of ICT and its influence on educational performance has been investigated in previous studies [16–18]. The results of recent studies have shown that the availability of ICT resources in schools was positively associated with students' academic success, whereas the availability of ICT resources at home was negatively associated [19]. It has also been observed that inappropriate use of ICT significantly affected students' learning [20]. However, specific software created and developed with attractive and dynamic platforms for students was more effective than general software for teaching and learning [21].

The use of computers at home and in school will decrease in terms of capacity over the medium grade for the teaching and learning, without appropriate hardware, software, and pedagogical design improvements by teachers [22]. Some authors have argued that the use of portable devices was more effective in learning than the use of computers, because it facilitated a mobile, ubiquitous, collaborative, and creative form of learning [23]. This difference may also be due to the fact that portable devices tended to integrate innovative teaching methods [24].

On the one hand, in a meta-analysis, reference [25] suggested that the use of mobile devices (tablets, smartphones, etc.) in education was significantly more effective than traditional methods, and it positively influenced student learning [24,25]. In addition, the degree of influence depended on several factors such as the diversity of the learning stage, the hardware used, the teaching methods used, and the affective variables [21,23]. The effect on cognitive achievement in primary school was greater than the effect in secondary school. However, these results were not comparable, as studies with computers lasted more than a semester, and the studies with portable devices only lasted a few weeks. This suggests that the results could be due to the "novelty effect" [25,26].

On the other hand, the use of unsupervised mobile phones has a negative impact on the academic performance of students [27]. The negative effect was higher if mobile possession occurs in early ages [28]. The main findings have also shown low significant and negative associations between mobile phones' radiation and cognitive function [29]. Other studies have shown the negative effects that online chats have on memory performance and students' learning [30]. Instead, there there have been positive effects on teaching, when adopting social medias such as Facebook as an additional learning management system (LMS) [31].

Nevertheless, another study highlighted that girls obtained better results than boys in associated ICT literacy evaluations, and that the gender differences were greater in primary than secondary school [18]. Moreover, on the one hand, the existence of distinctive patterns regarding the function and purpose of the use of ICT, and academic performance, was evident, both for gender and for age [32]. On the other hand, the use of internet was negative for both, not observing any gender differences [33]. However, it is evident that the association with the use of ICT in mathematics is weaker for girls than for boys, and that this association was influenced by perceptions towards technology and its use in education [34]. In addition, there were significant negative effects of ICT skills on mathematical performance of boys, but, for girls, the effects were positive [35]. Gender differences could be due to personal preferences during the educational stage [36]. Thus, it has been proposed that adequate use of digital interactive whiteboards could decrease gender differences [37] and could improve academic performance [38].

Conversely, the scientific literature has affirmed that the use of social media had an important impact on students with poor academic performance, whereas higher performing students were not significantly affected [3]. Similarly, it has been demonstrated that students with good grades maintained them throughout their academic life. Additionally, active participation on e-learning platforms promoted the improvement of students' academic performance [39].

1.3. Justification

In 2018, thirteen countries reduced early school leaving to 10%, as benchmarked by the European Union (EU) for 2020. Among the countries which have not met this benchmark, Spain (17.9%) registered the highest rate, ahead of Portugal (11.8%) and Germany (10.3%) [40]. In the group of European countries, it was observed that the phenomenon of early school leaving had a greater impact on men (12.2%) than on women (8.9%). Among the 28 European Union countries, Spain registered the greatest gender gap (7.7 percentage points). The dropout rate in Melilla increased to 31.9% for boys and 26.9% for girls, with an average increase of 29.5% [40]. Moreover, it was noted that poor academic performance was a possible cause of this early school leaving [41].

In the present study, school failure is analyzed from an innovative perspective using gender differentiated case studies. Some variables which may influence student performance are investigated. For this purpose, we analyze the dimensions related to ICT use and resources associated with performance in mathematics. In order to "display" the items which have more influence on students' academic performance in Melilla, the following research objectives are posed: (1) to examine the profile of the sample according to the correlations between the variables of the study and (2) to determine the existing relationship between performance and ICT uses and resources.

2. Materials and Methods

A total of 2018 secondary and post-16 education students from the Autonomous City of Melilla participated in the present observational study without pre-post study and without a control group. Of the total sample, girls comprised 53.40%. The registered student population in the city is 5875 students, 50.84% of whom are girls. The questionnaires were sent to all educational centers of the city, during school hours, with authorization from the Provincial Directorate of the Ministry of Education and Professional Training of Melilla, to avoid any type of variation.

Google Forms was used to administer the questionnaires; therefore, the reliability of the data collection was guaranteed. Prior to the implementation of the questionnaires, all voluntarily participating subjects were informed of the nature and objectives of the study. The validation was conducted by expert judges (content validity), at both the composition level and at the level of adequacy of the items. A trial questionnaire was also conducted to detect final aspects that could be improved. Subsequently, with the data matrix completed, the instrument was validated using the Kaiser–Guttmand and Tucker–Lewis index criteria, with a score of 1.052. The variable used to analyze the students' academic performance was the second trimester mathematics mark (the questionnaire was conducted during the third assessment) because it was the most reliable predictor [42,43].

Table 1 provides the different dimensions and their indicators with the corresponding analyzed items.

Table 1. Relationships among dimensions, indicators, and items.

Dimension	Indicator	Code	Items
A. General students' data	A.1 Students' data	**NST**	What mark did you get in the second trimester?
		ECC	Are you a boy or a girl?
		NEC	Educational level
D. ICT uses and resources	D.2 ICT uses	**UMC**	Do you use a mobile phone while studying at home?
		UOE	Do you use a computer while studying at home?
	D.4 Daily ICT consumption	**LJC**	From Monday to Thursday, how many hours do you dedicate each day to cyber chats (Whatsapp, Telegram ...)?
		LJR	From Monday to Thursday, how many hours do you dedicate to social media, (Instagram, Facebook . . .)
		LJV	From Monday to Thursday, how many hours do you dedicate to playing video games?
		LJB	From Monday to Thursday, how many hours do you dedicate each day to searching for material on the Internet for the sole purpose of studying or doing class work?
E. ICT and mathematics learning	E.1 At home	**RTC**	Do you use the technological resources that you have at home to study mathematics?
	E.3 Perception	**TTM**	Do you think you work on mathematics more and better using ICT?

Statistical Procedure

To analyze the variables of the study, several statistical models were used. One model was the Bayesian model, which allowed us to calculate the posterior conditional probabilities of a categorical class variable, given the independent predictor variables, via the Bayes rule. For that purpose, the R Studio e1071 package (https://cran.r-project.org/web/packages/e1071/index.html) was used. Subsequently, the variables of the study were correlated, without requiring that each of the research factors was transformed into numerical variables.

In addition, other regression models were used that allowed us to also predict an answer variable, on the basis of one or several predictors. To analyze possible linear relationships among variables, the general linear model (GLM) was used, and random forest (RF) and the gradient boosting machine (GMB) were used to analyze nonlinear relationships among the predictors.

To determine the variables with a greater relevance to the study, the algorithm h2o was used. The procedure used was as follows:

- Transformation of dataset into a h2o class object;
- Partition of the dataset into three segments, i.e., training, validation, and testing;
- Application of the DALEX algorithm, and creation of a customized function, followed by the implementation of a general linear model, random forest, and gradient boosting machine, initially, each model using h2o was calculated and, subsequently, that model was incorporated into the DALEX algorithm;
- Calculation of the predictions and the residual values (see Figure 1).

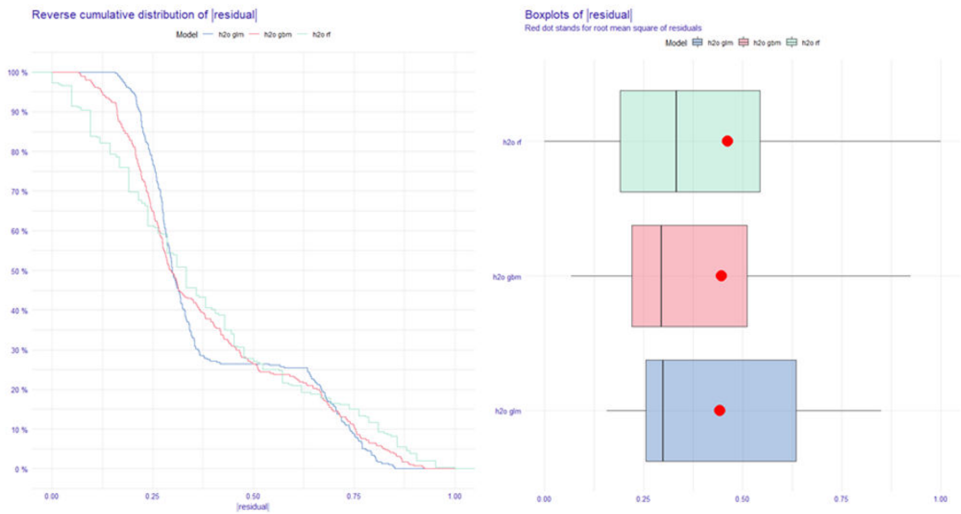

Figure 1. Residual values and determination of the best predictive model.

3. Results

The Bayesian model was obtained by calculating the values of NST (second trimester marks) and the conditional probabilities of the items NEC (economic level), ECC (educational level), RTC (ICT resources for educational purposes), TTM (perceived usefulness of ICT), UOE (computer use), LJB (daily dedication to the Internet for educational purposes), UMC (non-academic uses of smartphones), LJC (daily dedication to online chats), LJR (daily dedication to social media), and LJV (daily dedication to video games) with respect to NST. The results are shown in Table 2.

Table 2. A priori probabilities of second trimester marks (NST) and conditional probabilities/NST.

NST Second Trimester Marks (a priori probabilities)					
Fail	**Adequate**	**Good**	**Merit**	**Outstanding**	**Graph**
0.2721923	0.2069642	0.1760667	0.2265817	0.1181952	
Conditional Probability/NST					
TTM Do you think you work on mathematics more and better with ICT?					
	None	**A Little**	**Enough**	**A Lot**	**Graphs**
Fail	0.2000000	0.3045045	0.3603604	0.1351351	
Adequate	0.1729858	0.3293839	0.3270142	0.1706161	
Good	0.1727019	0.3175487	0.3147632	0.1949861	
Merit	0.2077922	0.2943723	0.3636364	0.1341991	
Outstanding	0.2406639	0.2738589	0.3568465	0.1286307	

Table 2. *Cont.*

UOE Do you use a computer while studying at home?					
	None	**A Little**	**Enough**	**A Lot**	**Graphs**
Fail	0.39099099	0.34234234	0.19099099	0.07567568	
Adequate	0.36966825	0.34834123	0.19431280	0.08767773	
Good	0.32033426	0.33983287	0.23398329	0.10584958	
Merit	0.31168831	0.31818182	0.26406926	0.10606061	
Outstanding	0.32365145	0.28215768	0.25311203	0.14107884	

LJB From Monday to Thursday, how many hours do you dedicate each day to searching for material on the Internet for the sole purpose of studying or doing class work?					
	None	**1–2 h**	**3–4 h**	**>4 h**	**Graphs**
Fail	0.42522523	0.34054054	0.14234234	0.09189189	
Adequate	0.41232227	0.35545024	0.16113744	0.07109005	
Good	0.37883008	0.37604457	0.16155989	0.08356546	
Merit	0.43506494	0.33549784	0.16233766	0.06709957	
Outstanding	0.50207469	0.31535270	0.12448133	0.05809129	

UMC Do you use a mobile phone while studying at home?					
	None	**A Little**	**Enough**	**A Lot**	**Graphs**
Fail	0.2036036	0.3099099	0.2540541	0.2324324	
Adequate	0.2014218	0.3222749	0.2274882	0.2488152	
Good	0.2172702	0.2813370	0.2813370	0.2200557	
Merit	0.2034632	0.2900433	0.2770563	0.2294372	
Outstanding	0.2323651	0.2074689	0.3360996	0.2240664	

LJC From Monday to Thursday, how many hours do you dedicate each day to cyber-chat (Whatsapp, Telegram, etc.)?					
	None	**1–2 h**	**3–4 h**	**>4 h**	**Graphs**
Fail	0.1459459	0.4072072	0.1765766	0.2702703	
Adequate	0.1279621	0.3886256	0.1990521	0.2843602	
Good	0.1671309	0.4261838	0.1559889	0.2506964	
Merit	0.1212121	0.4610390	0.1796537	0.2380952	
Outstanding	0.1410788	0.4315353	0.1867220	0.2406639	

LJR From Monday to Thursday, how many hours do you dedicate to social media, (Instagram, Facebook, etc.)?					
	None	**1–2 h**	**3–4 h**	**>4 h**	**Graphs**
Fail	0.1171171	0.3513514	0.2216216	0.3099099	
Adequate	0.1374408	0.3222749	0.2298578	0.3104265	
Good	0.1309192	0.3509749	0.2618384	0.2562674	
Merit	0.1406926	0.3593074	0.2554113	0.2445887	
Outstanding	0.2157676	0.3236515	0.2157676	0.2448133	

LJV From Monday to Thursday, how many hours do you dedicate to playing video games?					
	None	**1–2 h**	**3–4 h**	**>4 h**	**Graphs**
Fail	0.5135135	0.2558559	0.1081081	0.1225225	
Adequate	0.4786730	0.2867299	0.1066351	0.1279621	
Good	0.4679666	0.2646240	0.1392758	0.1281337	
Merit	0.5043290	0.2554113	0.1341991	0.1060606	
Outstanding	0.5435685	0.2365145	0.1120332	0.1078838	

RTC Do you use technological resources that you have at home to study mathematics?					
	Fail	**Adequate**	**Good**	**Merit**	**Outstanding**
NO	0.4018018	0.3388626	0.3036212	0.3658009	0.3900415
YES	0.5981982	0.6611374	0.6963788	0.6341991	0.6099585

Table 2. *Cont.*

NEC Educational Level.							
	1°ESO	**2°ESO**	**3°ESO**	**4°ESO**	**1°Bach**	**2°Bach**	**Graphs**
Fail	0.18198198	0.23783784	0.17297297	0.26666667	0.10990991	0.03063063	
Adequate	0.21563981	0.21327014	0.23696682	0.21327014	0.08767773	0.03317536	
Good	0.22284123	0.24512535	0.22284123	0.16155989	0.10863510	0.03899721	
Merit	0.20562771	0.23593074	0.18181818	0.18831169	0.13203463	0.05627706	
Outstanding	0.22821577	0.24481328	0.15767635	0.15767635	0.15352697	0.05809129	

Note: ESO, compulsory secondary school; Bach, post-16 education.

Table 2 shows the students' grades. It shows that one out of three students achieved a grade of good or merit. The highest percentage of merits is among 2ºESO secondary school students (24.48%), whereas only 5.81% of the 2ºBach post-16 students reach that score. Conversely, the highest percentage of fails appears among the 4ºESO secondary school students (26.67%) and the lowest in the 2ºBach post-16 students (3.06%).

In terms of gender, it is observed that female students acquire a percentage increase in all grades. The smallest difference in gender is 0.4 percentage points and appears in the highest level, and the largest percentage difference is among fails with more than 10.64 percentage points, with 44.68% of boys and 55.32% of girls.

In terms of technological resources at home (RTC), on average, 64% of students affirm that they use these to study mathematics. The higher values of RTC are among the students with a mark of adequate and good, with 2 and 5 percentage points increases, respectively. Conversely, analysis of student perceptions (TTM) shows that an average of 20% respond that they do not work on mathematics more and are better using ICT. The highest percentage corresponds to the students with a merit, who respond "enough" in TTM (36.36%). However, the lowest percentage appears in the students with a mark of outstanding, who respond "a lot" in TTM (12.86%).

On average, two out of three students state that they use the computer "a little" or "none" while studying at home (UOE). This percentage increases in the students who fail (73.33%), whereas it decreases in the case of the students with a mark of outstanding (60.58%). The highest percentage for UOE is reported by the students who fail and respond "none" in this item (39.10%). In contrast, the lowest value is found among the students with a mark of inadequate who respond "a lot" for UOE, with 7.57%. In addition, in "the time used to search for material on the Internet for the sole purpose of studying" (LJB), 42.52% are students who fail and do not dedicate any time. On average, 43.07% of students respond "none" in LJB as compared with 7.44% of students who dedicate "more than 4 h. The percentage patterns repeat regardless of the academic results.

In terms of the use of technological resources for non-educational purposes (UMC), the average percentage of students who affirm that they do not use their mobile phone "at all" while studying, regardless of the mark obtained, is 21.16%. A 12.5 percentage points increase is observed between the students with a mark of outstanding, who declare that they use their mobile phone "enough" while studying at home. It is relevant that, of students with a mark of outstanding, 56.02% affirm that they use their mobile phone "enough" or "a lot".

However, the proportion of students who declare that they dedicate "none" of the day to cyber chats (Whatsapp, Messenger, Telegram) during the week (LJC), is 14.07%. It should be noted that one out of four students spend "more than 4 h" per day on cyber chats. The highest average percentage (42.29%) of time dedicated to cyber chats was of those students who consumed between 1 and 2 h daily during the week. In terms of social media, the highest percentage ranged between students with a mark of merit, who dedicate between "1 and 2 h" daily to social media (35.93%), and the lowest in the case of students who fail, who do not dedicate "any" time to social media (11.71%). A 19 percentage point increase is observed between the failed students who score "nothing" and those who spend "more than 4 h" each day on social media. The largest increase in social media consumption

(24 percentage points) is between the failed students who consume "nothing" and those who spend "1–2 h." On average, more than a half of students dedicate more than 3 h to social media.

Regarding the time dedicated to video games, a change in trend in relation to cyber chats and social media is observed. It is remarkable that, on average, more than a half of all responses affirm that do not dedicate "any" time daily to video games. Of those that do, 25.98% dedicate "1–2 h", 12.01% dedicate "between 3 and 4 h", and 11.85% dedicate "more than 4 h" daily to video games.

In Figure 2, positive, strong correlations between LJR and LJC are observed. There are also positive but weak correlations among UMC, LJC, and LJR. A negative and weak correlation between LJV and ECC should be highlighted. The remainder of the variables show very weak correlations.

To specify variables of the study with less importance, the following variables were analyzed: NST, ECC, NEC, RTC, TTM, UOE, UMC, LJC, LJR, and LJV.

Figure 3 indicates that the most influential variables in NST were, for the GBM model, TTM, NEC, UMC, RTC, LJC, LJR, UOE, and LJV. According to the GLM model, the most relevant variables were TTM, NEC, UMC, RTC, LJR, UOE, LJB, and ECC. Regarding the RF model, the variables which had the greatest impact were TTM, NEC, UMC, RTC, and LJC.

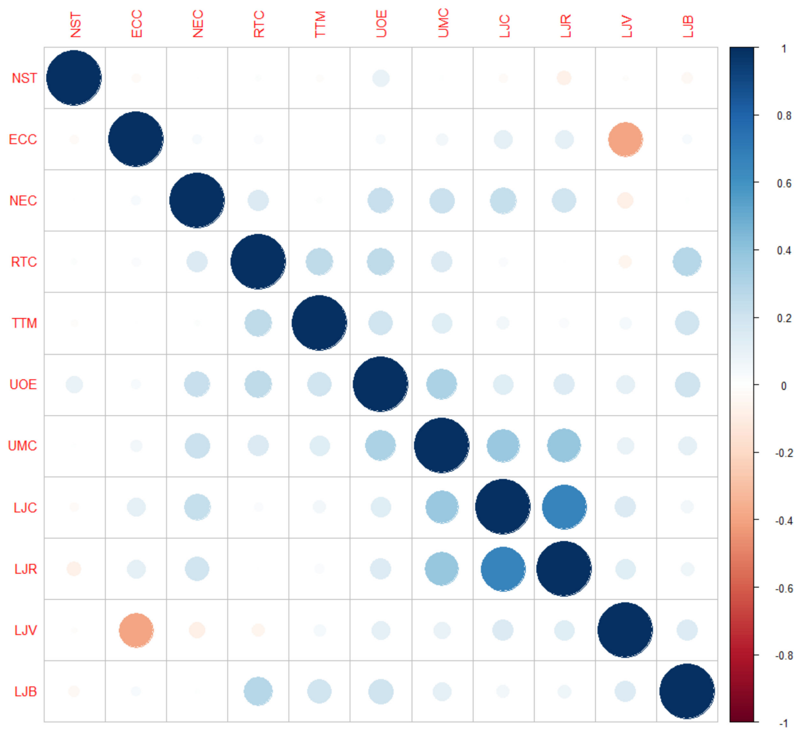

Figure 2. Correlations among the variables of the study.

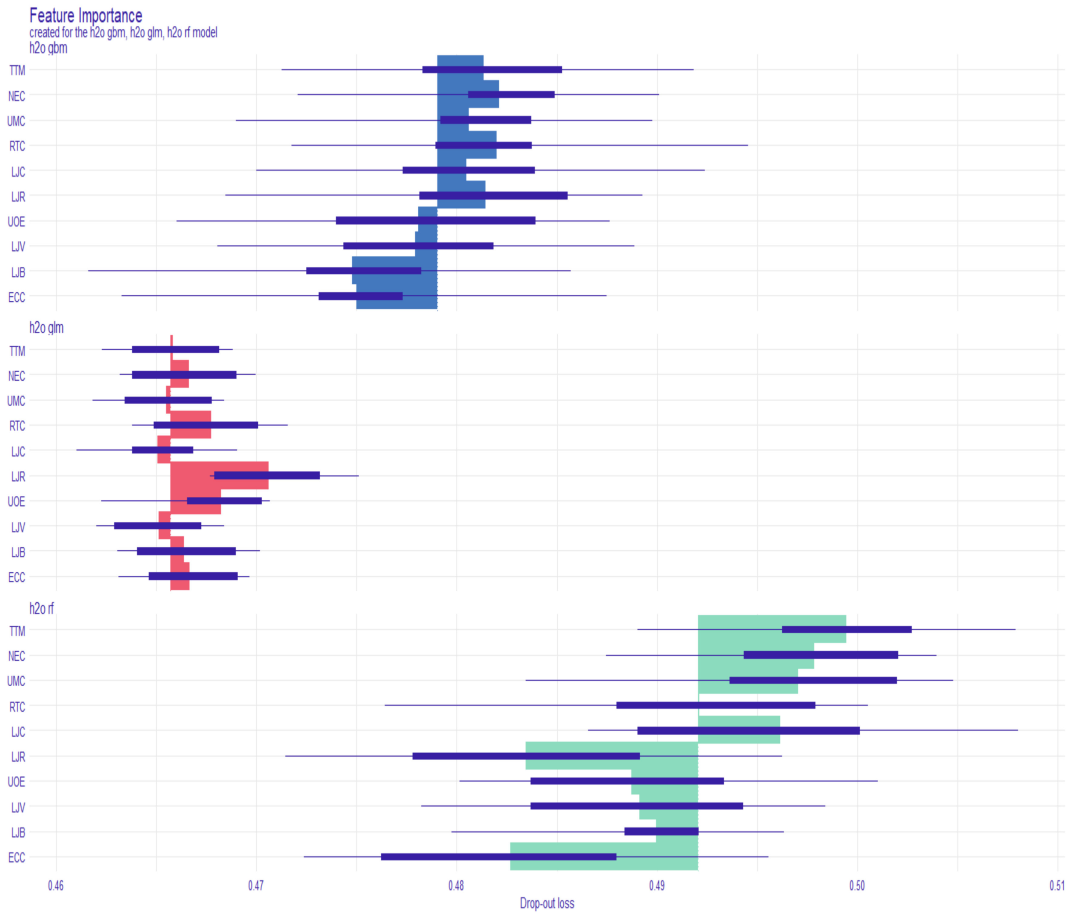

Figure 3. Importance of the research predictors based on the general linear model (GLM), random forest (RF), and gradient boosting machine (GBM).

4. Discussion

The findings summarized in Table 2 show that approximately one of every three students fails mathematics. Similar results are noted in the State School Council report regarding the rate of early school leavers in Melilla. However, the dropout rate is significantly different from the EU predictions for 2020, which foresaw a 10% reduction [44]. In the present study, the highest percentage of failures, around 26%, appears at 4ºESO, which could be explained by the change of school stage. Similarly, the lowest rate, below 4%, is produced in the second stage of post-16 education. This result could be due to the fact that the sample of these groups comprised only 4.2% of participants, and the students that reached this level had clear intentions to continue to higher studies. Consistent with this result, reference [41] maintained that poor academic performance was a predictor of early school leaving.

Regarding students who pass, the highest percentage of outstanding marks is in 2ºESO, which is due, in part, to the contents of this level being a slight extension of the contents taught at 1ºESO. However, these results are not observed in 1ºESO because it is considered to be an adaptation period, due to the change of school stage from primary and, in the remaining levels, mathematics content is more challenging. However, the lowest percentage of outstanding marks corresponds to the second stage of post-16 education, which may be due to the requirements of the level and the sample taken. Reference [27] maintained that there was a trend that students with good academic results remained in this profile during their whole academic life, as also happened with poor performing students.

Regarding the analysis differentiated by gender, girls consistently obtain higher marks than boys, although this difference decreases with age, and as the marks of the students increase. In fact, no differences were found among students with a mark of outstanding. In contrast, a significant percentage difference of more than 10 points was found in girls over boys among the students who failed. However, these results seem to differ from the State School Council's results, which, for the Autonomous City of Melilla, show a difference of 5 percentage points of boys over girls in early school leaving [40]. Similarly, it is observed in the group of European countries that there is a greater incidence in boys regarding the early school-leaving phenomenon, with a difference of less than 4 percentage points [40]. These apparent differences between the results could be attributed to the fact that the data correspond to different periods.

Concerning technological resources at home, the INE's report on Equipment and Use of ICT in Spanish homes in 2019, highlighted that more than 80% of homes had a computer, and more than 90% had a mobile phone and Internet. These high data regarding ICT resources predicted their use by students. Similarly, in the present study, it is observed that, on average, 64% of students affirm that they use ICT to study mathematics. The higher values of RTC are among the students with marks of adequate and good, with an average percentage higher than 66%. However, it is estimated that the use of computers at home for educational purposes will decrease over the medium grade, if educational hardware and software is not innovated to make it attractive to students [22].

However, analysis of the perceptions held by students of technology shows that an average of 20% do not work more and better on mathematics using ICT. The highest percentage, 36.36%, corresponds to students with a mark of merit who respond "enough" in TTM. In contrast, the lower percentage of 12.86% appears for students with a mark of outstanding who respond "a lot" in TTM. Similarly, it is postulated that the existence of adequate technological resources and connections promotes students' positive perceptions towards the use of ICT [22]. Moreover, technological advances, duly evaluated and oriented towards students, would, as a consequence, see more active participation by them [45]. The rise of the use of mobile devices for teaching could be a good example, because it facilitates a mobile, ubiquitous, collaborative, and creative form of learning [23].

By comparison, reference [34] maintained that the perception of ICT and its educational use was higher in boys, due to gender roles assumed by girls. These results contrasted with those of [18] who found that girls achieved higher marks in ICT literacy and that differences were more significant in primary education than in secondary education. In addition, there were significant negative effects of ICT skills on the mathematical performance of boys, but positive effects in girls [35]. Gender differences could be due to personal preferences during the educational stage [36]. These differences could be reduced with adequate training programs [18].

The previous data on TTM could predict a similar response in UOE. However, an analysis of the associated graphs shows a clearly differentiated pattern. These results are strengthened due to the fact that, on average, more than 66% of the students declare that they use the computer "a little" or "none" while studying at home. In terms of the use of the Internet for academic use, it is observed that the responses of LJB are similar to those of UOE, and their graphs show the same decreasing trend with respect to use. Consistent with this, reference [3] maintained that accessibility to online technology and online connectivity was used by some students, in a limited way, for educational purposes. Similar findings have shown that students had a basic digital competence for academic purposes, the main use of which was copying and pasting files or folders, installing software or apps, and transferring files between a computer and other devices [1]. Moreover, in terms of gender, the average daily use of the Internet was slightly higher for girls [1].

Regarding the use of technological resources with non-academic purposes, it is observed that, on average, 21.16% of students affirm that they do not use their mobile phone "at all" while studying at home. The highest percentage, 33.61%, corresponds to students with a mark of outstanding who affirm that they use their mobile phone "enough" while studying at home. In contrast, the lowest value appears among the students with a mark of adequate who respond "none" in UMC, with 20.14%. It should be noted that more than 50% of students with a mark of outstanding use their mobile phone "enough" or "a lot". In this sense, a previous study suggested negative associations between the availability of ICT resources at home and academic performance. Moreover, it maintained the existence of a positive relationship between the ICT resources in the classroom with the students' academic success [19]. Similarly, reference [20] affirmed that inadequate use of technological devices had negative repercussions on learning and on students' academic performance.

However, roughly 59% of educational centers have integrated the use of mobile phones for educational purposes into secondary school and for educational cycles [2], and their use could influence academic performance positively, regardless of the methodology used [8]. Thus, better results are observed than when using computers, due in part to ubiquity [23], and the pedagogical innovations developed [24]. In the same line, positive effects on education are observed, by adopting social media as an additional learning management system (LMS) [31]. However, other studies have shown negative effects of online chats on students' memory and learning [30]. Reference [9] highlighted the scarce research on the didactic effect of mobile devices and their application to student learning.

Furthermore, only 14.07% of students affirm that they do not dedicate "any" of the day to cyber chats (Whatsapp, Messenger, Telegram,) during the week. It must be noted that, on average, more than 25% of students spend "more than 4 h" daily on cyber chats. Regarding social media, a higher increase of more than 23 percentage points is observed among the students with a mark of inadequate, who do not consume "at all" and "1–2 h". On average, more than 50% spend more than 3 h on social media.

The results observed in this study are in line with those found in the report on the ICT resources in Spanish homes. In this report, it is shown that students with 91.1% are the more participatory population on social media. Of these, the age range of between 16 and 24 years makes up 90.6% [1]. Moreover, reference [11] highlighted a significant relationship among age, gender, the ICT education received, and the free time which students dedicated to technology. However, other authors have argued that unsupervised internet use was negative for both genres, without significant differences [33]. Reference [12] stressed that excessive use of mobile devices encouraged addictive behaviors, mainly in young people from urban areas. In contrast, reference [3] highlighted the negative impact of social media on students with poor academic performance, whereas for students with good marks, significant effects were not noted. Similarly, other findings have shown a significant correlation, among teenagers, between age and mobile phone connection frequency, and between the number of years of mobile phone use and the positive perception of them [10].

A deeper analysis of Table 2 shows clearly differentiated patterns between the time dedicated to cyber chats and social media and the time dedicated to video games. The time dedicated to video games is similar among the different responses, however the graphs show a decreasing trend. Although roughly 50% respond "none" in LJV, it should be highlighted that more than 23% dedicate more than 3 h daily to video games. In contrast with previous results, a significant correlation between the time dedicated to video games and academic performance was not detected. However, the findings of [13] concluded that addiction to video games or online games impacted negatively on the attention deficit of young people and on their academic performance [14]. Nevertheless, other studies have highlighted that students with good academic results and students with poor marks both tended to remain in this profile [46,47].

Figure 1 shows significant positive correlations between LJR and LJC. Positive, but weak correlations are also found between UMC, and LJC and LJR. These results could be explained by the addictive effect of cyber chats and social media, and the fact that the mobile phone is used as the main tool of connection [48]. In contrast, a negative and weak correlation between LJV and ECC, found in this study, should be noted. Similarly, reference [15] maintained that video game addiction had a greater effect on young people whose profile among secondary students tended to be multiplayers, obese, and male.

The analysis of RF, GLM, and GBM models, shown in Figure 3, summarizes the findings obtained with the Bayesian and correlations models. The implications are discussed in the previous paragraphs.

5. Conclusions

In the present study, the possible impacts on the performance of technological variables associated with education, ICT resources, and their uses for recreational purposes or social interaction are shown. Among the notable findings, it is worth highlighting that educational level was an influential predictor, however, a difference of little significance regarding gender was observed.

Regarding ICT resources, in addition to influencing performance in a significant way, they also influence the students' perceptions. However, the use of ICT for educational purposes is limited. The similar responses of UOE and LJB could indicate that computers are generally used for internet searches. Other notable points are the significant correlations between the LJC and LJR variables, which indicate that the time spent on cyber chats and social media by the students follows a general and highly similar pattern. However, a different behavior in LJV is observed and the results show an influence of little significance on the performance of this predictor.

The limitations of the study are related to its design and in the number of variables analyzed. The main strength of the present research was the statistical analysis used, which combined different models to analyze the influence of the predictors on students' academic performance. Future lines of research should contemplate other predictors and quantify the effect of technology on student performance throughout their academic lives.

Author Contributions: Conceptualization, H.H.-M. (Hassan Hossein-Mohand) and M.G.-G.; methodology, H.H.-M. (Hassan Hossein-Mohand) and J.M.T.-T.; software, H.H.-M. (Hassan Hossein-Mohand); validation, H.H.-M. (Hossein Hossein-Mohand), M.G.-G., J.M.T.-T. and I.A.-D.; formal analysis, M.G.-G.; investigation, H.H.-M. (Hassan Hossein-Mohand); resources, H.H.-M. (Hassan Hossein-Mohand); data curation, H.H.-M. (Hossein Hossein-Mohand); writing—original draft preparation, H.H.-M. (Hassan Hossein-Mohand); writing—review and editing, H.H.-M. (Hassan Hossein-Mohand) and J.M.T.-T.; visualization, M.G.-G.; supervision, M.G.-G., J.M.T.-T., H.H.-M. (Hossein Hossein-Mohand) and I.A.-D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

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

References

1. INE. *Encuesta Sobre Equipamiento Y Uso de Tecnologías de Información Y Comunicación en Los Hogares*; INE: Madrid, Spain, 2019.
2. INE. *Estadística de la Sociedad de la Información y la Comunicación en Los Centros Educativos no Universitarios*; Curso 2018–2019; Instituto Nacional de Estadística: Madrid, Spain, 2020.
3. Wakefield, J.; Frawley, J.K. How does students' general academic achievement moderate the implications of social networking on specific levels of learning performance? *Comput. Educ.* **2020**, *144*. [CrossRef]
4. Comisión Europea. *Comunicación de la Comisión al Parlamento Europeo, al Consejo, al Comité Económico y Social Europeo y al Comité de Las Regiones Sobre el Plan de Acción de Educación Digital*; Comisión Europea: Brussels, Belgium, 2018.
5. Olofsson, A.D.; Lindberg, O.J.; Fransson, G. Students' voices about information and communication technology in upper secondary schools. *Int. J. Inf. Learn. Technol.* **2018**, *35*, 82–92. [CrossRef]
6. De Vita, M.; Verschaffel, L.; Elen, J. Towards a better understanding of the potential of interactive whiteboards in stimulating mathematics learning. *Learn. Environ. Res.* **2018**, *21*, 81–107. [CrossRef]
7. 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]
8. Gómez-García, M.; Soto-Varela, R.; Morón-Marchena, J.A.; Del Pino-Espejo, M.J. Using Mobile Devices for Educational Purposes in Compulsory Secondary Education to Improve Student's Learning Achievements. *Sustainability* **2020**, *12*, 3724. [CrossRef]
9. Sánchez-Prieto, J.C.; Huang, F.; Olmos-Miguelanez, S.; García-Penalvo, F.J.; Teo, T. Exploring the unknown: The effect of resistance to change and attachment on mobile adoption among secondary pre-service teachers. *Br. J. Educ. Technol.* **2019**, *50*, 2433–2449. [CrossRef]

10. Nikolopoulou, K. Mobile learning usage and acceptance: Perceptions of secondary school students. *J. Comput. Educ.* **2018**, *5*, 499–519. [CrossRef]
11. Brinda, T.; Napierala, S.; Behler, G.A. What do secondary school students associate with the digital world? In Proceedings of the WiPSCE' 18: Proceedings of the 13th Workshop in Primary and Secondary Computing Education, Potsdam, Germany, 4–6 October 2018; pp. 25–34. [CrossRef]
12. Hostovecky, M.; Prokop, P. The relationship between internet addiction and personality traits in Slovak secondary schools students. *J. Appl. Math. Stat. Inform.* **2018**, *14*, 83–101. [CrossRef]
13. Petilli, M.A.; Rinaldi, L.; Trisolini, D.C.; Girelli, L.; Vecchio, L.P.; Daini, R. How difficult is it for adolescents to maintain attention? The differential effects of video games and sports. *Q. J. Exp. Psychol.* **2020**, *73*, 968–982. [CrossRef]
14. Fabito, B.S.; Rodriguez, R.L.; Diloy, M.A.; Trillanes, A.O.; Macato, L.G.T.; Octaviano, M.V., Jr. IEEE. Exploring mobile game addiction, cyberbullying, and its effects on academic performance among tertiary students in one university in the Philippines. In Proceedings of the Tencon 2018—2018 IEEE Region 10 Conference, Jeju, Korea, 28–31 October 2018; pp. 1859–1864.
15. Oflu, A.; Yalcin, S.S. Video game use among secondary school students and associated factors. *Arch. Argent. De Pediatr.* **2019**, *117*, E584–E591. [CrossRef]
16. Chen, I.H.; Gamble, J.H.; Lee, Z.-H.; Fu, Q.-L. Formative assessment with interactive whiteboards: A one-year longitudinal study of primary students' mathematical performance. *Comput. Educ.* **2020**, *150*. [CrossRef]
17. Sharma, R.; Ali, S. Embedding concepts of sustainability in secondary school mathematics through games based learning. In Proceedings of the 12th European Conference on Games Based Learning (ECGBL), SKEMA Business School, Sophia Antipolis, France, 4–5 October 2018; pp. 583–589.
18. Siddiq, F.; Scherer, R. Is there a gender gap? A meta-analysis of the gender differences in students' ICT literacy. *Educ. Res. Rev.* **2019**, *27*, 205–217. [CrossRef]
19. Hu, X.; Gong, Y.; Lai, C.; Leung, F.K.S. The relationship between ICT and student literacy in mathematics, reading, and science across 44 countries: A multilevel analysis. *Comput. Educ.* **2018**, *125*, 1–13. [CrossRef]
20. Benitez Diaz, L.M.; Sevillano Garcia, M.L.; Vazquez Cano, E. Effects on academic performance in secondary students according to the use of ICT. *Int. J. Educ. Res. Innov.* **2019**, 90–108.
21. Becker, S.; Klein, P.; Gossling, A.; Kuhn, J. Using mobile devices to enhance inquiry-based learning processes. *Learn. Instr.* **2020**, *69*. [CrossRef]
22. Weber, M.; Becker, B. Browsing the Web for School: Social Inequality in Adolescents' School-Related Use of the Internet. *Sage Open* **2019**, *9*. [CrossRef]
23. Fuentes, J.L.; Albertos, J.E.; Torrano, F. Towards Mobile-Learning in the School: Analysis of Critical Factors on the Use of Tablets in Spanish Schools. *Educ. Knowl. Soc.* **2019**, *20*. [CrossRef]
24. Hochberg, K.; Becker, S.; Louis, M.; Klein, P.; Kuhn, J. Using Smartphones as Experimental Tools-a Follow-up: Cognitive Effects by Video Analysis and Reduction of Cognitive Load by Multiple Representations. *J. Sci. Educ. Technol.* **2020**, *29*, 303–317. [CrossRef]
25. Sung, Y.-T.; Chang, K.-E.; Liu, T.-C. The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Comput. Educ.* **2016**, *94*, 252–275. [CrossRef]
26. Chauhan, S. A meta-analysis of the impact of technology on learning effectiveness of elementary students. *Comput. Educ.* **2017**, *105*, 14–30. [CrossRef]
27. Felisoni, D.D.; Godoi, A.S. Cell phone usage and academic performance: An experiment. *Comput. Educ.* **2018**, *117*, 175–187. [CrossRef]
28. Dempsey, S.; Lyons, S.; McCoy, S. Later is better: Mobile phone ownership and child academic development, evidence from a longitudinal study. *Econ. Innov. New Technol.* **2019**, *28*, 798–815. [CrossRef]
29. Brzozek, C.; Benke, K.K.; Zeleke, B.M.; Croft, R.J.; Dalecki, A.; Dimitriadis, C.; Kaufman, J.; Sim, M.R.; Abramson, M.J.; Benke, G. Uncertainty Analysis of Mobile Phone Use and Its Effect on Cognitive Function: The Application of Monte Carlo Simulation in a Cohort of Australian Primary School Children. *Int. J. Environ. Res. Public Health* **2019**, *16*, 2428. [CrossRef] [PubMed]
30. Aharony, N.; Zion, A. Effects of WhatsApp's Use on Working Memory Performance Among Youth. *J. Educ. Comput. Res.* **2019**, *57*, 226–245. [CrossRef]
31. Chang, D.-F.; Huang, Y.-L.; Wu, B. Analyzing the Functions and Benefits of Using Mobile Facebook as a Supplemental LMS in Higher Education. *J. Adv. Comput. Intell. Intell. Inform.* **2017**, *21*, 971–979. [CrossRef]

32. Garcia-Martin, S.; Canton-Mayo, I. Use of technologies and academic performance in adolescent students. *Comunicar* **2019**, *27*, 73–81. [CrossRef]
33. Cabero-Almenara, J.; Meza-Cano, J.-M. Online undergraduate students' perceptions of the impact of Web 2.0 on higher education. *Cult. Educ.* **2019**, *31*, 481–508. [CrossRef]
34. Meggiolaro, S. Information and communication technologies use, gender and mathematics achievement: Evidence from Italy. *Soc. Psychol. Educ.* **2018**, *21*, 497–516. [CrossRef]
35. Lu, C.; Yang, X.; Wu, D. ICT Competency, network interaction, internet self-efficacy, and mathematical achievement: Direct and mediating effects. In Proceedings of the 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering; Wollongong, NSW, Australia, 4–7 December 2018; Lee, M.J.W., Nikolic, S., Shen, J., Lei, L.C.U., Wong, G.K.W., Venkatarayalu, N., Eds.; IEEE: Piscataway, NJ, USA, 2018; pp. 534–539.
36. Barone, C.; Assirelli, G. Gender segregation in higher education: An empirical test of seven explanations. *High. Educ.* **2020**, *79*, 55–78. [CrossRef]
37. Cussó-Calabuig, R.; Farran, X.C.; Bosch-Capblanch, X. Effects of intensive use of computers in secondary school on gender differences in attitudes towards ICT: A systematic review. *Educ. Inf. Technol.* **2018**, *23*, 2111–2139. [CrossRef]
38. Park, J.-H.; Kim, C.; Ham, J. High-school students' understanding and use of mathematics textbooks. *Math. Educ.* **2019**, *58*, 589–607.
39. Habes, M.; Salloum, S.A.; Alghizzawi, M.; Mhamdi, C. The relation between social media and students' academic performance in Jordan: YouTube Perspective. In Proceedings of the International Conference on Advanced Intelligent Systems and Informatics, Cairo, Egypt, 26–28 October; pp. 382–392.
40. *Informe 2019 Sobre el Estado del Sistema Educativo: Curso 2017–2018*. 2019. Available online: http://www.educacionyfp.gob.es/mc/cee/publicaciones/informes-del-sistema-educativo/informe-2019.html (accessed on 20 September 2020).
41. Sánchez, E.R.; Pedreño, M.H. Análisis de las causas endógenas y exógenas del abandono escolar temprano: Una investigación cualitativa. *Educ. XX1* **2019**, *22*. [CrossRef]
42. Barca, A.; Peralbo, M.; Porto, A.; Marcos, J.; Brenlla, J. Metas académicas del alumnado de Educación Secundaria Obligatoria (ESO) y Bachillerato con alto y bajo rendimiento escolar. *Rev. De Educ.* **2011**, *354*, 341–368.
43. Córdoba, L.; García, V.; Luengo, L.; Vizuete, M.; Feu, S. How academic career and habits related to the school environment influence on academic performance in the physical education subject. *Retos Nuevas Tendencias en Educación Física Deporte y Recreación* **2012**, *21*, 9–13.
44. Del Estado, C.E. *Informe 2019 Sobre el Estado del Sistema Educativo*; Ministerio de Educación y Formación Profesional: Madrid, Spain, 2019.
45. Coyne, B.; McCoy, S. Forbidden fruit? Student views on the use of tablet PCs in education. *Technol. Pedagog. Educ.* **2020**. [CrossRef]
46. Asif, R.; Merceron, A.; Ali, S.A.; Haider, N.G. Analyzing undergraduate students' performance using educational data mining. *Comput. Educ.* **2017**, *113*, 177–194. [CrossRef]
47. Burgos, C.; Campanario, M.L.; De la Peña, D.; Lara, J.A.; Lizcano, D.; Martínez, M.A. Data mining for modeling students' performance: A tutoring action plan to prevent academic dropout. *Comput. Electr. Eng.* **2018**, *66*, 541–556. [CrossRef]
48. Royant-Parola, S.; Londe, V.; Trehout, S.; Hartley, S. The use of social media modifies teenagers' sleep-related behavior. *Encephale-Revue de Psychiatrie Clinique Biologique et Therapeutique* **2018**, *44*, 321–328. [CrossRef]

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).