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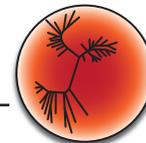
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Twitter as a Tool for Teaching and Communicating Microbiology: The #microMOOCSEM Initiative †

Ignacio López-Goñi^{1*}, M^a José Martínez-Viñas², Josefa Antón³, Víctor J. Cid⁴, Ana Martín González⁵, Maryury Brown-Jaque⁶, Juan M. García-Lobo⁷, Manuel Sánchez⁸, Juan Ignacio Vilchez⁹, Tatiana Robledo-Mahón⁹, Marina Seder-Colomina¹⁰, Silvana Teresa Tapia-Paniagua¹¹, Alma Hernández de Rojas¹², Alejandro Mira¹³, José Jesús Gallego-Parrilla¹⁴, Teresa María López Díaz¹⁵, Sergi Maicas i Prieto¹⁶, Eduardo Villalobo¹⁷, Guillermo Quindós¹⁸, Sabela Balboa¹⁹, Jesús L. Romalde¹⁹, Clara Aguilar-Pérez²⁰, Anna Tomás²¹, María Linares²², Óscar Zaragoza²³, Jéssica Gil-Serna⁵, Raquel Ferrer-Espada¹, Ana I. Camacho¹, Laura Vinué²⁴, and Jorge García-Lara²⁵

¹Departamento de Microbiología y Parasitología, Universidad de Navarra, Pamplona, Spain, ²Secció Departamental de Microbiologia, Universitat de Barcelona, Barcelona, Spain, ³Departamento de Fisiología, Genética y Microbiología, Universidad de Alicante, Alicante, Spain, ⁴Departamento de Microbiología II, Universidad Complutense de Madrid, Madrid, Spain, ⁵Departamento de Microbiología III, Universidad Complutense de Madrid, Madrid, Spain, ⁶Departamento de Genética, Microbiología y Estadística, Universitat de Barcelona, Barcelona, Spain, ⁷Instituto de Biotecnología y Biomedicina de Cantabria, Santander, Spain, ⁸Departamento de Producción Vegetal y Microbiología, Universidad Miguel Hernández, Elche, Spain, ⁹Instituto del Agua, Universidad de Granada, Granada, Spain, ¹⁰Institut de Radioprotection et de Sûreté Nucléaire, Fontenay-aux-Roses, France, ¹¹Departamento de Microbiología, Universidad de Málaga, Málaga, Spain, ¹²Instituto Español de Oceanografía, Centro Oceanográfico de Gijón, Gijón, Spain, ¹³Centro Superior de Investigación en Salud Pública, Fundación FISABIO, Valencia, Spain, ¹⁴Grupo de Docencia y Difusión de la Microbiología, Sociedad Española de Microbiología, Spain, ¹⁵Departamento Higiene y Tecnología de los Alimentos, Universidad de León, León, Spain, ¹⁶Departament de Microbiologia i Ecologia, Universitat de València, Valencia, Spain, ¹⁷Departamento de Microbiología, Universidad de Sevilla, Sevilla, Spain, ¹⁸Departamento de Inmunología, Microbiología y Parasitología, Facultad de Medicina y Enfermería, Universidad País Vasco, Bilbao, Spain, ¹⁹Departamento de Microbiología y Parasitología, Universidad Santiago de Compostela, Santiago de Compostela, Spain, ²⁰Departamento de Microbiología, Medicina Preventiva y Salud Pública, Universidad de Zaragoza, Zaragoza, Spain, ²¹Departamento de Microbiología, Universitat Autònoma de Barcelona, Barcelona, Spain, ²²Hospital Doce de Octubre-CNIO, Madrid, Spain, ²³Servicio de Micología, Centro Nacional de Microbiología, ISCIII, Madrid, Spain, ²⁴Division of Infectious Diseases, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA, ²⁵School of Medicine, University of Central Lancashire, Preston, UK

INTRODUCTION

Social networks are already being exploited for searching, storing, and sharing knowledge, demonstrating that they are an efficient vehicle for social learning. Consequently, they could be implemented as a competent tool for formal learning. Twitter is among the 10 most popular

online social networks, integrating a community of over 500 million users around the world. Twitter has already been used in several educational programs and evaluated as a positive teaching experience with an outstanding potential in academic and educational environments (1–6). However, there are scarce examples available in the literature about its use in science teaching and communication. In this work, we present and analyze the application of Twitter to create an online space for communication and learning of basic microbiology. With this aim, a team of professionals in the field has imparted, to our knowledge, the first worldwide open access microbiology course via

*Corresponding author. Mailing address: Departamento de Microbiología y Parasitología, Universidad de Navarra, C/ Irunlarrea n° 1, 31008, Pamplona, Spain. Phone: +34 948 425600. E-mail: ilgoni@unav.es.

†Supplemental materials available at <http://asmscience.org/jmbe>

Twitter. Here we assess the results of our experience of using this social network as a tool for teaching, promoting, and communicating scientific knowledge to a wide audience.

PROCEDURE

A total of 30 professionals were involved, all members of the Spanish Society for Microbiology (SEM, *Sociedad Española de Microbiología*), affiliated with 25 different universities or research centers located in different cities in Spain, France, the USA, and the UK. The layout of the course was elaborated and agreed on by discussion via e-mail with the Massive Online Open Course (MOOC)'s coordinator, who delivered some basic instructions to the rest of the virtual faculty members in order to ensure homogeneous material (see Appendix 1 for a course syllabus). Briefly, each participant prepared a lecture consisting of a series of 30 to 50 sentences (tweets), each one a maximum of 140 characters, often including links to diverse curated on-line free access or contents specifically generated for the course, web pages, news, and especially images or videos. Each tweet was to be written in Spanish, using simple and concise language, meant to communicate science to a general audience outside the academic environment. It was advised that humorous tweets be included periodically to emotionally involve and motivate the reader (see Appendix 2 for examples of representative tweets). Most of the lecturers spent more than three hours preparing the class. The hashtag #microMOOCSEM was created for this course: "micro" acknowledges both the subject under focus, microbiology, and the fact that it is conceived for the small 140-character format; "MOOC" for Massive Online Open Course; and SEM for the Society. Thus, each tweet included the #microMOOCSEM hashtag. The course took place over 10 weeks (April 5 to June 8, 2016), with classes scheduled every Tuesday, Wednesday, and Thursday at 22:00 h (GMT +1) so that they could be followed at convenient times in Spanish-speaking countries in the American continent. Tweets were sent from the @SEM microbiologia Twitter account and programmed to be posted at a frequency of one tweet per minute using the application TweetDeck (<https://tweetdeck.twitter.com/>). Students were encouraged to follow the course through their mobile devices or computers, either live at the scheduled time or later, searching the hashtag #microMOOCSEM. The same hashtag could be used by the students to interact with the lecturers. Three weeks before the start of the course, an intense promotion campaign was run through social networks, universities, and scientific institutions, as well as the press and radio, in diverse locations around Spain. Contacts were also made with some Latin-American Microbiology Societies. After each lesson was posted, tweets were compiled and stored online using the open tool Storify (<https://storify.com/SEM microbiologia>), so that they could be consulted any time after the class was over. Once the course was completed, data were analyzed using the open software Twitter analytics (<https://analytics.twitter.com/>).

RESULTS AND CONCLUSION

Comprehensively, the course consisted of 28 lessons plus a "Graduation Party" (Appendix 3), involving 1,225 tweets, 702 images, 265 hyperlinks to web pages, and 136 videos related to microbiology. Considering the total number of tweets and their release frequency, the total length of the course was approximately 20 hours. Certain classes became a Twitter *trending topic* in Spain. Figure 1 shows the number of Twitter daily impressions along course development. Some classes reached over 260,000 impressions and 3,700 retweets. However, data trend reaches a plateau in the number of impressions from the fifth week on, suggesting that longer courses may result in a decrease in followers. We could not detect a direct relationship between the number of impressions for a particular class and the day of the week, the social interest of the topic, or the number of images or videos included. Appendix 4 compares the monthly activity of the @SEM microbiologia Twitter account before starting the MOOC to that in April, the month that marked a peak of activity. Before the start of the course, the number of followers for the @SEM microbiologia Twitter account was 2,176, and the last day of the course it rose to 7,240 (Appendix 5).

The course has been followed worldwide: 62% of the followers were located in Spain, 29% were from Mexico, Venezuela, Argentina, Colombia, Peru, Ecuador, and Chile (from the most represented to the least), 2% in the USA and the UK, and the remaining 7% in other countries. Regarding gender, 61% of followers were female. The most represented followers were college and high school students, high school and higher education teachers, as well as healthcare and science professionals, journalists, and scientific communicators.

To assess the acquisition of knowledge by the followers, we included three or four quiz questions (Appendix 1) at the end of each class, reaching a total of 78 questions that were answered by an average of 309 followers per day. Figure 2 ranks the questions according to the percentage of correct answers obtained.

At the end of the course, a satisfaction survey was completed by the lecturers: all of them confirmed that this experience has been useful to improve their teaching skills and, at the same time, to learn new concepts related to microbiology in topics different from their own; they would recommend this course to their students and colleagues for technology-enhanced teaching and learning, and they would like to participate again in a similar course via Twitter.

The #microMOOCSEM experience demonstrates that, when properly used, Twitter is an excellent means for collaborative teaching and active learning, as well as for establishing professional networks and communicating science to society. With this first online Microbiology course via Twitter, we have proved that science lectures can be taught by this means to a wide interested audience in a highly interactive way, with immediate feedback, and

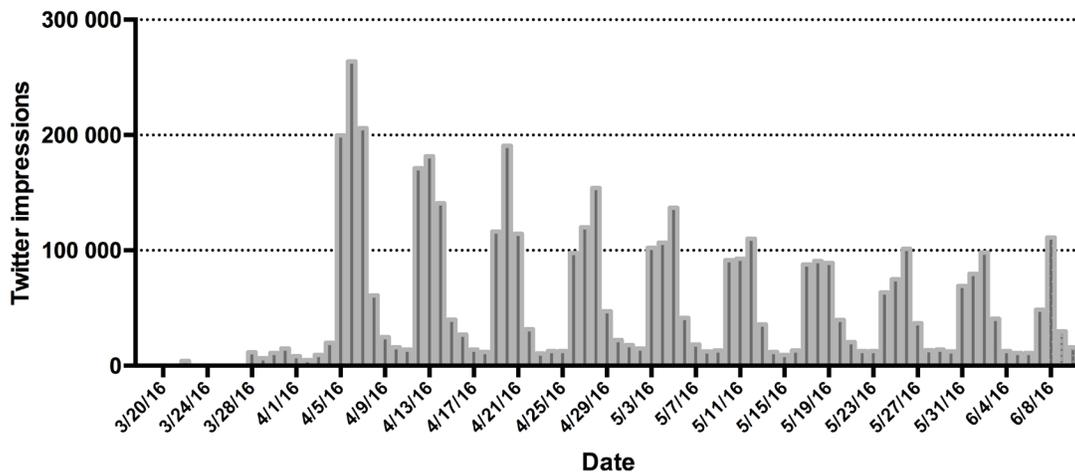


FIGURE 1. Number of Twitter daily impressions during the time that the course was active. Impressions refer to the number of times that users visualized a particular tweet with the hashtag #microMOOCSEM. Peaks coincide with broadcasting days. During the time that the course was active, the Twitter account of the SEM received a total of 4,420,172 impressions and over 175,000 visits. SEM = Spanish Society for Microbiology.

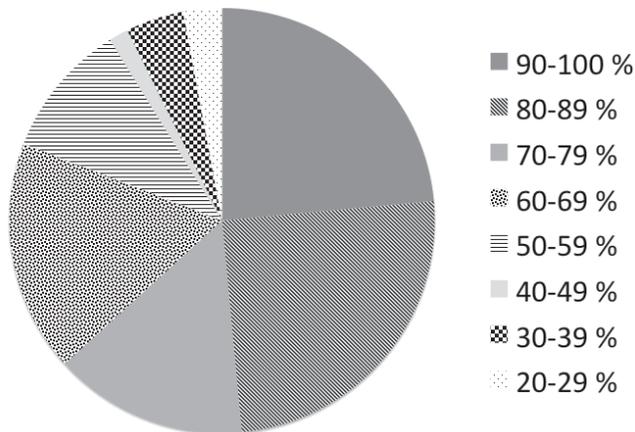


FIGURE 2. Number of questions correctly answered. Data from 68 questions are included. The results show the percentage of followers (virtual students) who answered correctly. More than 90% of virtual students correctly answered 16 questions, and more than 50% correctly answered 62 questions. None of the questions had a 100% failure score.

with the convenience of access from home or any place in which a mobile device has access to internet data.

SUPPLEMENTAL MATERIALS

Appendix 1: Table 1. Twitter course syllabus

Appendix 2: Figure 3. Image captures of representative tweets posted during #microMOOCSEM course

Appendix 3: Table 2. Structure of #microMOOCSEM lessons

Appendix 4: Table 3. Activity of the Twitter account @SEM microbiologia before and after the course

Appendix 5: Figure 4. Evolution of the number of followers of the @SEM microbiologia Twitter account

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The authors declare that there are no conflicts of interest.

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