




Revista Prisma Social Nº 41

RESEARCH IN EDUCATION: PEDAGOGICAL INNOVATION AND VIRTUAL EDUCATION

2nd TRIMESTER, APRIL 2023 | THEMATIC SECTION | PP. 146-172

RECEIVED: 6/2/2023 – ACCEPTED: 10/4/2023

REGRESSION MODEL STUDY OF THE COMMUNICATION OF SPANISH UNIVERSITIES ON SOCIAL MEDIA

REGRESSION ANALYSIS OF ENGAGEMENT AND FOLLOWERS OF UNIVERSITIES ON SOCIAL NETWORKS

ESTUDIO CON MODELOS DE REGRESIÓN DE LA COMUNICACIÓN DE LAS UNIVERSIDADES ESPAÑOLAS EN REDES SOCIALES

ANÁLISIS DE REGRESIÓN DE LA INTERACCIÓN Y DE LOS/LAS SEGUIDORES/AS DE LAS UNIVERSIDADES EN REDES SOCIALES

Marc Pérez-Bonaventura / marcperezbonaventura@gmail.com

Universitat Politècnica de Catalunya (UPC) / Euncet Business School, Spain

Jordi Vilajosana / jordi.vilajosana@upc.edu

Universitat Politècnica de Catalunya (UPC), Spain

prisma social
revista de ciencias sociales

ABSTRACT

Previous investigations focused on web 2.0 communication in Spanish universities reach contradictory conclusions, although they agree on the existence of problems in their use of social networks. The present work delves into this field, expanding the limits of the number of universities, social networks and statistical analyses of prior studies.

A descriptive quantitative research is carried out using multiple linear regression models with the aim of explaining and predicting the number of followers and reactions that universities obtain on social networks based on independent variables. Thereby, the communication of the 83 Spanish universities on Facebook, Instagram, Twitter and YouTube is analysed for 14 weeks.

The results show that the exposed regression models manage to predict a fundamental part of the followers that Spanish universities have on Facebook and Twitter networks, and a more discreet part on Instagram. Likewise, the regression models manage to predict a significant part of the weekly interaction that universities achieve on Instagram, Facebook and Twitter. Finally, they moderately explain the interaction per post on Instagram and Twitter. On YouTube the models do not work, so other variables should be investigated.

KEYWORDS

Education; ICT; social networks; university; communication; higher education; social media

RESUMEN

Las investigaciones previas centradas en la comunicación web 2.0 de las universidades españolas llegan a conclusiones contradictorias, aunque coinciden en la existencia de problemas en el uso de las redes sociales. El presente trabajo profundiza en este campo, ampliando los límites del número de universidades, redes sociales y análisis estadísticos de los estudios anteriores.

Se realiza una investigación cuantitativa descriptiva mediante modelos de regresión lineal múltiple con el objetivo de explicar y predecir el número de seguidores y reacciones que obtienen las universidades en redes sociales a partir de unas variables independientes. Para ello se analiza la comunicación de las 83 universidades españolas en Facebook, Instagram, Twitter y YouTube, durante 14 semanas.

Los resultados demuestran que los modelos de regresión expuestos consiguen predecir una parte fundamental de los/as seguidores/as que tienen las universidades españolas en las redes de Facebook y Twitter, y más discreta en Instagram. Asimismo, los modelos de regresión logran predecir una parte importante de la interacción semanal que consiguen las universidades en Instagram, Facebook y Twitter y explican moderadamente la interacción por publicación en Instagram y Twitter. En YouTube los modelos trabajados no funcionan, por lo que se deberían investigar otras variables.

PALABRAS CLAVE

Educación; TIC; redes sociales; universidad; comunicación; educación superior

1. INTRODUCTION

1.1. UNIVERSITIES, MARKETING AND WEB 2.0 COMMUNICATION

Today 96% of Spanish households have access to the Internet, reaching 100% in households with children (INE Instituto Nacional de Estadística, 2022). The high digitalisation of today's society, as well as the globalisation of markets, has increased competition among higher education institutions, which has led them to an increase in their online presence (Maresova et al., 2020). Due to the rise of more higher education opportunities and the current competitive scenario, universities need communication and marketing (Doña Toledo and Luque Martínez, 2017). Therefore, universities must focus on implementing successful communication and marketing strategies that allow them to compete and stand out among the existing higher education offer (Guilbault, 2018).

Not all marketing mix tools have the desired influence on the brand building of higher education institutions (Lim et al., 2020). Communication and interaction between students and the higher education institution on social media has been shown to help build the institution's brand (Simiyu et al., 2020).

Over the last years, the growth of social media has shown exponential growth (IAB Spain, 2022) with young people making regular use of it. For this reason, social networks are perceived as very effective communication outlets by higher education institutions (Alcolea Parra et al., 2020). As a consequence, universities have been increasing their use of social media as a communication and marketing tool over the last years (Maresova et al., 2020).

1.2. UNIVERSITIES AND SOCIAL MEDIA

Social networks have had a great impact on the university world in several ways. Firstly, social media can be used in teaching processes at higher education levels becoming online learning platforms (Zachos et al., 2018). Secondly, social networks can be used to publish and share scientific papers and articles (Campos-Freire and Rúas-Araújo, 2016). Thirdly, social networks are a space for communication and interaction between universities and their audiences which, if used effectively, can have great potential (Alcolea Parra et al., 2020). Finally, social networks are also very valuable in universities' recruitment processes (Shields and Peruta, 2019) and there is a correlation between the interaction of students with universities on networks and the level of subsequent recruitment that institutions achieve (Rutter et al., 2016).

According to IAB Spain (2021), 85% of Internet users between 16 and 70 years of age use social networks, and their use is even higher and more frequent among young people. Young students and graduates are the main target of universities (García, 2018) and research reveals that the use of social networks among 18-29 year old is as high as 90% (Perrin, 2015). For this reason, educational institutions need social media to communicate and interact with their students (Amaral and Santos, 2020). This is the reason why universities need to know how to use social media effectively (Constantinides et al., 2013).

Digital marketing and especially social media are essential for the communication between universities and students. However, the efforts made by universities in social media often do not have the desired results due to the lack of a strong social media strategy focused on their target

audience (Maresova et al., 2020). To address this issue, it is important to note that universities that, seek interaction with their publications, instead of a one-way communication, obtain better results and a benefit for their brand (Pringle and Fritz, 2019). In terms of communication, Facebook and Twitter stand out as the most frequently used social media by the best universities in the world (Segura-Mariño et al., 2020). However, and according to Bélanger et al. (2014) Facebook stands out from the rest. Similarly, Pérez-Bonaventura et al. (2021) argue that Facebook and Twitter are the networks where higher education institutions have the most followers.

1.3. SPANISH UNIVERSITIES AND SOCIAL NETWORKS

Regarding Spanish higher education institutions, the most frequently used social networks are Facebook, Twitter, LinkedIn and YouTube (Zarco et al., 2016), as well as Instagram, which is a social network that has shown a strong penetration in university communication over the last years (Alcolea Parra et al., 2020). In general, the most popular and most widely used social networks in Spain are Facebook, Instagram, Twitter, WhatsApp, TikTok and YouTube (IAB Spain, 2021). So far, WhatsApp and TikTok have a reduced use by universities so they will not be included in this study.

It seems that Spanish universities have realised the importance of social media and consider them as an essential part of their marketing strategies (Blázquez et al., 2020). However, several authors have carried out research focused on the communication of Spanish higher education institutions through social networks, and their conclusions are not optimistic.

Even though Spanish universities have a strong presence on social networks, this presence is not very effective if there are no well-thought-out strategies behind it, nor are they connected with their global communication approach (Simón Onieva, 2014). Consequently, it is important to bear in mind that what really increases the visibility of universities through social networks is the activity they carry out on them (Amaral and Santos, 2020).

The communication problems on universities' social networks are a global phenomenon, although in Spain they are slightly more accentuated. Regarding this, the authors point out that there are problems in the communication of Spanish universities due to the lack of good planning and a specific social media strategy that seeks to obtain more interaction with the student body (Matosas-López and Cuevas-Molano, 2021). In brief, they argue that Spanish universities have failed to effectively use social media (Simón Onieva, 2015). Therefore, managers of higher education institutions should be made aware of the great value of social networks in the communication of universities with their target audience (García, 2018).

1.4. UNIVERSITIES, SOCIAL MEDIA AND STUDY VARIABLES

In order to delve deeper into this field, several studies focusing on 2.0 communication in universities have attempted to identify the indicators and variables that have an impact on their communication success. The success of a brand in social networks can be measured by the number of followers it has or the interaction it achieves with users (De Vries et al., 2012). In this respect, Simón Onieva (2014) argues that user interaction with university publications can be measured by the number of likes they get.

Several authors have investigated the interaction and followers of higher education institutions, drawing different conclusions without a clear common denominator.

Analyzing the variables that influence user interaction with university profiles on social networks, Palmer (2013) argues that there is a positive relationship between user interaction and the number of followers that universities have on Twitter. Alonso García and Alonso García (2014) agree with this thesis by observing that universities with more followers are those that achieve greater interaction. Other authors argue that it is the number of students at a university that has a strong positive relationship with the level of interaction it receives (Amaral and Santos, 2020; Pérez-Bonaventura and Rodríguez-Llorente, 2023). This is also defended by Zarco et al. (2016) who state that the number of students at universities influences the response they receive from users. Lund (2019), in turn, adds that the number of publications made by a university has no influence on interaction. However, other authors do not believe that there is a cause-effect relationship between the number of followers of a university and the interaction they achieve (Paniagua Rojano and Gómez Calderón, 2012) or between the number of publications and the interaction received (Simón Onieva, 2014).

Some authors assert that interaction increases when quality content of interest to followers is published (Blázquez et al., 2020) or that the use of images or videos in posts leads to more user interaction (Rodríguez-Vázquez et al., 2016; Sabate et al., 2014). Other studies note that Facebook hashtags and posts with a call to action create more interaction. In the case of Twitter, it would be the use of emojis (Segura-Mariño et al., 2020).

Regarding the number of followers that higher education institutions have on networks, Brech et al. (2016) point out that there are two highly influential variables on followers; the reputation of the university and the number of students. Some authors support their theory about students by asserting that universities that have more students also have more followers on social networks (Maresova et al., 2020; Pérez-Bonaventura and Rodríguez-Llorente, 2023). Lund (2019), on the other hand, confirms his theory on reputation by arguing that the prestige of a higher education institution positively influences the number of followers on Facebook, but he claims that the number of publications it makes does not have a relevant influence on followers.

Finally, the use of linear regressions for an in-depth statistical study of university social media profiles is very limited in this field. Brech et al. (2016) use regressions to investigate followers and reactions in Western universities, concluding that the strongest predictors of university followers on Facebook are the number of students and the reputation, the latter being the most influential variable. Likewise, Brech et al. (2016) argue that the number of university followers has a strong influence on the interaction that universities receive from their publications. Similarly, Matosas-López and Cuevas-Molano (2021) have studied 10 Spanish universities on Twitter obtaining two regression models: on the one hand, how the interaction of publications measured by shares is highly influenced by the use of links and hashtags; and, on the other hand, how the number and the time of the post may influence the recognition of publications as favourites.

In summary, the divergent results of the studies on the variables that affect followers and the interaction of higher education institutions on social networks to a greater or lesser degree, the lack of studies that cover the entire population of Spanish universities as well as the four most popular social networks, and the scarcity of studies that analyse these social networks in the Spanish

university environment using linear regressions, justify the need for the present study necessary to try to gain a better understanding on these issues and shed light on this field.

2. DESIGN AND METHOD

2.1. OBJECTIVES

The aim of this research is to analyse the communication and interaction of higher education institutions on social media. The goal is to use regression models to predict the success of universities in social networks through the number of followers and the interaction they achieve based on some independent variables. The specific objectives are:

- To ascertain whether it is possible to explain or predict the number of followers that universities have on their social network profiles using regression models and independent variables.
- To determine whether it is possible to explain or even predict the interaction in likes that universities receive on social networks. This objective can be split up into two:
  - To try to explain or predict the weekly interaction in likes that universities receive for their publications on social networks based on independent variables.
  - To try to explain or predict the interaction in likes per publication that universities achieve on social networks based on independent variables.
- And finally, to detect which independent variables have the greatest influence on the model in each of the regression models studied.

2.2. METHODOLOGY AND TECHNIQUES

2.2.1. Methodology and techniques

In order to achieve these objectives, a descriptive quantitative research has been carried out using multiple linear regression models at a 95% confidence level to explain the behaviour of the variables of number of followers and reactions that universities get on social networks based on independent variables.

The regression study by Brech et al. (2016) analysed Facebook whereas the study by Matosas-López and Cuevas-Molano (2021) analysed Twitter. This article extends the analysis to the 4 social networks most widely used by universities: Facebook, Instagram, Twitter and YouTube.

In order to carry out this research, the entire population of universities in Spain was analyzed rather than a sample of the population, or the universities of a specific region, as in the studies carried out to date. Thus, the 83 Spanish universities with academic activity (Ministerio de Universidades, 2022), both public and private, were analysed over a period of 14 weeks.

The fact that for the first time the four social networks are analysed at the same time and the entire population of universities in Spain using linear regressions for the statistical study determines the added value of this research.

The techniques used are quantitative and, as mentioned above, multiple linear regressions have been used. The programmes used to carry out the research are the Microsoft Excel programme initially to collect the data obtained and the Statistical Package for the Social Sciences (SPSS) programme for the statistical analysis of the data.

2.2.2. Variables studied

In this study, there are variables obtained from primary and secondary sources of information. The data obtained from primary sources come from the authors' own observation and research of the universities' profiles on social networks. The data extracted from secondary sources come from contrasted studies that will be discussed later.

The dependent variables studied using multiple linear regression models are: followers and like reactions. These variables are used depending on the independent variables: number of students, number of publications, university prestige (ranking) and public or private ownership of the universities. The variables have been chosen following previous studies in this field (Brech et al., 2016; Matosas-López and Cuevas-Molano, 2021; Simón Onieva, 2017).

The variables and how they were obtained are described below, firstly setting out the dependent variables analysed:

- **Number of university followers**: these were obtained from observation and analysis of the followers "fans" that the university profiles had on the different social networks during the period studied.
- **Reactions measured in weekly likes**: these were obtained by observing the interaction generated by the universities' publications on their profiles on the different social networks. The number of likes was observed on a weekly basis, obtaining the interaction received by the university from its publications during the time analysed.
- **Reactions measured in likes per publication**: these were obtained by analysing the universities' profiles on social media. The procedure was to add up the interaction of the likes in the corresponding period based on the publications that the university had made on the social network. Unlike the previous one, this variable is not influenced by the number of publications made by universities.

Secondly, the independent variables that have been analyzed are shown:

- **Number of students**: this is the number of students enrolled in university degrees. It has been obtained from "Estadísticas e Indicadores Universitarios" (Ministerio de Educación y Formación Profesional, 2021) reports.
- **University prestige (ranking)**: this variable is indicative of the scientific production, research, innovation and teaching quality of the universities and has been obtained from the "Ranking de Indicadores Sintéticos de las Universidades Españolas" (Pérez and Aldás, 2021) called U-Ranking.
- **Public or private ownership of the university**: the information on whether the universities are public or private has been extracted from the reports of the Ministerio de Universidades (2021).

• **Number of publications**: this was obtained by observing and analysing on a weekly basis the activity of the universities on their official profiles on the different social networks during the study period.

3. FIELDWORK AND DATA ANALYSIS

The data collection for this study was carried out over a period of 14 consecutive weeks, between 29 March and 4 July 2021. During this period, the communication of the public profiles of the 83 Spanish universities on the social networks Facebook, Instagram, Twitter and YouTube was analysed on a weekly basis. Consequently, the variables in the different social networks of each university profile were monitored every 7 days during the period studied.

On the day of the analysis, the publications made by the university and the reactions received in the form of likes over the last 7 days and the followers of the last day were counted. As followers are a cumulative value, its daily value should not be added up. For the subsequent data analysis, the average of the values of the variables for the 14 weeks of the study was used, obtaining one value per variable for each of the 83 universities and each of the 4 social networks.

From the data collected from the universities' profiles on social networks the variable of followers has been studied with a regression model as well as the interaction, measured by the reactions received by the universities with two regression models: one based on the variable of weekly likes obtained by the universities and another one based on the likes per publication. The latter variable (likes per publication) is not influenced by the number of publications, which is why it is very interesting to study.

In order to obtain the regression models, each social network has been analysed on an individual basis. In other words, in the case of the regression model for followers, four different regression models have been created, one for each of the social networks investigated and for the 83 universities as a whole. The same applies to the regression model for interaction measured in weekly likes and likes per post. The regressions were developed at a 95% confidence level and a 0.05 significance level.

The variables of the multiple regression analysis of the number of followers are shown below (Table 1). The quantitative variables are incorporated into the model with their values, but the public/private university variable, being a qualitative categorical variable, must be transformed into a numeric variable for the statistical analysis, so it is represented with a "0" if it is public and a "1" if it is private. The variable of followers is represented in the tables throughout the work as: FACEBOOKFans, INSTAGRAMFollowers, TWITTERFollowers and YOUTUBESubscribers.

Table 1. Variables of the multiple regression model of followers

Dependent variable	Independent variables	Representation in tables
Number of followers	Number of students	Students
	Number of publications	FACEBOOKPublications INSTAGRAMPublications TWITERTweets YOUTUBEVideos
	University prestige	URanking
	Public or private university	PublicPrivate01

Source: Own elaboration

Table 2 shows the variables of the multiple regression analysis of user interaction measured in weekly likes. The weekly likes variable is represented in the tables as: FACEBOOKLikes, INSTAGRAMLikes, TWITTERLikes and YOUTUBELikes.

Table 2. Variables of the multiple regression model of the interaction on likes

Dependent variable	Independent variables	Representation in tables
Interaction measured in weekly likes	Number of students	Students
	Number of followers	FACEBOOKFans INSTAGRAMFollowers TWITTERFollowers YOUTUBESubscribers
	Number of publications	FACEBOOKPublications INSTAGRAMPublications TWITERTweets YOUTUBEVideos
	University prestige	URanking
	Public or private university	PublicPrivate01

Source: Own elaboration

To avoid the distortion that could be caused by the variable number of posts in the interaction model above, another regression model has also been studied in which the likes per post are analysed with the same independent variables (Table 3). The variable of likes per post is shown in the tables in the following forms: FACEBOOKPublicationLikes, TWITTERTweetLikes, INSTAGRAMPublicationLikes and YOUTUBEVideoLikes.

Table 3. Variables of the multiple regression model of the interaction in likes by publication

Dependent variable	Independent variables	Representation in tables
Interaction measured in likes per post	Number of students	Students
	Number of followers	FACEBOOKFans INSTAGRAMFollowers TWITTERFollowers YOUTUBESubscribers
	Number of publications	FACEBOOKPublications INSTAGRAMPublications TWITERTweets YOUTUBEVideos
	University prestige	URanking
	Public or private university	PublicPrivate01

Source: Own elaboration

As a preliminary step to the regression model, it was confirmed that there was no multicollinearity between the variables and a hierarchical multiple regression was carried out to verify the value contributed by each variable. In this respect, whilst some variables had little value to a social network, they were not eliminated from the study, in order to harmonise the regressions, observing that they did added value in other networks. This would also allow for a better examination of the differences of the same variable in different networks and models.

Finally, it should be noted that once the multiple regressions had been carried out, a few times an atypical case (more than 3 standard deviations away from the mean) was observed. This case, discovered through the diagnosis of cases, has been excluded and the regression has been repeated to obtain a model that is more in line with reality.

4. RESULTS

This article investigates the followers and interaction of universities on Facebook, Instagram, Twitter and YouTube. Followers have been analysed using a regression model and for the interaction, two different regression models have been chosen to be used, one for weekly likes and the other for likes per post, in order to avoid distorting the number of posts. Consequently, the results present the linear regression models found in three sections: the first focused on university followers, the second on the interaction received by the universities in weekly likes and the third on the interaction obtained in likes per publication. It is also important to highlight the fact that different regression models have been used for each of the three dependent variables analyzed and for each social network. The aim is to analyse whether the models presented are strong enough to explain the dependent variables. In this study, the regression models are used at a confidence level of 95% and the significance level is 0.05, i.e., the results are considered significant if $p < 0.05$.

The standardised Beta coefficients of the independent variables are also examined to understand the influence of each variable in the model. In this respect, it is important to point out that, in the study of the variable of university prestige (ranking), the lower ranking number has been given to the universities with the highest prestige and the higher ranking number to the universities with the lowest prestige. For this reason, a positive relationship of the prestige variable (ranking) with the regression model will be represented by a negative result in the standardised coefficient of Beta and vice versa, a negative relationship will be represented by a positive result.

4.1. FOLLOWER REGRESSION MODELS

This section shows the linear regression models of university followers for the 4 social networks studied, in order to check whether they can explain this dependent variable. In addition, as mentioned above, the weight of the different independent variables in the model is analysed.

4.1.1. Facebook - Followers

The regression model of Facebook followers obtains a coefficient of determination $R^2 = 0.506$ (Table 4), so it can be stated that this model explains an important part of the behaviour of the dependent variable followers "fans" of higher education institutions.

In this regression, an atypical case has been eliminated, which is the International University of Valencia because it had follower values that were more than three standard deviations (3σ) away from the mean. For this reason, it has been excluded from the model and a new regression model has been created that is more in line with reality, which is the one shown below.

Table 4. Multiple linear regression analysis of Facebook for the followers variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.711[a]	.506	.475	30130.384940548200000
a. Predictors: (Constant), PublicPrivate01, FACEBOOKPublications, Students, URanking				
b. Dependent variable: FACEBOOKFans				

ANOVA[a]						
F = 16.392 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	38115.791	14811.218		2.573	.012
	Students	1.149	.236	.552	4.871	.000
	PublicPrivate01	32882.437	10900.459	.371	3.017	.004
	URanking	-1635.532	647.077	-.356	-2.528	.014
	FACEBOOKPublications	313.925	404.615	.073	.776	.441
a. Dependent variable: FACEBOOKFans						

Source: Own elaboration based on SPSS data

By observing the standardised Beta coefficients of the regression model, it can be argued that the independent variable that most strongly explains the number of followers in this network is the number of students (0.552), followed in the model with a similar weight between them by the variable that determines whether a university is public or private (0.371) and the prestige variable measured by the ranking (-0.356). The prestige variable has a negative value indicating a positive relationship with the model, as previously explained. Finally, the variable that has the lowest impact on the model is the number of publications made by the universities (0.073).

4.1.2. Instagram – Followers

Regarding Instagram, the regression model of followers obtains a value of $R^2 = 0.394$ (Table 5). In this case the regression model is moderate-weak to explain the variable of followers of each university. In this regression of the Instagram network, no atypical cases are observed.

Table 5. Instagram multiple linear regression analysis for the followers variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.628[a]	.394	.347	9972.798929
a. Predictors: (Constant), PublicPrivate01, INSTAGRAMPublications, Students, URanking				
b. Dependent variable: INSTAGRAMFollowers				

ANOVA[a]						
F = 8.448 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	6600.004	8869.350		.744	.460
	Students	.519	.192	.569	2.707	.009
	PublicPrivate01	12684.932	4298.864	.500	2.951	.005
	URanking	-255.040	336.921	-.197	-.757	.452
	INSTAGRAMP Publications	175.131	236.230	.088	.741	.462
a. Dependent variable: INSTAGRAMFollowers						

Source: Own elaboration based on SPSS data

In Instagram, examining the standardised Beta coefficient, it can be seen that the students variable (0.569) has the greatest weight in the model, ahead of the public-private variable (0.500) and the prestige variable (ranking) (-0.197), which has little influence. As in the Facebook social network, the publications variable has the lowest weight (0.088).

4.1.3. Twitter - Followers

The regression model of followers on the Twitter social network obtains a $R^2 = 0.602$ coefficient of determination (Table 6), so it is a strong regression model that can explain a large part of the followers variable of different universities.

Table 6. Multiple linear regression analysis of Twitter for the followers variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.776[a]	.602	.577	20247.73051
a. Predictors: (Constant), PublicPrivate01, TWITTERTweets, Students, URanking				
b. Dependent variable: TWITTERFollowers				

ANOVA[a]						
F = 24.571 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	50549.795	10077.450		5.016	.000
	Students	.652	.158	.417	4.131	.000
	PublicPrivate01	-1692.558	6880.481	-.026	-.246	.806
	URanking	-1382.157	425.055	-.404	-3.252	.002
	TWITTERTweets	106.157	69.588	.121	1.526	.132
a. Dependent variable: TWITTERFollowers						

Source: Own elaboration based on SPSS data

In this case of Twitter, in which the followers regression model is a strong model, the students variable continues to be the one with the highest standardised Beta coefficient (0.417) ahead of the prestige variable (ranking) (-0.404), which considerably increases its weight with respect to the previous model, and the variable for the number of publications "Tweets" (0.121). In this

model, unlike the previous networks, the variable indicating the public or private ownership of the university (-0.026) is the least important.

4.1.4. YouTube - Followers (subscribers)

In the case of YouTube, the regression model that seeks to explain the followers "Fans" obtains a value of R^2 = 0.366 (Table 7). Thus, it can be affirmed that the regression model is weak and therefore the independent variables do not fully explain the followers' variable.

Table 7. YouTube multiple linear regression analysis for the followers variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.605[a]	.366	.322	36141.134333795
a. Predictors: (Constant), PublicPrivate01, YOUTUBEVideos, Students, URanking				
b. Dependent variable: YOUTUBESubscribers				

ANOVA[a]						
F = 8.228 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	-2637.570	20713.138		-.127	.899
	Students	.472	.293	.223	1.608	.113
	PublicPrivate01	24900.151	13729.025	.260	1.814	.075
	URanking	-741.581	864.450	-.152	-.858	.395
	YOUTUBEVideos	3727.046	758.323	.537	4.915	.000
a. Dependent variable: YOUTUBESubscribers						

Source: Own elaboration based on SPSS data

On YouTube, the weight of independent variables differs significantly from that of other social media platforms. In this network, where the regression model of followers can be considered weak, the publications variable has the highest standardised Beta coefficient (0.537), followed by the public-private variable (0.260) and the number of students (0.223). The prestige variable (ranking) (-0.152) is the least important variable in this case.

4.2. REGRESSION MODELS OF WEEKLY LIKES INTERACTION

This section presents the results of weekly likes linear regression models obtained by higher education institutions in the different social networks. The weekly likes have been analysed with the intention of studying the global interaction obtained by universities.

4.2.1. Facebook - weekly likes

The regression model of weekly likes interaction obtained by universities on Facebook has a R^2 = 0.470 coefficient of determination (Table 8), so it can be stated that the regression model explains the behaviour of the dependent variable of likes in a percentage close to 50%.

In the data analysis it was found out that the University of Salamanca at the level of weekly likes was an outlier (value more than three standard deviations (3σ) away from the mean) and was in consequence excluded from the model.

Table 8. Facebook multiple linear regression analysis for the likes variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.686[a]	.470	.428	147.012925
a. Predictors: (Constant), FACEBOOKFans, FACEBOOKPublications, PublicPrivate01, Students, URanking				
b. Dependent variable: FACEBOOKLikes				

ANOVA[a]						
F = 11.175 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	158.166	73.510		2.152	.035
	Students	-3.180E-05	.001	-.003	-.025	.980
	PublicPrivate01	-41.215	56.026	-.101	-.736	.465
	URanking	-5.557	3.211	-.261	-1.730	.088
	FACEBOOKFans	.001	.000	.344	3.075	.003
	FACEBOOKPublications	7.902	1.984	.395	3.983	.000
a. Dependent variable: FACEBOOKLikes						

Source: Own elaboration based on SPSS data

Observing the standardised Beta coefficients of the regression model, it can be affirmed that the publications variable is the most defining variable in the model (0.395), which is explained by the fact that likes reactions are produced in response to the publications made by the university. The second most important variable in the model is the number of followers (0.344). The prestige of the university (ranking) in this case has less influence than in the previous models (-0.261), although it is still negative indicating its positive relationship with the dependent variable, as explained above. Finally, the two remaining variables, students (-0.003) and public/private university variable (-0.101) have practically no impact on the model.

4.2.2. Instagram - weekly likes

In Instagram social network, the regression model that aims to predict like reactions obtains a value of R^2 = 0.648 (Table 9). As a result of this, it can be affirmed that the regression model largely explains the behaviour of the dependent variable like reactions by the strength of its R^2.

Table 9. Multiple linear regression analysis of Instagram for the likes variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.805[a]	.648	.614	626.866289422502000
a. Predictors: (Constant), INSTAGRAMFollowers, INSTAGRAMPublications, PublicPrivate01, Students, URanking				
b. Dependent variable: INSTAGRAMLikes				

ANOVA[a]						
F = 18.778 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	641.405	560.467		1.144	.258
	Students	-.024	.013	-.319	-1.848	.070
	PublicPrivate01	-258.956	291.964	-.125	-.887	.379
	URanking	-23.134	21.294	-.219	-1.086	.282
	INSTAGRAMFollowers	.064	.009	.780	7.308	.000
	INSTAGRAMP Publications	56.522	14.927	.346	3.787	.000
a. Dependent variable: INSTAGRAMLikes						

Source: Own elaboration based on SPSS data

By observing the standardised Beta coefficients of the regression model, it can be affirmed that the followers variable (0.780) is the independent variable that most strongly explains the number of like reactions, followed at a great distance by the publications variable (0.346) and the students variable (-0.319), which interestingly has a negative effect on the model. It is noteworthy that the public or private university variable (-0.125) and the prestige variable (ranking) (-0.219) have almost no impact on the regression.

4.2.3. Twitter - weekly likes

The regression model of like interactions on Twitter social network achieves an R^2 value of = 0.425 (Table 10), confirming that the model can moderately explain a part of the dependent variable of likes.

Table 10. Twitter multiple linear regression analysis for the likes variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.652[a]	.425	.380	124.392344191540000
a. Predictors: (Constant), TWITTERFollowers, TWITTERTweets, PublicPrivate01, URanking, Students				
b. Dependent variable: TWITTERLikes				

ANOVA[a]						
F = 9.471 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	242.927	72.916		3.332	.001
	Students	-.001	.001	-.125	-.912	.365
	PublicPrivate01	20.735	42.290	.062	.490	.626
	URanking	-7.538	2.816	-.435	-2.677	.009
	TWITTERTweets	1.654	.435	.373	3.801	.000
	TWITTERFollowers	.001	.001	.219	1.456	.150
a. Dependent variable: TWITTERLikes						

Source: Own elaboration based on SPSS data

When observing the standardised Beta coefficients, it can be seen that the independent variable of prestige (ranking) (-0.435) is the most influential, closely followed by the number of publications "Tweets" (0.373). The followers variable has little weight (0.219), and the non-significant variables are the students variable (-0.125), which maintains a negative relationship with the model as in the previous case, and the public/private variable (0.062).

4.2.4. YouTube - weekly likes

In the case of YouTube, the regression model that has the like reactions variable as the dependent variable, obtains a value of $R^2 = 0.194$ (Table 11). This very low value of the coefficient of determination is not strong enough to explain the like reactions variable.

Table 11. Multiple linear regression analysis of YouTube for the likes variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.441[a]	.194	.117	26.886024265236500
a. Predictors: (Constant), YOUTUBESubscribers, PublicPrivate01, Students, YOUTUBEVideos, URanking				
b. Dependent variable: YOUTUBELikes				

ANOVA[a]						
F = 2.507 / Sig. = 0.042						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	17.273	15.897		1.087	.282
	Students	.000	.000	.193	1.145	.257
	PublicPrivate01	20.990	10.712	.342	1.960	.055
	URanking	-.606	.661	-.195	-.917	.364
	YOUTUBESubscribers	8.154E-05	.000	.129	.826	.412
	YOUTUBEVideos	.775	.686	.175	1.130	.264
a. Dependent variable: YOUTUBELikes						

Source: Own elaboration based on SPSS data

Investigating the standardised Beta coefficients of the regression model proposed, despite being a very weak regression model, it can be seen that the variable with the greatest weight would be the public or private variable (0.342), followed by the prestige variable (ranking) (-0.195). The other variables of students (0.193), publications (0.175) and followers (0.129) have a much lower weight.

4.3. REGRESSION MODELS OF LIKES PER POST INTERACTION

This section investigates the linear regression models of the likes per publication achieved by universities on social networks. The aim is to analyse the interaction achieved by universities in each of the publications, thus eliminating the possible distortion caused by the number of posts published in the number of likes achieved by universities.

4.3.1. Facebook - likes per post

Regarding Facebook, the regression model that explains the variable likes per post obtains a value of $R^2 = 0.353$ (Table 12). In other words, the regression model does not effectively explain the like reactions per post achieved by the university.

In this network, the University of Salamanca was found to be an outlier with a level of likes more than three standard deviations away from the mean and was therefore excluded from the model.

Table 12. Facebook multiple linear regression analysis for the likes per post variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.594[a]	.353	.302	16.7183
a. Predictors: (Constant), FACEBOOKFans, FACEBOOKPublications, PublicPrivate01, Students, URanking				
b. Dependent variable: FACEBOOKPublicationLikes				

ANOVA[a]						
F = 6.886 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	31.424	8.360		3.759	.000
	Students	-6.805E-06	.000	-.007	-.047	.962
	PublicPrivate01	-2.704	6.371	-.064	-.424	.673
	URanking	-.635	.365	-.290	-1.739	.087
	FACEBOOKFans	.000	.000	.383	3.095	.003
	FACEBOOKPublications	-.507	.226	-.246	-2.245	.028
a. Dependent variable: FACEBOOKPublicationLikes						

Source: Own elaboration based on SPSS data

By observing the standardised Beta coefficients, it can be seen that the variable that most powerfully explain the model is the number of followers that the university has on the social network (0.383), followed by the prestige of the university (ranking) (-0.290). It should be noted that the publications have a negative effect on this model (-0.246), when in the regression of the weekly likes they had a significant positive relationship with the model. Finally, the variables public or private (-0.064) and students (-0.007) are not significant.

4.3.2. Instagram - likes per post

The Instagram regression model predicting the variable likes per post achieves a coefficient of determination $R^2 = 0.499$ (Table 13). With this result, the regression model demonstrates its ability to moderately explain (50%) the like reactions per post.

Table 13. Multiple linear regression analysis of Instagram for the likes per post variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.706[a]	.499	.449	172.9926810765
a. Predictors: (Constant), INSTAGRAMFollowers, INSTAGRAMPublications, PublicPrivate01, Students, URanking				
b. Dependent variable: INSTAGRAMPublicationLikes				

ANOVA[a]						
F = 10.142 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	508.933	154.669		3.290	.002
	Students	-.012	.004	-.688	-3.340	.002
	PublicPrivate01	8.758	80.572	.018	.109	.914
	URanking	-13.067	5.876	-.535	-2.224	.031
	INSTAGRAMFollowers	.014	.002	.748	5.872	.000
	INSTAGRAMP Publications	-8.377	4.119	-.222	-2.034	.047
a. Dependent variable: INSTAGRAMPublicationLikes						

Source: Own elaboration based on SPSS data

From the standardised Beta coefficients it is observed, as in the previous model, that the independent variable with the greatest weight in predicting the interaction likes per publication is the followers variable (0.748). The number of students (-0.688) is also very strong, although it has a negative influence on the dependent variable, followed by the prestige variable (ranking) (-0.535). The remaining variables such as publications (-0.222), which maintain their negative relationship, and the public or private variable (0.018) have very low standardised coefficients.

4.3.3. Twitter - likes per post (tweet)

In the Twitter social network, the regression model of likes per publication achieves a value of R^2 = 0.468 (Table 14), and can therefore explain a percentage of 47% of the like reactions per tweet achieved by the universities on this network.

Table 14. Twitter multiple linear regression analysis for the likes per post variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.684[a]	.468	.426	2.8795
a. Predictors: (Constant), TWITTERTweets, Students, PublicPrivate01, TWITTERFollowers, URanking				
b. Dependent variable: TWITTERTweetLikes				

ANOVA[a]						
F = 11.261 / Sig. < .001						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	7.112	1.688		4.214	.000
	Students	-2.172E-05	.000	-.114	-.861	.392
	PublicPrivate01	.608	.979	.076	.621	.537
	URanking	-.126	.065	-.303	-1.938	.057
	TWITTERTweets	-.037	.010	-.349	-3.702	.000
	TWITTERFollowers	6.401E-05	.000	.524	3.629	.001
a. Dependent variable: TWITTERTweetLikes						

Source: Own elaboration based on SPSS data

By observing the standardised Beta coefficients of the regression model, as in the two previous models, the independent variable that most strongly explains the number of like reactions per publication is the followers variable (0.524), the next most important predictors are the number of publications (-0.349), which continues to have a negative effect, and the prestige variable (ranking) (-0.303). The other variables such as students (-0.114) and public or private university (0.076) contribute very little to the model.

4.3.4. YouTube - likes per post (video)

In the YouTube social network, the regression model that explains the independent variable likes per post obtains a value of R^2 = 0.286 (Table 15), i.e., the regression model does not really explain the variable of reactions likes per video achieved by universities.

Table 15. Multiple linear regression analysis of YouTube for the likes per post variable

Summary of the model[b]				
Model	**R**	**R2**	**R2 adjusted**	**Standard error of the estimate**
1	.535[a]	.286	.218	5.4887
a. Predictors: (Constant), YOUTUBE Fans, PublicPrivate01, Students, YOUTUBEVideos, URanking				
b. Dependent variable: YOUTUBEVideoLikes				

ANOVA[a]						
F = 4.172 / Sig. = .003						
Coefficients[a]						
Model		Unstandardised coefficients		Standardised coefficients	t	Sig.
		B	Error	Beta		
M1	(Constant)	4.732	3.245		1.458	.151
	Students	4.878E-05	.000	.168	1.058	.295
	PublicPrivate01	4.547	2.187	.342	2.079	.043
	URanking	-.067	.135	-.099	-.493	.624
	YOUTUBESubscribers	5.135E-05	.000	.374	2.549	.014
	YOUTUBEVideos	-.326	.140	-.339	-2.327	.024
a. Dependent variable: YOUTUBEVideoLikes						

Source: Own elaboration based on SPSS data

Although the regression model is weak, the analysis of the standardised Beta coefficients allows us to conclude that the independent variable of the number of followers (0.374) has the greatest influence on the interaction of the universities on YouTube, as was the case in the other networks. The second strongest variables are the public/private variable (0.342) and the number of publications (-0.339), which is negative as in the other networks. The least important variables are the number of students (0.168) and prestige (ranking) (-0.099).

5. DISCUSSION AND CONCLUSIONS

This paper analyses the communication of all Spanish higher education institutions, 83 universities on Facebook, Instagram, Twitter and YouTube with their audience, current and potential students. Multiple linear regression models have been developed with the aim of understanding and predicting the followers they have and the interaction they receive on these social networks. The analysis of the followers has been carried out using a regression model and two separate regression models have been used to investigate the interaction, one for the weekly likes and one for the likes per post. The findings and results are thus divided into three parts, each focusing on one dependent variable: followers, weekly likes and likes per post. In each part, different regression models have been developed for the 4 social networks, which shows the complexity of this study.

The first section studies the multiple linear regression models that aim to predict the number of followers that universities have on the different social networks according to the independent variables of the number of publications, the number of students, the prestige (ranking) and the public or private ownership of the university. For this purpose, a different regression model has been developed for each of the social networks. The multiple regression models that determine the behaviour of followers with respect to the independent variables achieve high coefficients of determination in the cases of Twitter ($R^2 = 0.602$) and Facebook ($R^2 = 0.506$) and more discrete in the cases of Instagram ($R^2 = 0.394$) and YouTube ($R^2 = 0.366$). Based on these results, it is possible to state that the regression models explain a significant part of the followers that Spanish universities have on Twitter (60%) and Facebook (51%) social networks. In Instagram, although in a more moderate way, they explain almost 40% of the followers variability and in YouTube there is also a relationship, but somewhat weaker. The study of the standardised Beta coefficients of the independent variables has allowed us to conclude that the variable with the greatest influence on the followers regression is the number of students in all the social networks analysed, except YouTube. This confirms Maresova et al. (2020) who stated that universities that have more students usually also have more followers. The position of second most influential variable in the model is shared by prestige (ranking) and the public-private variable. The strong influence of prestige in the regression model is in line with the findings of Lund (2019) who pointed out that the university prestige positively affects the number of followers. These results also confirm the study by Brech et al. (2016) which considered reputation together with university size, measured by the number of students, as the two strongest variables in the regression. However, Brech et al. (2016) concluded that university reputation was the strongest variable in the model, a fact from which the present study differs, concluding that the strongest variable is the number of students. The low influence of the number of publications variable in the followers' model corroborates the research of Lund (2019). YouTube behaves differently vs. other networks and in its case the

most influential variable, unlike the rest, is the number of publications that the university makes on a weekly basis. The prestige variable (ranking) has a positive relationship with the dependent variables, although it is shown with negative values in the standardised coefficients, given that in the prestige ranking used, low numbers represent a higher level of university prestige and high numbers a lower level.

In the second section, multiple linear regression models have been investigated to predict weekly likes interaction perceived by universities on social networks. The interaction model is worked on the basis of the independent variables: number of students, university prestige (ranking), number of publications, number of followers and public or private ownership of the university. The multiple regression models that determine the behaviour of the interaction measured in the weekly likes perceived by universities predict a high percentage of the dependent variable in Instagram ($R^2 = 0.648$) and a considerable percentage in Facebook ($R^2 = 0.470$) and Twitter ($R^2 = 0.425$). However, the percentage in YouTube ($R^2 = 0.194$) is not representative. These results show that the multiple regression models used could largely explain the interaction received by universities on Instagram (65%) and moderate percentages of interaction on the Facebook (47%) and Twitter (43%) networks based on the independent variables studied. Nevertheless, the behaviour of the YouTube network cannot be explained by the variables used. From the standardised Beta coefficients, it is concluded that the independent variable with the greatest weight in the weekly likes is the number of publications made by the university, followed by the number of followers it has on the social network. As likes are a more impulsive reaction on the part of users (Bonilla Quijada et al., 2022) it makes sense that a larger community and a greater number of publications would be transformed into a greater number of likes. This result is in line with Matosas-López and Cuevas-Molano (2021) who state that the number of posts has an important effect on the recognition of posts by users. This article is also aligned with Brech et al. (2016) confirming the positive relationship between the size of the follower community and interactivity. However, it differs from the author by considering the number of publications as the most influential variable, whereas Brech et al. (2016) believed that the number of followers was the most important variable in interaction. On the other hand, as in the regression model for followers, the independent variables act differently on YouTube. Thus, in this network, the most influential variables are the variable indicating whether the university is public or private and the prestige of the university (ranking).

The third and last section studies the interaction of likes per publication to prevent the results from being distorted by the number of publications variable, as this has a strong relationship with the interaction received by universities. The same independent variables are used as in the previous model. The multiple regression models that aim to predict the like reactions per publication achieve moderate coefficients of determination in the Instagram ($R^2 = 0.499$) and Twitter ($R^2 = 0.468$) networks and weak ones in the Facebook ($R^2 = 0.353$) and YouTube ($R^2 = 0.286$) networks. Consequently, the regression models presented can explain moderate percentages of the interaction of likes per publication perceived by Spanish universities on the Instagram (50%) and Twitter (47%) networks on the basis of the independent variables introduced in the model. In the Facebook network, only 35% of the variability of interaction is explained, and in YouTube it is too low to be considered. The fact that the relationship at this point is not of a higher value is understandable because there are other qualitative variables that can also affect

user interaction with university publications, such as the use of images or videos in messages (Rodríguez-Vázquez et al., 2016; Sabate et al., 2014) or even the presence of hashtags in Facebook publications or emojis on Twitter (Segura-Mariño et al., 2020). Investigating the standardised Beta coefficients, it is discovered that the variable with the greatest weight in all the likes per post regression models is the number of followers that the university has on the social network. This statement ratifies the research of Brech et al. (2016) which described this variable as the most influential in interaction and argued that if a university has a larger community of followers, the interactivity it achieves increases accordingly. This result is also in line with Palmer (2013) and Alonso García & Alonso García (2014) who stated that there was a positive relationship between the number of followers that universities have in networks and the interaction they receive. In a first analysis, it is strange to note that the significant relationship between the number of students and the interaction received by the universities defended by Amaral and Santos (2020) and Zarco et al. (2016) is not directly perceived in these regression models, as the student variable has little relevance. However, in the followers regression model, the variable with the most weight was the number of students. Therefore, indirectly, this relationship would exist because students influence the number of followers and followers variable is the strongest one in the interaction regression model.

Different from the previous model, the regression of likes per publication shows that the number of post made by universities has very little influence and is negative. This finding is in line with Lund (2019) who considered that the number of posts by a university had no influence on interaction. However, in this research a duality in the influence of this variable is observed, as the number of publications by universities affects the two interactions studied differently. On the one hand, it has very little effect and this is negative with respect to the regression model of likes per publication. On the other hand, it has a positive effect on the weekly likes model. In essence, the more posts the university makes, the more interaction it achieves on a weekly level, but at the same time its interaction per post is not affected or even decreases, because although the number of likes has increased, so has the number of posts.

In summary, the multiple linear regression models used are able to significantly predict the number of followers that higher education institutions have on Facebook and Twitter as a function of the independent variables, and moderately so on Instagram. In this model, the number of students is revealed as the most influential variable. As for weekly likes interaction that universities get, the regression models can predict a high percentage of these reactions on Facebook, Instagram and Twitter. The study of the independent variables shows that the number of publications is the one that has the greatest weight in the weekly interaction. Regarding likes per post, the coefficients of determination explain this interaction moderately on Instagram and Twitter and more weakly on Facebook. The number of followers that the universities have on the social networks is revealed as the variable with the strongest influence on the likes per publication. In YouTube network, the regression models only manage to explain a very small part of followers and are not significant for interaction, consequently in this case it should be investigated with other types of independent variables.

This study is one of the first to look for regression models in all Spanish universities (83), analysing their actions and results in the 4 most popular social networks at the same time. The large volume of universities analysed, the joint study of 4 social networks and the depth of the statisti-

cal work, add greater value to this study. Moreover, the methodology described using multiple linear regression can be extrapolated to future research and other educational levels, as well as to other areas outside the educational world to improve communication on social networks in these institutions.

In terms of potential limitations, this study has a clearly quantitative focus, so that in future lines of research it could be interesting to use a more qualitative approach, for example, by focusing on the way in which universities publish. This work could also be complemented with the analysis of new social networks used by young people such as TikTok or Twich. Finally, another future line of research would be an in-depth study of YouTube as the results obtained in the different regression models are not very representative, as well as to look for other independent variables that could better explain the followers or the interaction on this social network.

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