Hachetetepé. Revista científica de educación y comunicación
ISSN: 2172-7910
ISSN: 2172-7929
revista.http@uca.es
Universidad de Cádiz
España

Dorca-Fornell, Carmen; Nieto-Márquez, Natalia Lara;
Gómez-Sebastián, Silvia; Josa-Prado, Fernando

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Hachetetepé. Revista científica de educación y comunicación,
núm. 27, 2023, Noviembre-Diciembre, pp. 1-16
Universidad de Cádiz
España

DOI: https://doi.org/10.25267/Hachetetepe.2023.i27.2205

Disponible en: https://www.redalyc.org/articulo.oa?id=683775220007

Hachetetepé. Revista científica de Educación y Comunicación
nº27,1-16, 2023

PRE AND POST-PANDEMIC PERCEPTION OF SCIENCE: A CASE STUDY UPON SCIENTIFIC COMMUNICATION IN SECONDARY EDUCATION DIDACTICS

PERCEPÇÃO DA CIÊNCIA PRÉ E PÓS-PANDEMIA: UM ESTUDO DE CASO SOBRE A COMUNICAÇÃO CIENTÍFICA NA DIDÁTICA NO ENSINO SECUNDÁRIO

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Carmen Dorca-Fornell
Universidad Internacional de la Rioja, España
https://orcid.org/0000-0003-1545-9669
mariadelcarmen.dorcafornell@unir.net

Natalia Lara Nieto-Márquez
Universidad Camilo José Cela, España
https://orcid.org/0000-0002-2404-4521
natalia.lara@ucjc.edu

Silvia Gómez-Sebastián
Universidad Autónoma de Madrid, España
https://orcid.org/0000-0002-7326-3181
silvia.gomezs@uam.es

Fernando Josa-Prado
Asoc. Científicos Retornados a España - CRE, España
https://orcid.org/0000-0002-6162-3231
fjpcre@gmail.com

Received:21/09/2023 Revised:15/10/2023 Accepted: 22/10/2023 Published: 30/10/2023

Abstract: Social perception of science is a multi-faceted concept that helps to understand the evolving relations between the knowledge ecosystem and the public opinions and views on it. Science communication is a key aspect of science perception as a flow of information from science, research and innovation professionals to civil society that helps to shape its conceptions/opinions. This work is framed into a science outreach activity, in which scientists directly interacted with secondary educational centres, to analyse the effect of scientific communication as a didactic methodology. Since the COVID-19 pandemic hit, we hypothesised that this could have affected these students' perception of science. We used grouped-longitudinal quantitative methodology to address this hypothesis and evaluated the changes in perception of science through a survey scored twice; firstly, after a scientific communication (pre-pandemic) and secondly, after students returned to classes (post-pandemic). Results showed COVID-19 pandemic has positively influenced the interest in science in society. Interestingly, students declared a loss of confidence in scientific integrity due to a lack of transparency of the scientific

e-ISSN:2172-7910
Doi: 10.25267/Hachetetepe.2023.i27.2205
Universidad de Cádiz

news in post-pandemic surveys. These results suggest the need to have access to clear and scientifically validated information to increase the positive social perception of this stratum of society.
Keywords: Scientific communication; Perception of Science; Secondary Education; Science, culture and society; Pre and post-COVID-19 pandemic.

Resumo: A percepção social da ciência é um conceito multifacetado que ajuda a compreender as relações em evolução entre o ecossistema do conhecimento e as opiniões e pontos de vista públicos/cidadãos sobre ele. A comunicação científica, um aspecto chave, consiste num fluxo de informação dos profissionais da ciência, investigação e inovação para a sociedade civil, contribuindo para moldar as suas conceções/opiniões. No âmbito de uma atividade de divulgação entre cientistas e centros educacionais do ensino secundário, analisamos o efeito da comunicação científica como metodologia didática. Hipotetizamos qual seria o efeito da pandemia na perceção da ciência dos estudantes. Para estudá-la, utilizamos uma metodologia quantitativa longitudinal por grupos e avaliamos as mudanças na perceção da ciência através de um inquérito de opinião recolhido em dois momentos temporais: pré-pandemia e pós-pandemia. Os resultados demonstraram que a COVID-19 influenciou positivamente o interesse pela ciência. Curiosamente, os estudantes perderam confiança na integridade científica devido à falta de transparência nas notícias científicas nos inquéritos pós-pandemia. Estes resultados sugerem a necessidade de acesso a informações claras e cientificamente validadas para aumentar a perceção social positiva deste estrato da sociedade.
Palavras-chave: Comunicação científica; Percepção da Ciência; Educação Secundária; Ciência, cultura e sociedade; Pré e pós-pandemia de COVID-19.

Resumen: La percepción social de la ciencia es un concepto multifacético que ayuda a comprender las relaciones cambiantes entre el ecosistema del conocimiento y las opiniones y puntos de vista públicos/ciudadanos sobre él. La comunicación científica, aspecto clave de la misma, constituye un flujo de información desde profesionales de la ciencia, investigación e innovación hacia la sociedad civil y contribuye a moldear sus concepciones/opiniones. Enmarcado en una actividad divulgativa entre científicos y centros educativos de secundaria, analizamos el efecto de la comunicación científica como metodología didáctica. Hipotetizamos cuál sería el efecto de la pandemia en la percepción de la ciencia de estudiantes. Para estudiarla, usamos una metodología cuantitativa longitudinal por grupos y evaluamos los cambios en la percepción de la ciencia a través de una encuesta de opinión recogida en dos puntos temporales: pre-pandemia y post-pandemia. Los resultados mostraron que el COVID-19 ha influido positivamente en su interés por la ciencia. Curiosamente, los estudiantes perdieron confianza en la integridad científica debido a la falta de transparencia de las noticias científicas en las encuestas post-pandemia. Estos resultados sugieren la necesidad de contar con acceso a información clara y científicamente validada para aumentar la percepción social positiva de este estrato de la sociedad.
Palabras claves: Comunicación científica; Percepción de la Ciencia; Educación Secundaria; Ciencia, cultura y sociedad; Pre y post pandemia de COVID-19.

How to cite this article? Dorca-Fornell, C., Nieto-Márquez, N.L., Gómez-Sebastián, S & Josa-Prado, F. (2023). Pre and post-pandemic perception of science: a case study upon scientific communication in secondary education didactics .*Hachetetepé. Revista científica en Educación y Comunicación*, (28), 1-16 https://doi.org/10.25267/Hachetetepe.2023.i27.2205

1. INTRODUCTION: Theoretical and sociocultural framework

In recent years, it has become clear that society is a key element in the knowledge ecosystem. The role that society plays and its perception of science, research, and innovation are two great challenges in that ecosystem. In fact, the public as civil society has been considered one of the elements in the multiple helix science and innovation framework, which highlights that the knowledge ecosystem is not complete without the society (Galvao et al., 2019; Peris-Ortiz et al., 2016). To account for this, the European Commission has a dedicated and ever-increasing budget (462 million euros for Horizon 2020) for the "Science with and for Society" programme, which funds projects in several areas, including 'Science Communication', 'Open Access', 'Science Education 'or 'Citizen Science and Citizen Engagement' amongst others (European Commission Directorate-General for Research & Innovation et al., 2020). Thus, efforts into involving society within the knowledge ecosystem are being actively sought and promoted. In fact, scientific communication is one of the key resources to modify social perception of science, and although it is a fairly popular activity today, its beginnings go back quite a long way in history. One of the first best-known works in the field of scientific popularisation is the work entitled "The Dialogue Concerning the Two Chief World Systems" by Galileo Galilei, (1632) (de Semir, 2016). Currently, scientific communication can be considered a scientific field which, in synergy with new information and communication technologies (ICT), has given rise to multiple methods of expression (Villanueva Baselga et al., 2020; Vizcaíno-Verdú et al., 2020; Warwick et al., 2020).

Science communication and education are closely related, since the transmission of knowledge and the dissemination of results are fundamental for the advancement of science and the formation of critical and aware citizens. The current spanish law on education establishes the organisation and minimum teachings of Compulsory Secondary Education (ESO for spanish translation) and includes the transmission of scientific culture as part of the teaching program. Scientific culture acquisition brings students closer to scientific advances, their contributions to progress and their difficulties. In this way, it is defined that the acquisition of scientific culture implies including science in daily life through the scientific literacy of students. Moreover, the acquisition of scientific culture will encourage critical thinking about the information they receive from different sources, and thereby impact society's perception of science (Díaz & García, 2011).

In particular, the curriculum for compulsory secondary education in Andalusia (Spain), where this study was carried out, is established by the regional legislation "Orden del 15 de Enero de 2021" [Spanish Order of 15th of January of 2021] and, relevantly for this work, these laws point out the need to achieve learning and knowledge standards that encourage scientific culture in society.

The current teaching programs that aim for the acquisition of scientific culture are based, on one hand, on the acquisition of the scientific knowledge which is worked with the students in subjects at these educational levels, and on the other hand on the scientific competences, which focus on the development of the skills and abilities to step forward and use such scientific knowledge for the resolution of problems in daily life. To that aim, the learning of science and the acquisition of a scientific culture can be approached in the classroom with various didactic methodologies. Some examples that are currently being applied in teaching are: Project Based Learning (PBL), gamification, service learning or

e-ISSN:2172-7910
Doi: 10.25267/Hachetetepe.2023.i27.2205

the transmission of knowledge in master classes, among others (Hurlbut, 2018; Moreno-Guerrero et al., 2020; Parra-González et al., 2020). Within these didactic methodologies, we can find scientific communication for student learning (Villanueva Baselga et al., 2020; Warwick et al., 2020) as, for example, television channels dedicated exclusively to scientific communication, such as the Discovery Channel or the National Geographic Channel, which have given rise to scientific journalism; journals based on popular science; as well as popular science blogs, YouTube channels, Facebook, Instagram or Twitter pages, which are even being used to promote the scientific work of research centres (Sánchez Fundora & Roque García, 2011).

Scientific communication talks are turning out to be a revolution in this field and have even led to the appearance of humorous monologues as a method of communication. Examples of this phenomenon are the international outreach festival Pint of Science (https://pintofscience.com/) or the group known as Big Van Science (www.bigvanciencia.com). Universities are also trying to promote scientific communication through talks in programs entitled "Science in the bar", where they try to transmit scientific culture in a casual and accessible way (Martinez Mendoza & Nieto Navarro, 2013).

However, scientific communication is not a simple process, specific skills are required for the transmission of this scientific knowledge. In order to perform good scientific communication, the development of communication skills is required, as well as skills to explain, teach or facilitate the understanding of ideas and perspectives to the different profiles that can be found in the population. (Dahlstrom et al., 2022; Davis & D'Lima, 2020; Ross-Hellauer et al., 2020). An example of the challenges posed by this scientific communication or communication to the population is the case experienced with the COVID-19 pandemic, where scientists cope with the task of providing scientific advances information to the wide audience in a very short period of time, with a lack of scientific edu-communicative skills training in social media (Iyengar & Massey, 2019; Navarro Zamora, 2021). Indeed, it is reasonable to deduce that society has received miscommunications or misinformation about scientific knowledge and concepts when being informed about COVID-19 events. This has resulted in a substantial part of the population questioning scientific information and its importance (Bridgman et al., 2020).

Focusing on the topic of social perception of science in the spanish context, the most relevant investigations are the survey studies on the social perception of science by the Spanish Foundation for Science and Technology (FECYT, 2021). Their last report of 2020, will serve us to contrast our results but also to contextualise our study in teenage students into the broader scope of general society. In fact, according to this report, there is an increasing interest in science and technology in Spain as the communication activity has expanded from 2004 to 2018, especially in the age ranges of people from 15 years to 24 years old, which includes the age range of our study (FECYT, 2019). However, the interest slightly decreased from 16.3% to 14.2% in 2020, being still in the range of other topics of great relevance, such as education and the economy, with around 15% and 16% respectively (FECYT, 2021).

This work is based on a scientific communication program designed and run by the Científicos Retornados a España, CRE [Scientist Returned to Spain] society. This program, called CREdivulga Institutos, has been running since 2014 (https://cre.org.es/), and in particular, this study uses the data running from 2018-2020 gathered at three specific educational centres, selected for being comparable between them (in terms of

socio-economic and educational parametres). The purpose of this program is to bring science and scientists closer to students in the last stages of secondary education and professional training. Similarly, this program aims to contribute to improving social awareness of science in society. Many students do not find real models in their environment that help them understand what the day-to-day life of a scientist is like and what it means to "be a scientist" (Botella et al.; Verdugo-Castro et al., 2022). This activity is intended to contribute to the popularisation of science, develop a better understanding of the figure of science professionals and their value to society, as well as promote a more deeply rooted scientific culture, these being basic objectives of CRE.

1.1. Theoretical and educational context of scientific communication as a didactic resource

In the context of educational psychology for learning, the talks and scientific communication of this program have their educational focus on social and cultural learning models (Palincsar, 1998). Among the perspectives of social constructivism, it is worth mentioning the relationship between thought and language for learning processes and cultural development (Vygotsky, 1978). Thus, both cultural context and social communications have an influence on education and are part of learning for students' future growth and development. From the experiences and interactions with the environment, culture and learning are consolidated, with language as an instrument to interpret individual experiences (Leontiev & Luria, 2005). Therefore, Vygotsky's Sociocultural Learning Theory contributes to the importance of language and communication in teaching and learning processes, as discussed by (Palincsar, 1998), (Soria & Giner Gomis, 2021) and (Lozada, 2022). Also, sociocultural theory establishes the relationship between learning and the cultural context that students experience in their daily lives (Verenikina, 2010). Another example of sociocultural learning is the relationship between scientific thinking and the cultural transmission of knowledge, as is reflected in the work performed by (Shaikh, 2011).

In this sociocultural frame, several agents contributing to learning processes can be identified. These can fall, although not exclusively in the category of "more knowledgeable others" (MKOs). Teachers and family, especially, but also other students within the same environment can act as MKOs. More recently, digital resources have been added as sources for supporting learning (Baig et al., 2021; García-Morales et al., 2021).

However, the contribution of another type of agent, external scientists and researchers brought in direct contact with students and teachers at schools and high schools, is still poorly understood. The theory of alternative conceptions in science (Taber, 2009, 2011) will serve us as a framework for this work too, since the constructivist perspective to science education (Matthews, 1998), with its limitations and virtues, intersect, at least partially, with the sociocultural perspective on "the development of scientific concepts in childhood" proposed by Vygotsky (Rieber & Carton, 1987). The sociocultural value provided to the learning (and teaching) of science, through the knowledge transfer that occurs by the interaction of the students and teachers with these highly-trained, highly-knowledgeable individuals, could reside in how these interactions modulate the construction of concepts related to science and research. We identify at least five conceptual landscapes that can be regulated through these interactions: i) the curriculum-related landscape; ii) the scientific methodologies landscape; iii) the

landscape of the roles of science and researchers in society; iv) the landscape of the perceived identities of the researchers as possible role-models; and v) the professional-career orientation landscape.

In addition, these scientific activities (such as CRE talks and scientific communications), raised from the perspective of sociocultural theory, also contribute to the development of competencies or acquisition of skills for the 21st century by students (Sánchez Mejía et al., 2013). In this way, the importance of bringing students closer to the scientific context through different didactic programs such as scientific talks, is emphasised for their interaction and experimentation, as part of the learning process (Verenikina, 2010).

With the previous background, in order to explore the effect of science communication on the perception of science by secondary students, the present case study has two aims of research. First, the results of the scientific popularisation talks were analysed as a part of a didactic methodology with secondary school students, who were involved in scientific communication programmes. Second, the effect of the COVID-19 pandemic on scientific perception was studied by the comparison of a subsequent survey to adolescents. We found the phenomenon of COVID-19 pandemic has positively influenced the interest in science in society. However, in the post-pandemic survey, most of the students declared an increased tendency to a loss of confidence in scientists' integrity due to a lack of solid science-based news received, in terms of scientific advances and their communication and even declared the news had not a clear and informative language, indicating a lack of transparency of scientific news.

2.METHODOLOGY

This work includes data collected over two academic years (2018/2019 and 2019/2020). In the first academic year (2018/2019), total of 6 scientific communication talks were given to 6 classrooms corresponding to 3º y 4 º ESO courses (Compulsory Secondary Education), which took place at 3 secondary schools: IES La Atalaya, IES Los Molinos and IES Jesús, María and José, placed in Conil de la Frontera, (Cádiz, Spain), making a total of 2 talks per educational centre. The talk we used in this study was titled: *"What are GMOs and what are they for?"* Each talk lasted one hour and were given during the students' school hours, coordinated with the teachers of the classrooms where the activity took place. The total number of students who participated were 131, with an average age of 14-15 years. At the end of the talk, the students were provided with the survey Google Form to know their perception of science, evaluate the quality of the talk and its success according to the interest of the students.

After lockdown, in the academic year 2019/2020, the students' perspective was collected again with the survey, to analyse the effect of the pandemic on their responses. On this occasion, the survey was filled out by 250 students and it was passed in the same classes by the teachers with whom we worked in the 2018/2019 academic year, ensuring students are in the same range of ages within this study.

In order to respond to the research hypothesis, we carried out a study using a grouped-longitudinal quantitative methodology in three schools is proposed.

2.1.Instrument

The measurement instrument used is an opinion survey. The reliability of the survey was confirmed with a Chronbach's alpha of 0.853 was obtained.

For the collection of information and evaluation of scientific communication, the survey prepared for the CREdivulga Institutos program (https://cre.org.es/proyectos/proyectos-de-divulgacion/#cre-divulga-institutos) was used pre-pandemic and post-pandemic. This survey is made up of 7 questions with answers mainly of "*yes*" or "*no*" to know the state of polarity of the study sample in relation to the items of the questions. General questions of the survey are outlined in Table 1. In addition to those questions, after the school's closure by the COVID-19 lockdown, 6 more questions were included in the survey to explore the scientific opinion of the students after the scientific diffusion of the pandemic by the different audio-visual media, which are outlined in Table 2.

Table 1.
Survey questions.

QUESTIONS	ANSWERS (Number of Votes)		
1-Do you think there is a good perception of science in Spain?	Yes	No	
2- Do you think that science is important for our society?	Yes	No	
3-Do you think science is more important than football?	Yes	No	
4-Do you think there is enough scientifically-based information accessible to everyone?	Yes	No	
5-Do you trust the integrity and criteria of scientists?	Yes	No	
6-Do you think only very, very smart people can become a science researcher?	Yes	No	
7-Do you want to become a science researcher in the future?	Yes	No	I don't Know

Source:The authors (in the context of CREdivulga Institutos program https://cre.org.es/)

e-ISSN:2172-7910
Doi: 10.25267/Hachetetepe.2023.i27.2205
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Table 2.
Post- pandemic specific survey questions.

QUESTIONS	ANSWERS (Number of Votes)	
1- Do you think it would be impossible to solve the current COVID-19 problem without the researchers' help?	Yes	No
2- Do you think the information you received about the pandemic had a scientific basis?	Yes	No
3- Do you think the accessibility to scientific news has improved during the pandemic?	Yes	No
4-Do you think the news about the pandemic had a clear and informative language?	Yes	No

Source: The authors

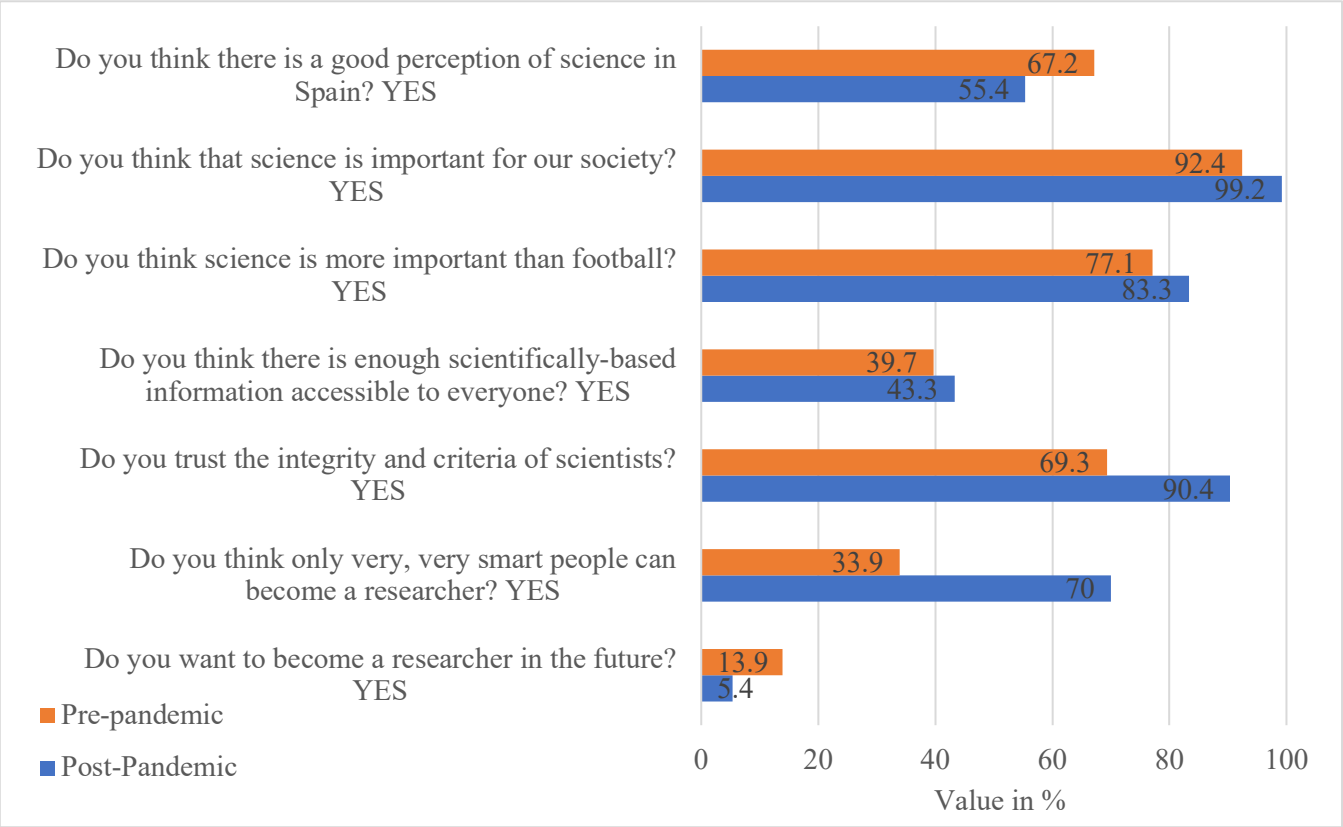
2.2.Data Analysis

The survey data have been analysed using Excel XLSX software and Chronbach's alpha was calculated with JASP 0.18.1 software. The overall results between the 3 secondary education centres were scored together by considering the students have the same scientific knowledge since they belong to the same educational level. Percentages of the comparison between pre and post-pandemic results were calculated on the total student base (n=240 students pre and post-pandemic respectively).

3. RESULTS AND DISCUSSION

The present study was carried out based on a scientific communication program, which intended to roughly understand the perception of science among secondary school students to promote and raise awareness about the work of the scientist in society. Once the talks were given, the results obtained in the survey outlined in Table 1, were analysed. The survey was scored to the students again after COVID-19 lockdown. Figure 1 shows an overview of the comparison between pre and post-pandemic results.

Figure 1.
Comparative chart of the results of the pre-pandemic and post- pandemic surveys results (only YES displayed).



Source: The authors.

In relation to whether the individual students think that science is important for society, the answer was positive in 92.4% of the cases in the pre-pandemic surveys. Interestingly, this value rose to 99.2% in the post-pandemic surveys. These results suggest that there is an increasing interest in science at this educational level promoted by the pandemic phenomenon. This is in line with the findings of the FECYT report (2020), considered post-pandemic studies, which reveals an increasing interest in science and technology in Spain in the age range of 15-25 years old people. This data could be linked to the higher perceived importance of scientific research over football shown in our pre-pandemic surveys (77.1% positive responses), which was increased to 83.3% in post-pandemic surveys. The results are in agreement with the data obtained in the FECYT report (2020), where the 82% of the 15-25 years old people interviewed declare that the scientist profession is of high/enough value for society, and with an encouraging future for young people, although it is poorly paid and with little social recognition.

Regarding the confidence of the students in scientific integrity, the pre-pandemic results indicated that around three quarters of the students interviewed, (69.3%), trust the integrity and criteria of scientists. Moreover, this value increased to 90.4% in post-pandemic surveys. Although these parameters are in contrast with the students' opinion about the perception of science in Spain. The pre-pandemic results indicated that students think that there is a good perception of science in Spain, with 67.2% positive responses.

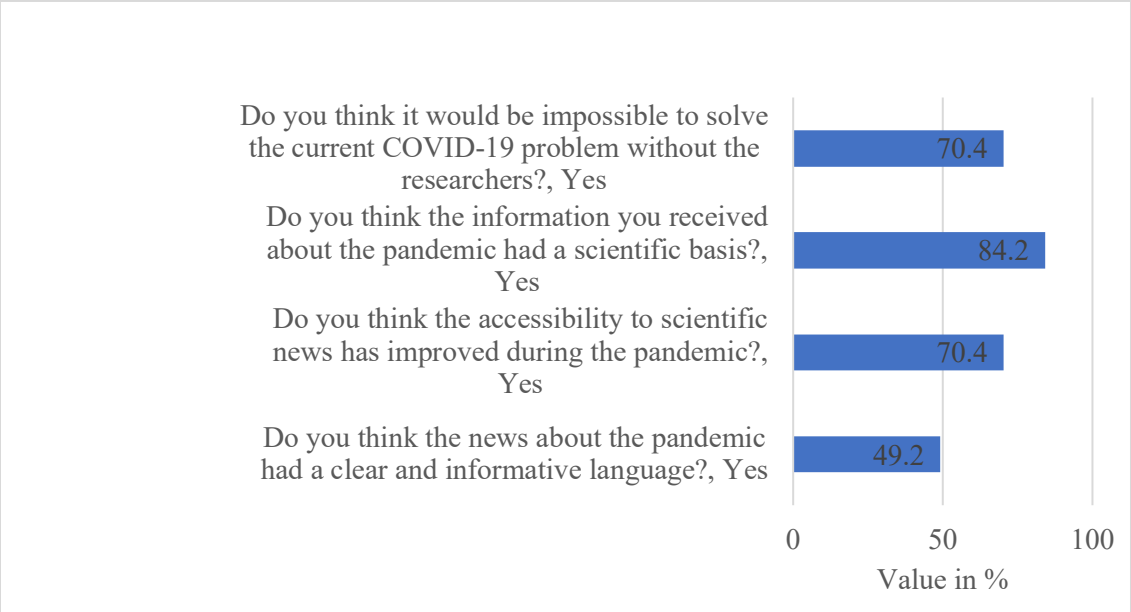
However, the post-pandemic results have been reduced, reaching a percentage of 55.4%. Post-pandemic results indicated that even though students declared science is very important to society, they thought that, in Spain, there is not a good perception of science in general.

The most interesting result to highlight in this study is the students' opinion about the accessibility and scientific basis of scientific news in the media. Students indicated there is not a good accessibility to science-based news in terms of scientific advances and their communication, with only 39.7% positive pre-pandemic responses. The results were slightly higher with 43.3% positive post-pandemic responses, but still more than half of the students declared a lack of accessibility to science-based news. These results reflect the confusion suffered by the students due to the massive and not very well-organised scientific news during the COVID-19 pandemic. This confusion, in turn, could be linked to the bad scientific perception in Spain the students declared and highlights their need to have access to clear and scientifically validated information (Bridgman et al., 2020; Iyengar & Massey, 2019).

Regarding the perspective of becoming researchers in the future, only 13.9% of those interviewed in pre-pandemic surveys are strongly determined to start a scientific career in contrast to 42.30% of the students who are convinced not to follow a scientific career. Nonetheless, it should be considered that around half of the students, 43.80% (data not shown) have not yet decided on any other career, presumably due to the age of the students. This result is even lower on the post-pandemic surveys in which only 5.4% of the students are determined to follow a scientific career with a clear negative response in 65% of students (data not shown) which definitely declared not to follow a scientific career in the future and 29.60% undecided students (data not shown). Even so, our results indicated there was no clear scientific vocation among the students interviewed. An important fact to highlight is that positive answers when asked if a very high intelligence level is needed to become a scientist increased from 33.9% in the pre-pandemic surveys, to nearly three quarter of the students (70%) in the post-pandemic ones. It is, thus, interesting to note that even though, after the pandemic, more students tended to think only very intelligent people have the chance to become a researcher, this trend align with the trend of the expectation to become a scientist, which as described above, suggesting students think that developing a career in science is a tough job that is only designed for very smart people.

In light of this, we were encouraged to dig deep into the specific opinion of the students about the scientific labour implication on the pandemic by scoring the questions on Table 2, the results of which are shown in figure 2.

Figure 2.
Results of the post-pandemic specific survey. Values represent the percentage of students selecting that option over the total of students surveyed.



Source: The authors.

Regarding the perception about scientist's essential involvement in helping to solve the pandemic scenario, 70.4% of students stated that scientific work was necessary to tackle the pandemic. This result is in line with the high percentage of the students who trust in the scientific integrity of the scientists stated above. It is worthwhile to note that, however, students declared a bad perception of science in Spain in general, they declared to rely on the scientific work. Thus, this may reflect a positive influence of the scientific communication talks on the student's opinion. In addition, it may suggest a positive influence of the communication talks on the teachers, which in turn is transmitted to the students in the classrooms.

In relation to the scientific information received during the pandemic, 84.2% of the students declared that they received scientific basic information. Although 70.4% of them agreed that the accessibility to scientific news had improved during the pandemic, 49.2% pointed out that the news about the pandemic had not a clear and informative language. In addition, previous works of Iyengar and Massey, (2019) and Bridgman, (2020) showed how the misinformation regarding COVID-19 news in social media has impaired public opinion and perception about science. It is important to remark that social media networks were the most used media to obtain information about COVID-19 news for 15-25 years old people in 2020 (FECYT, 2020). From the sociocultural perspective proposed by Vygotsky (1978), it can be challenging to follow scientific processes or the language used in scientific communications (e.g. (Lozada, 2022; Rieber & Carton, 1987; Soria & Giner Gomis, 2021)). Thus, language is a barrier to accessibility and transmission of scientific knowledge relevant at this point. Although there is greater accessibility to scientific news, it has not improved much due to the lack of a clear language in the transmission of knowledge. Similarly, this may also reinforce sociocultural beliefs such as the notion that it is necessary to be highly intelligent to become a scientist. This

phenomenon could align with the fact that students found that being a scientist is a very hard and difficult job. Moreover, according to FECYT surveys, (2020) 46.3% of the 15-25 years old people interviewed declare that science is so specialised that they cannot understand it. And, indeed the above-mentioned post-pandemic survey (Figure 1) showed that 70% of students positively answered the question about the high level of intelligence needed to become a researcher.

To demystify the scientific profession on this stratum of society educational programs count on several scientific approaches. Scientific communication activities, such as the one brought forward in this study or other didactic activities (as proposed by (Lozada, 2022; Rieber & Carton, 1987; Soria & Giner Gomis, 2021)), combine different disciplines of knowledge and contribute to the sociocultural inputs for the students' learning process and the teachers' continuous training. In addition, these activities further improve the processes of knowledge building in science from a social constructivism perspective (as also shown by Sánchez Mejía et al*.,* 2013), as well as positively fostering the cultural perception of science.

4.CONCLUSIONS

According to the results obtained, we can conclude that secondary school students thought that the positive perception of science in Spain has dropped during the pandemic situation by about 12% related to the pre-pandemic surveys. Interestingly, they thought that science is more important for society after the pandemic than before and, on top of that, around 70% of the students in the post-pandemic survey expressed that without the researchers the pandemic could not be resolved. In addition, the confidence in the integrity of the scientists increased upon the pandemic crisis. However, according to the latest FECYT 2022 (FECYT, 2023), the confidence in scientists has dropped again in this age range in 2022 in comparison to the results obtained in the FECYT report 2020, maybe because the need for immediacy in solving a problem of utmost importance has been lost.

Following our results, we can also conclude the pandemic phenomenon has highlighted the social need to have access to news with a solid scientific basis, as well as the need to understand the scientific advances that shape day-to-day life at the level of secondary education in Andalusia (Spain). Although the students declared the accessibility of the scientific news had improved upon the COVID-19 phenomenon, they declared a lack of the clarity of the scientific information. This fact has negatively influenced the scientific vocation, since we observed through our data that, remarkably, the desire to become a scientist has followed a downward trend. We can conclude students though the scientific career is a long and difficult way and only smart people can become a scientist.

Based on these results, we hypothesise the need to face the challenge of continuing to bring science closer to society through scientific outreach projects of any kind, which in turn will allow scientists to improve their communication skills through scientific communication training and event participation, and will pave the way for deeper inter-communication between science and society. In addition, the social perception of science would be further positively enhanced, taking in account that the five conceptual landscapes of science-education interaction proposed in the introduction of this article, would constitute a mechanism of perception modification in line with the constructivist theory of alternative conceptions. This conclusion is supported by a separate set of open questions that were asked to the educational institutions hosting our outreach activities

and surveys, where they expressed the need and positive outcomes, both for students and teachers, of getting scientists, researchers, and school communities in direct interaction. This assessment emphasises the importance of further exploring scientific communication (as part of the didactic methodology in secondary schools) which connects with Vygotsky's (1978) Sociocultural Learning Theory in achieving learning and knowledge standards that favour the improvement of scientific culture in society (Botella et al., 2020; Davis & D'Lima, 2020).

This case report, although limited, serves as a starting point to study whether the science communication activities directly brought to educational institutions represent a positive change of perception towards science in general and towards researchers in particular. Undoubtedly, continuous improvement in the design and scale of these activities throughout spanish geography will enrich the weight and reliability of this research avenue.

AUTHORS' CONTRIBUTION: Carmen Dorca-Fornell **(**Conceptualisation, Investigation, Resources, Data Curation, Writing - Original Draft), Natalia Lara Nieto-Márquez (Methodology, Writing - Original Draft, Project Management), Silvia Gómez-Sebastián (Conceptualisation, Methodology, Formal analysis, Data Curation, Project Management, Writing - Review & Editing) and Fernando Josa Prado (Conceptualisation, Methodology, Formal Analysis, Visualisation, Project Management Supervision).

FUNDING: This investigation did not receive any external funding.

ACKNOWLEDGEMENTS: The authors would like to thank Martín Carretero Sánchez and Carmen Cabrera Roldán at IES Los Molinos, David Sánchez Sánchez and Luis Francisco Gil Corral at IES La Atalaya and Daniel Torrejón Galván at IES Jesús, María y José for their invitation to their classrooms, and to Beatriz Pedrosa Vico (Universidad de Granada, Spain) for revising the manuscript.

*The authors have informed the participants of the research and they have given their consent to participate in it.

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