Deliverable No. D4.2

Report on social media responses to science performances

Project acronym:
PERFORM

Project Title:
Participatory Engagement with Scientific and Technological Research through Performance

Grant Agreement No: **665826**
This deliverable is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme

Start date of the project:
1st November 2015

Due date of deliverable: 30/09/2018
Submission date: 28/09/2018
File Name: D4.2 Report on social media responses to science performances
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SUMMARY

As a part of the impact assessment work package in the PERFORM project, this report was originally designed to investigate the social media-related dimensions of young people's reception of PERFORM project activities. The report is divided into two parts. First, an analysis is presented based on data gathered by an automated scraping tool designed to harvest tweets related to the different PERFORM activities (drawing on tweets associated with the PERFORM project feeds and hashtags). Second, the report describes the context, methods and findings from an in-depth qualitative study of the social media practices of young people who participated in the PERFORM project, and the implications for science education.

The research finds that the young people participating in the project activities were reluctant to share their PERFORM project experiences on social media, due to implicit norms for young people disallowing sharing of school-related content in the non-school, peer-to-peer social sphere of social media. While in this case, the PERFORM activities that students were reluctant to share about on social media took place during school time, their rationale for not sharing have much broader implications for science education- both performance-based and conventional approaches, given the primacy of social media in the lives of young people across Europe. The report highlights the social construction of 'share-worthiness' via social media as a key future research area that needs further exploration by science education researchers. It recommends a co-constructive, participatory process similar to the PERFORM research project to develop an understanding of how to build 'share-worthy' science content.

1. INTRODUCTION

PERFORM is a European Commission-funded project focusing on the development of innovative science communication tools and methods in the performing arts, with the aim of engaging young people with Science, Technology, Engineering, and Mathematics (STEM) academically and professionally by encouraging young people to build their own understanding of science's role in society. In the UK, France and Spain, the project tested the potential of performing arts as a means of engaging young people with science and responsible research and innovation. The aim was to help young people build their critical thinking and other skills.

One part of the impact evaluation work package for PERFORM was an exploration of the role of social media in young people's reception of the participatory performance processes they were involved in. The result of this exploration comprises the present deliverable.

This deliverable includes two main parts: First, it provides the results gathered by an automated tool designed to harvest tweets from a broad range of actors, including project partners and project followers on social media, related to the different PERFORM activities for processing. Second, the report presents findings from an in-depth qualitative study conducted with young people who participated in the PERFORM project.

Context: Adjustments to original plans

This automated Twitter content analysis tool was originally intended to focus on the content of students' responses to the project (specifically to activities taking place in Task 2.1) on Twitter. To this end, the UoW developed a social media analysis tool which was calibrated to automatically gather and analyse discourse about PERFORM-related tweets. The tool analysed social media data as they come in, producing analytics in real time. The tool exceeded the original vision in the grant application by accommodating non-English languages involved in the project.

The tool gathered tweets related to the different PERFORM activities by scraping from the Twitter project feeds for processing. The tool handled data in Spanish, English and other languages, with the help of a Google Translate filter that operated automatically.

However, the University of Warwick team leading this deliverable faced key challenges in accessing the expected student comments on social media data, especially in the UK and France cases due to difficulties reported by project partners with schools' regulations on the use of social media by students. Therefore, this tool focused on the overall project level in terms of data collection to still be a useful data analytic tool despite its original intended purpose no longer being feasible.

The original plan to conduct an online ethnography was not feasible because of this lack of student comments about the 2.1 activities appearing on Twitter. This risk was anticipated in the grant application, and the alternative approach that was outlined in the original proposal was implemented (the results can be seen in the second part of this report):

If students do not participate in Twitter, UoW will conduct qualitative interviews for assessment purposes by using skype and telephone in order to minimize cost.

This alternative research approach was implemented, shedding light on why there had been limited visible social media engagement by participants (especially on Twitter) relating to Task 2.1 activities.

2. Analysis of PERFORM project-related tweets

Figure 1: Screenshot from the analytic tool developed for the project to gather and analyse project-related tweets

The first section of this deliverable presents key information gathered using an automated scraping tool focusing on the Twitter content posted during the PERFORM project by a broad range of actors, including project partners and project followers on social media. These automated analytics are necessarily limited in depth (Jensen 2017), but nevertheless they offer an overall picture of the social media communications associated with the project. Unfortunately, for the reasons identified in the introduction, this part of the deliverable ended up needing to focus on the project communications overall, rather than students' online reception patterns.

2.1 Methods

A social media analysis tool was developed and calibrated to automatically gather and analyse discourse about science performances. The tool gathered tweets related to the different PERFORM activities from Twitter for processing. The tool analysed responses as they came in, producing analytics in real time. The tool is able to handle data in Spanish, English and other languages, with the help of a Google Translate filter that operates automatically.

The scraping tool focused on the official @performstem accounts of Twitter and the #performstem hashtag. Twitter scraping started in September 2016 (gathering data as far back as 23 May 2016) and continued through 6 September 2018 (n = 775).

The majority of the tweets were automatically identified as English, with Spanish as the next most prevalent. Other languages (viz., French) had sample sizes of tweets that were too small to use in the present analysis.

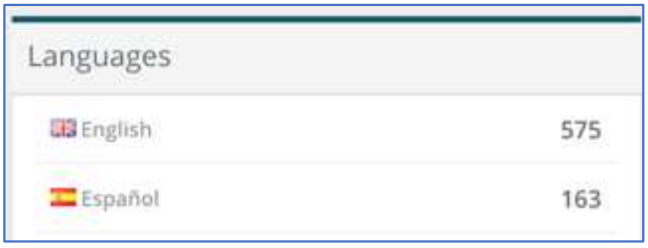


Figure 2: Screenshot from automated analytic tool showing languages most represented in project Twitter feeds and hashtags

2.2 Results

2.2.1 Hashtag analysis and tweet content

Hashtags are search terms or keywords that can be developed by anyone and used in tweets. The most frequently used hashtags are as follows:

Hashtags	Count
performstem[1]	200
PERFORMConference	64
RRI	36
EUSEA18	26
STEM	15
HEIRRIconf	10
Scientix	10
science	8
PERFORMconference	8
PCST2018	8
EUOpenDay	8
scicomm	7
H2020	7
PERFORMproject	7
PERFORM	6
education	6
STEMeducation	6
RRIinAction	5
responsibility	5
researchers	5
UNESCO	5

[1] This was the main project hashtag.

citizenscience	4
responsible	4
Education	4
Workshop	4
Science	4
teachers	4
Gender	4
stereotypesinscience	4
STEMDiscoveryWeek	4
ESOF2018	4
Participatory	4

The most frequently mentioned content in the tweets can be seen in the word cloud below:

To provide further detail about the nature of the Twitter content, more specific categories and details are summarized below.

Many of these tweets were sent by the project. This included tweets directly from the project account:

There were also tweets from project partners, for example, the following tweet:

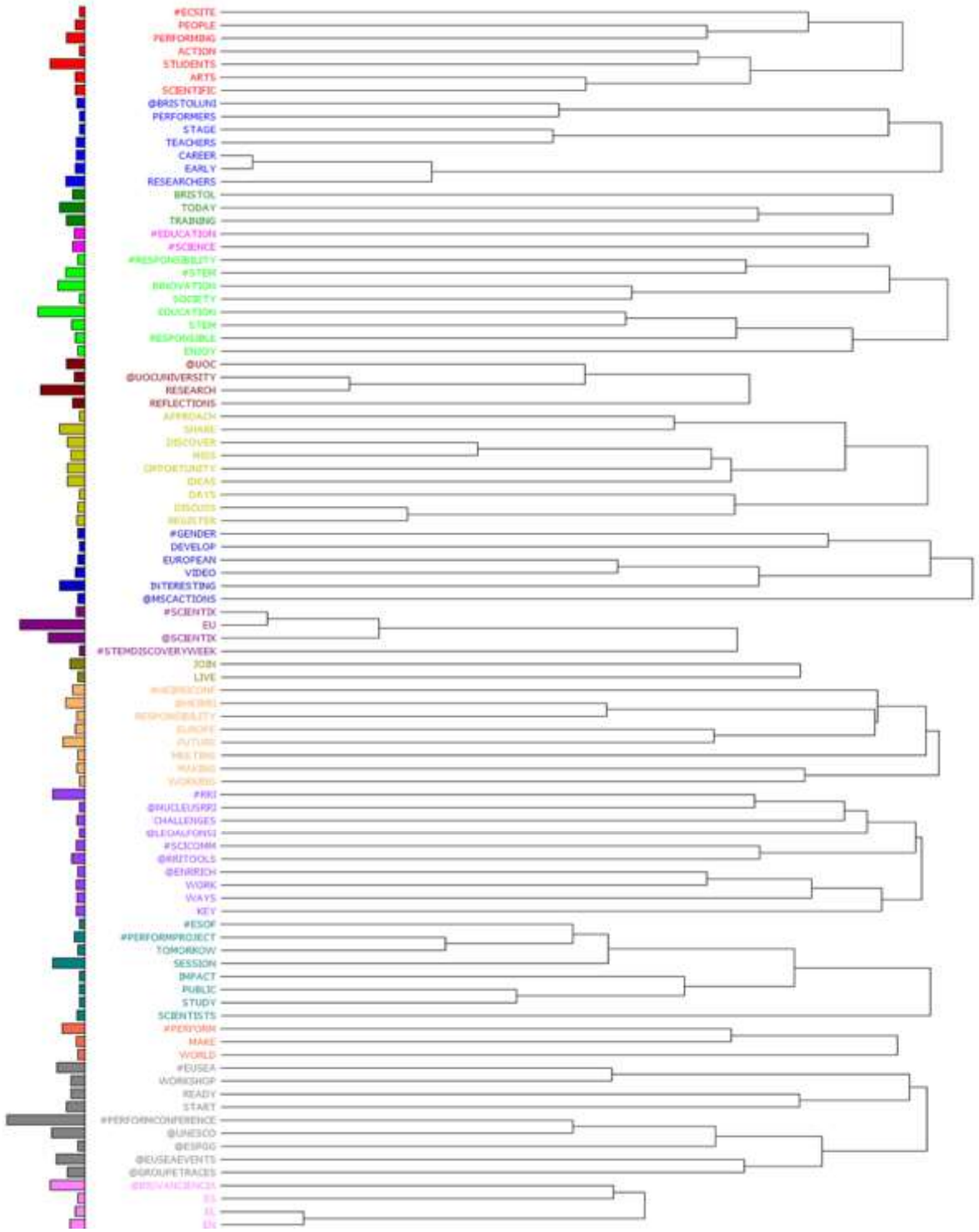
Others were sent by organisations participating in the project or learning from the project, for example, as conference participants.

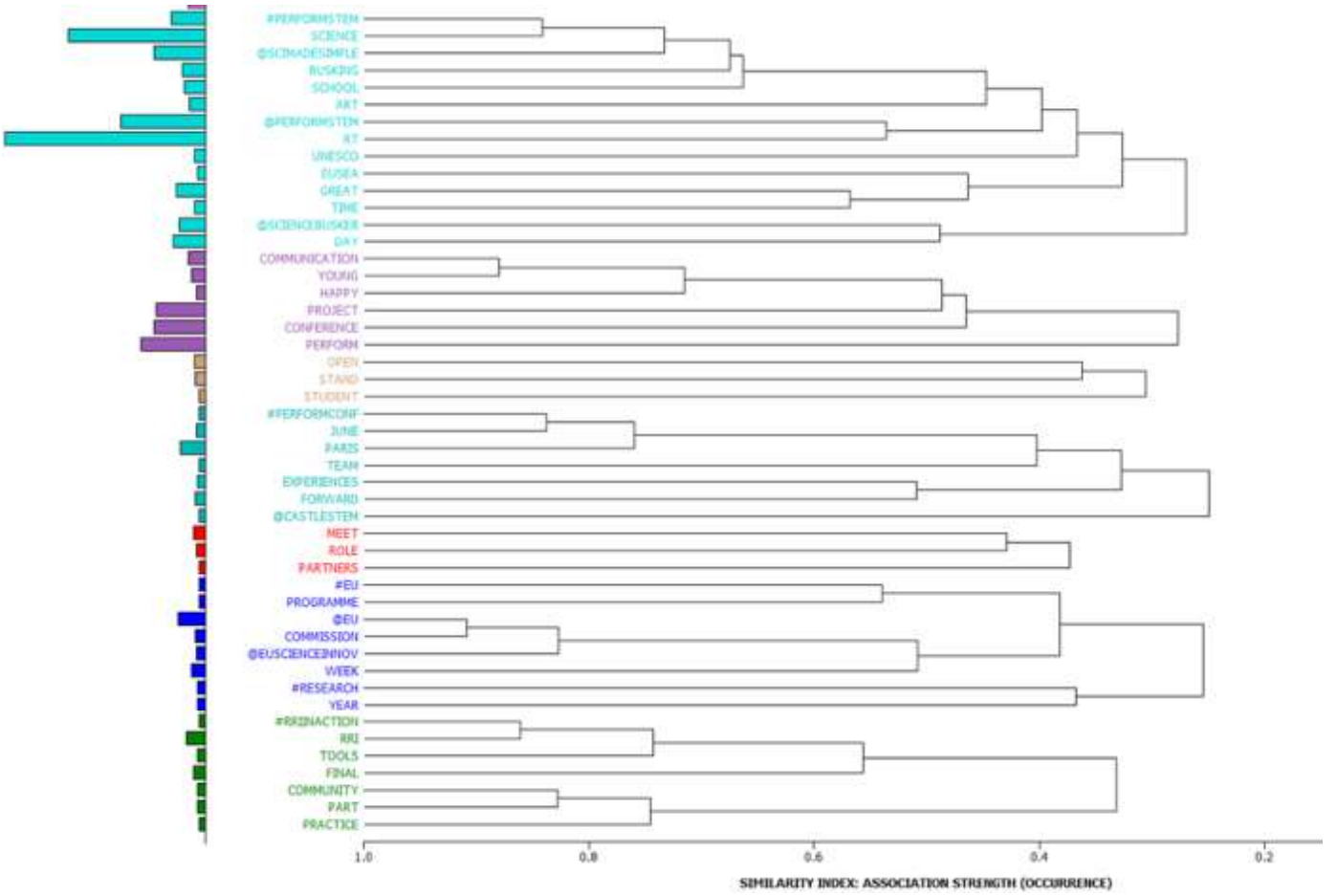
The other major category of tweets was questions from young people participating in activities led by the Big Van Theory (one of the project partners, based in Spain). The Big Van Theory performers explicitly elicit questions from young people when engaging with audiences. This kind of elicited open response can be seen in the following example:

The tweet above says, ‘How do you imagine science in 2040?’, a question relevant to the theme of responsible research and innovation that the PERFORM project engaged with through participatory processes with young people. However, there was no evidence of follow up and dialogue between the young people sending such open questions with the PERFORM project hashtag.

2.2.2 Cluster analysis and linguistic network analysis of Twitter data

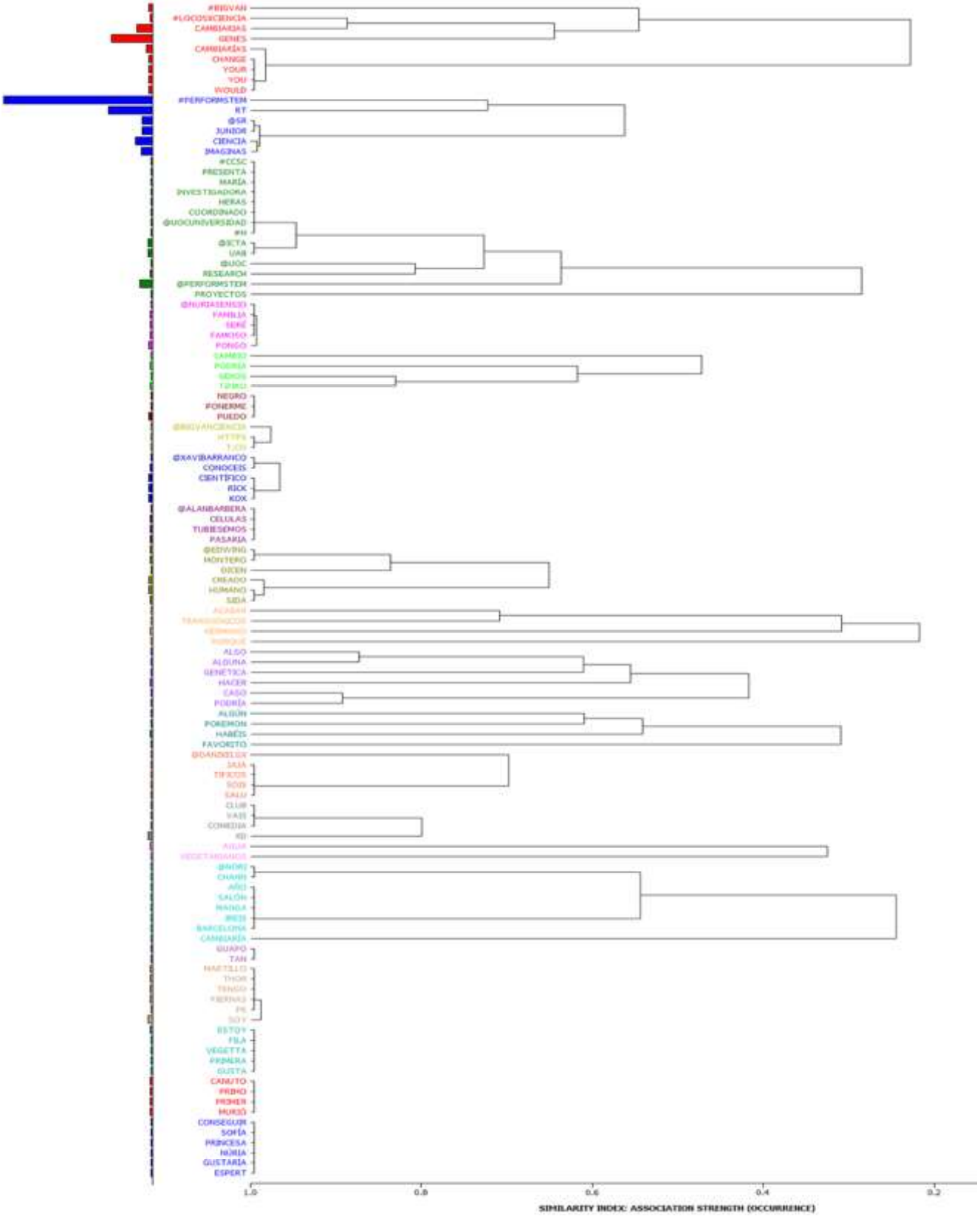
Cluster analysis provides shows connections between Twitter data based on co-occurrence. This analysis applied to PERFORM project feeds and hashtags is separated by language, starting with English.





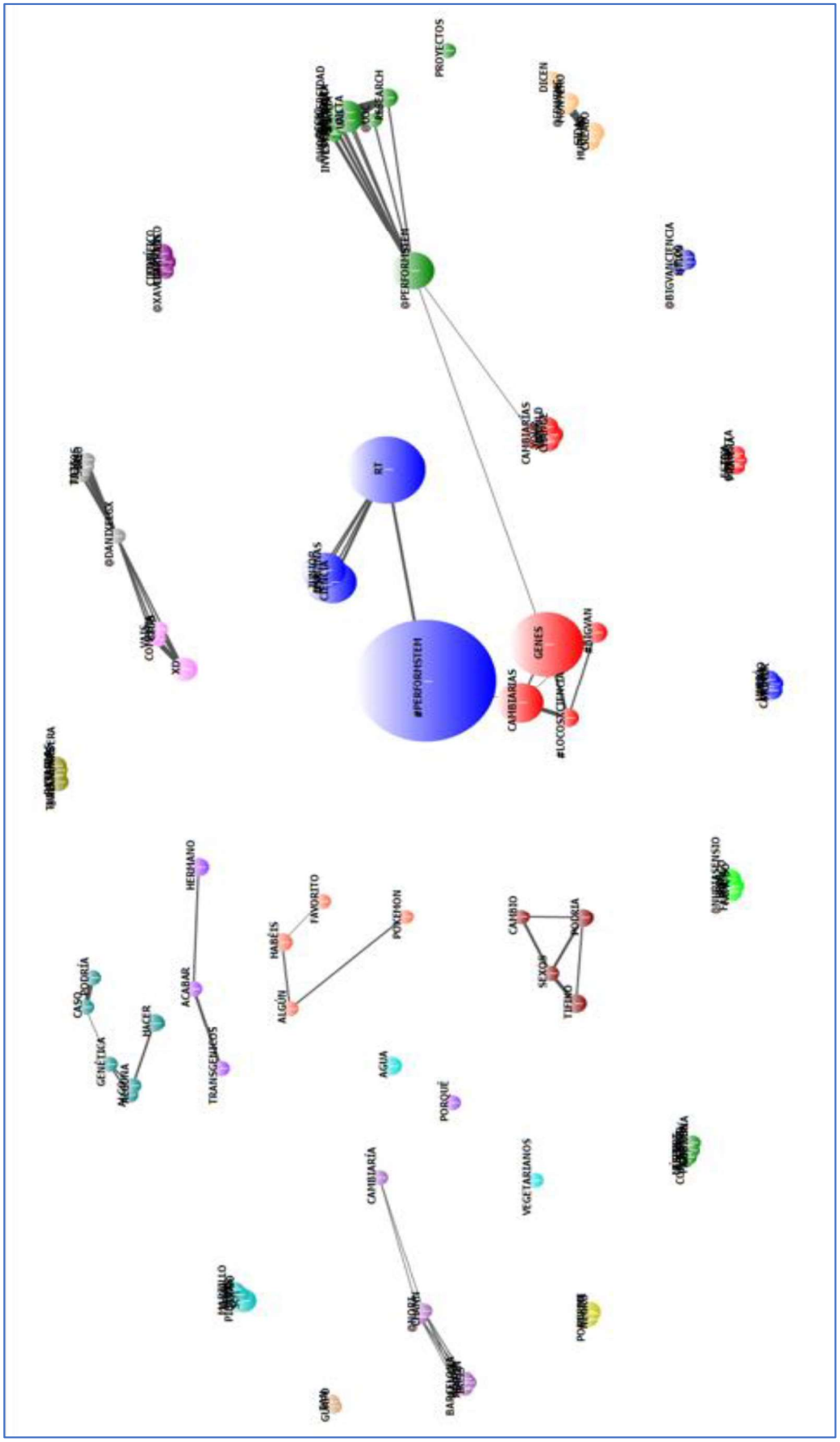
This extensive dendrogram above shows cooccurrence throughout the English language Twitter content coming from the PERFORM project feeds and hashtags. A further unpacking of these cooccurrence results is beyond the scope of this part of the deliverable (this kind of analysis requires full scale contextualization to make it fully useful). However, it indicates the potential in this exploratory development and application of an automated tool for processing Twitter data.

The Spanish language cluster analysis is represented below in a separate dendrogram.

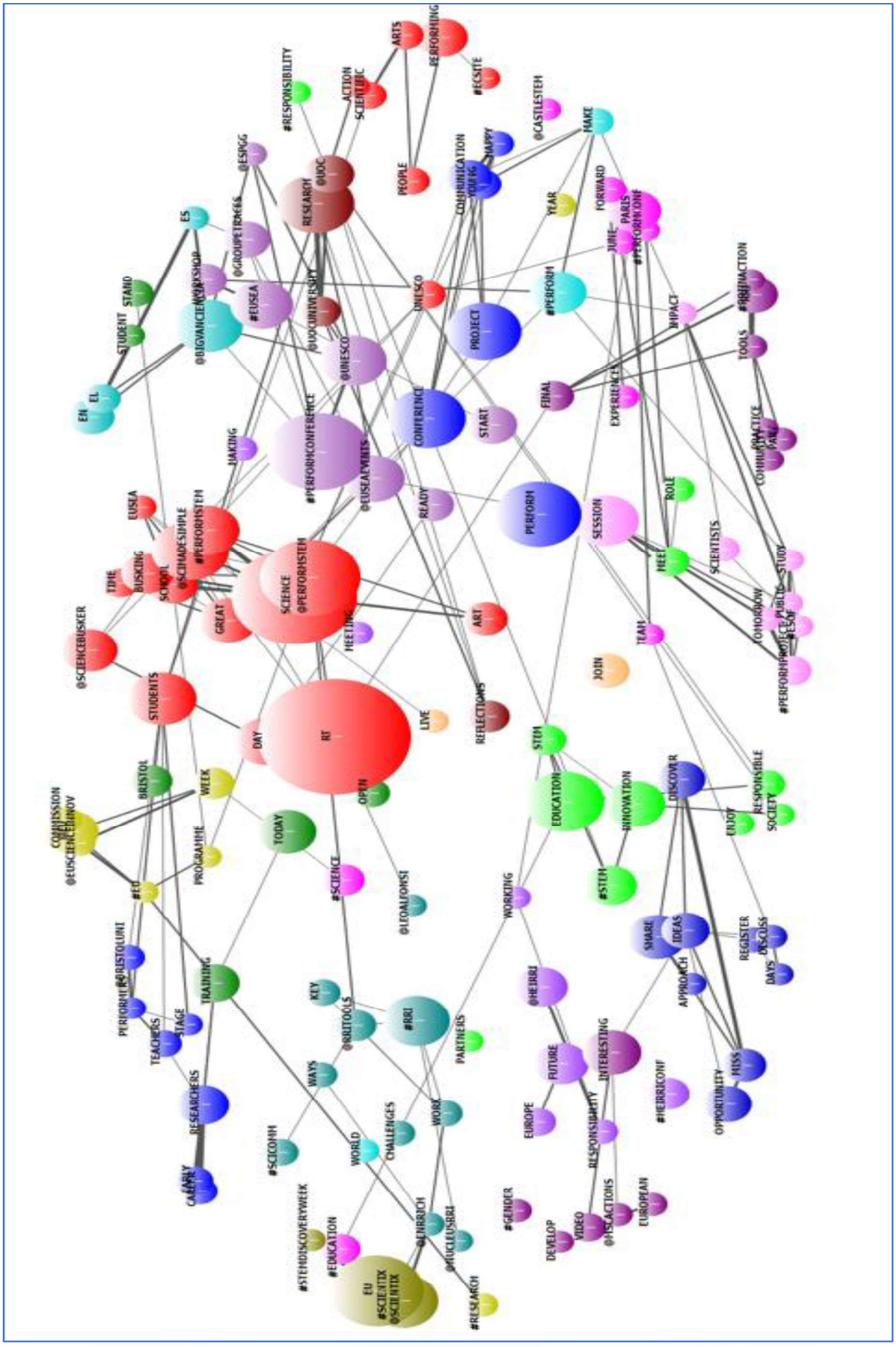


Finally, a more in-depth linguistic network analysis of the content connected to the PERFORM project feeds and hashtags was conducted separately for the Spanish and English language data.

On the following page is a 2D representation of the Spanish language linguistic network analysis.


PROYECTOS
DICEN
@PERFORMSTEM
@BIGVARCIENCIA
CAMBIARÍAS
RT
#PERFORMSTEM
GENES
CAMBIARÍAS
#LOCOSXLACIENCIA
@BIGVAN
XD
HERMANO
FAVORITO
HABÉIS
PONZHON
ALGÚN
CAMBIO
SEXOS
TIEMPO
CASO
GENÉTICA
HACER
ACABAR
TRANSGÉNICOS
AGUA
PORQUÉ
CAMBIARÍA
VEGETARIANOS

On the following page is a 2D representation of the English language linguistic network analysis for content associated with PERFORM project social media feeds and hashtags.


#RESPONSIBILITY
ACTION
SCIENTIFIC
ARTS
PERFORMING
#ECSITE
@CASTLESTEH
MAKE
@ESPGG
RESEARCH
@UOC
PEOPLE
COMMUNICATION
TOOLING
HAPPY
YEAR
FORWARD
PARIS
#PERFORMYONF
JURIE
ES
STAND
STUDENT
@GROUPETERRES
@DJOVARICIEWORKSHOP
#EUSEA
@UOCUNIVERSITY
@UNESCO
UNESCO
PROJECT
#PERFORM
#IMPACT
#INTERACTION
TOOLS
EN
EL
#PERFORMCONFERENCE
CONFERENCE
START
FINAL
EXPERIENCES
JIAKING
@EUSEAPARTNERS
READY
EUSEA
#PERFORMSTEM
@SCIMADESIMPLE
PERFORM
SESSION
ROLE
TIME
BUSKING
SCHOOL
SCIENCE
@PERFORMSTEM
SCIENTISTS
HEEF
GREAT
MEETING
ART
@SCIENCEBUSKER
TEAM
JOIN
STUDENTS
DAY
RT
LIVE
REFLECTIONS
STEM
BRISTOL
WEEK
OPEN
EDUCATION
INNOVATION
DISCOVER
RESPONSIBLE
SOCIETY
ENJOY
COMMISSION
@EUSCIENCEINNOV
TODAY
PROGRAMME
#EU
#SCIENCE
@LEOALFONSI
#STEH
WORKING
SHARE
IDEAS
REGISTER
DISCUSS
DAYS
APPROACH
TRAINING
KEY
@RRITOOLS
#RRI
@HEIRRI
PARTNERS
PERFORM
BRISTOLUNI
TEACHERS
STAGE
RESEARCHERS
WAYS
FUTURE
INTERESTING
MESS
OPPORTUNITY
#HEIRRICONF
EUROPE
RESPONSIBILITY
#SCICOMM
WORLD
CHALLENGES
WORK
#GENDER
DEVELOP
VIDEO
@HSCACTIONS
EUROPEAN
#STEMDISCOVERYWEEK
EDUCATION
@ENRRICH
@NUCLEUSRRI
EU
#SCIENTIX
@SCIENTIX
#RESEARCH

Ultimately, these analyses show a wide range of content related to the PERFORM project via its social media feeds and hashtags, ranging from Responsible Research and Innovation to project partner dissemination about the project to retweets of related content (examples shown above, such as the University of Bristol tweet: '#EarlyCareerResearchers and creative approach to #PublicEngagement here's a new video produced by @BristolUni [link]'.

3. Young people's engagement with social media and responses to science performances

This research investigates the role of social media in how young people in three different EU countries engaged with performing arts-based educational interventions by the Participatory Engagement with Scientific and Technological Research through Performance (PERFORM) project, an initiative which aims to foster young people's engagement with STEM (Science, Technology, Engineering, Mathematics) and responsible research and innovation. This research report specifically explores the role of social media in how young people understand and respond to the information presented to them in the performances, including their feelings, perceptions and attitudes towards science and scientists, and their views about the attractiveness of scientific careers. This social media-focused research started from the assumption that a variety of conversational strategies and practices may be used on social media, some of which may be unique to particular platforms such as Facebook, Twitter, Instagram, or Snapchat and their individual parameters. This is not a general study about students' social media involvement, but rather it focuses on aspects with implications for understanding how social media and sharing more generally fit into the picture of audience response to science engagement aimed at young people (and their responses to PERFORM project activities in particular). As such, we sought to address the following research questions:

- How do young people engage with the participatory science performance experience on a social level, and use information presented through the performances in subsequent conversations?
- How do participants bring information from outside sources including mass media, social media and educational institutions into modulating their conversations and responses to the performance-based science engagement experience?

- How and why do young people share their experiences with the PERFORM project on social media?
- What are the similarities and difference in participating young people's social media practices and sharing responses both within and between participating EU countries (viz., the UK, France and Spain)?

This research focused on students involved in PERFORM participatory processes, which took place in 3 EU countries, Spain, France and the UK. The aims of PERFORM, an EU Horizon 2020-funded initiative, are outlined by researcher Karla Berrens in an informal communication to the University of Warwick research team:

> *"We're trying to avoid any students being left out of any scientific topics… [STEM]… and we're doing this through trying to engage them, motivate them, and debunk scientific stereotypes through using performing arts… through using the paradigm of responsible research and innovation, we're trying to bring forth the idea of humanising science to engage secondary school pupils in these scientific topics."*

A literature review was needed to set the stage for the empirical study addressing the research questions enumerated above. The study focuses on young people's experiences and views about sharing science content on social media- both in general and specific to the project. Therefore, a review of relevant literature was undertaken to identify the state of the art in this topic area. Overall, the literature makes it clear that social media are undeniably an increasingly pervasive part of young people's lives. Although clearly a global phenomenon, Europe is one of the leading continents when it comes to youth social media consumption, with hundreds of millions of users (e.g. We Are Social, 2017). One study found that the pilot countries for PERFORM- the UK, France, and Spain- were the tenth, eighteenth and nineteenth greatest users of social media within their internet user populations in the world (Statista, 2017). It has also been reported that in July 2015, there were 26.1m social media users in France, with 3.5m of these being aged 12-17. This figure is projected to rise to 4m in 2019 (Génération Numérique, 2016).

Young people are particularly involved with this rapidly expanding phenomenon: For example, it was reported in 2016 that 99% of British youth aged 16-24 use social media weekly, at an average of two hours and twenty-six minutes a day (Elder, 2016). The increasing presence of social media in the lives of young people brings up concepts such as 'Digital Natives' (Prensky, 2001), that is, younger generations who develop a natural dexterity with technology due to their consistent exposure to it from a young age. The implications of such familiarity is certainly multidimensional, revealed by the unique uses of and motivations behind youth social media use.

Motivations for social media use include that it is viewed as an 'emotionally gratifying' space that fulfils a need to share experiences, it provides an opportunity to be recognised and validated by others, and it establishes new social relationships (Colás et al., 2013: 21). Social media also play a role in young people's development of social capital (Greenhow and Burton, 2011; Bourdieu et al. 1990; Ellison et al., 2007). Social media are the most used news source for young people (Wakefield, 2016), playing a key part in the shaping of youth socio-political opinion (Beer, 2017). Moreover, social media use has rapidly become established as a Generation Y social norm (Woodman, 2015).

The prevalence of social media has sparked debate about the role of social media in young people's education: That is, should social media be banned in educational spaces or incorporated to capitalise on young people's aptitude with such platforms? (Dyson et al., 2015: 304). The present literature review considers the role of social media in young people's lives and reception of educational interventions. This literature review addresses the topic of how social media connect with education for young people as a foundation for an empirical study of the role of social media in young people's reception of the PERFORM project activities that is presented after the literature review. This empirical study is at the intersection of social media, science education and young people's experiences with learning. Therefore this is the departure point for this literature review.

3.1 Social Media in Education

Many have noted the unique features of social media and wider Web 2.0 applications, such as user-created content, mobile accessibility and enhanced social connectivity, seeing educational potential in young people's social media participation. For example, Russo et al. (2009: 156) claim:

> *"Social media technologies have broadened learning options, shifting the focus from individual/institutional custodianship to participatory relationships where those involved in the learning process are seeking and sharing new knowledge"*

Similarly, McLoughlin and Lee (2010: 29) argue:

> *"Many social software tools afford greater agency to the learner by allowing autonomy and engagement in global communities where ideas are exchanged and knowledge is created as students assume active roles… The learning experiences that are made possible by social software tools are active, process based, anchored in and driven by learners' interests, and therefore have the potential to cultivate self regulated, independent learning"*

One of the ways the link between social media and education has manifested is in social theories of pedagogy, for example Situated Learning Theory (SLT) (Lave and Wenger, 1991). The idea that learning occurs in the realistic contexts where knowledge is applied, rather than in decontextualized environments, such as the formal classroom or lecture hall, incorporating social interaction, authentic contexts and learning in situ (Gikas and Grant, 2013: 22). SLT and this socialising of the learning process is consistent with other contemporary thought on the learning process. Kress (2011: 57) argues that the meaning-making process is largely social, and that people engage with their environment and others through "socially made and culturally specific resources, in ways that rise out of their interests". This engagement produces knowledge, and in turn determines future engagement with the social environment (Kress, 2010: 14).

Given that social media are underpinned by social interaction, experience sharing and validation (Colas et al., 2013), and is mobile so can be accessed in a variety of situations, it can be thought of as a 'culturally specific resource' which naturally compliments the social nature of learning itself. Tissington and Senior (2011: E90) go as far to claim that 'social networking sites… not only serve a vital role in complementing the needs of the new generation of digital natives but also maintain our evolutionary imperative to socialise and share knowledge'.

Another way in which social media have been brought into pedagogical debates is through the proven success of mobile technology to education. In 2014, Educause reported that 86% of undergraduates had a smartphone, and nearly half owned a tablet computer. In an earlier Educause survey, 67% of students believed mobile devices were important for their educational success, and use them for academic activities (Educause, 2012).When asked about the online Learning Management Systems (LMS) used in their university courses, the top two improvements suggested by respondents were 'Better features for interaction and communication', and 'More friendly user-interfaces' (Educause, 2014), both of which are attractive features of social media, and suggest it could fill the educational gaps left by LMS. The advantages of mobile learning are well documented by the academy. Mottiwalla highlights how mobile learning "combines individual learning with anytime and anywhere learning (…) the relationship between the device and its owner becomes one-to-one, always on, always there, location aware, and personalised" (2007: 582). Traxler claims that 'mobile learning increases motivation, especially amongst learners who would normally be considered distant, disengaged or disenfranchised, and hence improves retention and progression" (2010: 131). For Sharples et al., customisability is a key factor in favour of mobile learning, allowing mobile learners "the transfer and access of information in order to build on their skills and knowledge to meet their own educational goals" (2007: 223). Being a heavily mobile phenomenon, social media also possesses many of these mobile technology learning traits, so arguments in favour of one are frequently translated into those promoting the other.

Some scholars are attempting to bring social media into pedagogy through the concept of a Personal Learning Environment, inspired by how '[l]earners constantly seek information to address a problem at work, school, or just to satisfy a curiosity' (Dabbagh and Kitsantas, 2011: 1). Social media naturally fit into this type of informal learning because of their flexibility and sociability: "a Personal Learning Environment consists of social media tools that allow students to gain competence or knowledge regardless of whether the tool enables interaction with another student about a class project or going online to find examples or suggestions on how to approach a project" (Ibid: 2). Personal Learning Environments have gained traction through addressing the faults of LMS, which were originally designed to provide a flexible framework for students in higher education, but have been frequently shown to prioritise faculty dissemination tools over student learning tools, despite the latter being more likely to foster student engagement and interaction (Ibid.). Because social media are dependent upon each individual users' social network, personal interests and generated content, they open-up an educational space that the formal structure of LMS does not allow for. Overall, Personal Learning Environments reveal how social media are highly suitable for tackling issues related to informal learning rather than formal learning.

This literature review will now consider literature on how social media have been incorporated into both formal and informal learning. This is not only because there is limited literature on the latter, but to assess what the wider pedagogical advantages of incorporating social media into education may be for young people.

3.1.1 Social Media in Formal Education

There has been research on the role of social media in formal education settings, but this research has not been evenly distributed across the levels of education. Attempts at integrating social media into young people's education- and research assessing its efficacy- have been most prolific at the level of higher education where in some places it is helping to transform the ways that students communicate, collaborate and learn (Tess, 2013: A60). Freberg and Mae Kim (2017: 2) concur, suggesting:

"More students enter universities as digital natives, or learners who have grown up in a world with social media and expect it to be integrated into all of their experiences. To better meet these students halfway, institutions are grappling with the best ways to integrate social media as a pedagogical practice."

Role of social media in supporting learning

There is some degree of optimism about the potential of social media for enhancing young people's learning, particularly in the domain where much of this research has taken place: Higher education. There are several examples of social media integration in higher education courses having successful pedagogical outcomes. For example, Junco et al. (2011) analyse how Twitter was incorporated into a first-year pre-health professional course. The study aimed to see if a group of students using Twitter could engage better with a required text, *Mountains Beyond Mountains*, by tweeting their thoughts about the book, tweeting each other responses, and beginning online discussion. Twitter was also used for several educationally-supportive activities, including: continuing class discussions outside the limited one-hour class time, as a low-stress way to ask questions, and for class reminders, campus event reminders, and organising volunteer projects and study groups. A control group of students not using Twitter was used to measure the outcomes. The study found that the group of students using Twitter produced a richer discussion of the book because conversations could be extended beyond class time, such as in the following exchange:

"Student02: @Faculty It made me realize how selfless I need to be, just like how Farmer put his dedication toward helping others before helping his own needs.

Student04: @Faculty it helped me see that one person really can make the difference if the effort is put forth

Student02: @Student04 Do you think that just one person can make a difference, or that one person inspires many people to help make a difference?

Student04: @Student02 I think in a way it's the same thing because that one person inspiring others is still making it all happen by involving others

Student02: @Student04 That's a good point. Farmer made a difference in people's lives while inspiring others, like us, at the same time!" (Ibid: 126)

The study also found that students were more expressive of their personal feelings because discussions were not in an intimidating face-to-face environment. Furthermore, the use of Twitter generated different types of questions than in class discussion, and the public nature of the format helped students be more comfortable asking each other for help. On a more practical level, Twitter helped students overcome scheduling conflicts, and they found it easier to set up study groups because scheduling information could be shared and updated in real-time.

McCarthy (2010) also found potential educational value by integrating social media- in this case Facebook- into a first-year architecture course. In the experiment, students were required to access a series of image galleries on Facebook on different types of architecture. They were then asked to find their own images to submit to each gallery, and then to provide critiques on their peers' submissions. The gallery topics were relatively open to the students' interpretation, and they were assessed on the relevance and quality of the submitted images, the descriptions they provided the content with, and the quality and consistency of their critiques and discussions. The study found that 95% of participants agreed that the inclusion of Facebook helped them to develop peer relationships. Further, most (92%) appreciated the interactive discussions with peers in a virtual classroom. The researchers discovered an increased student engagement level with the course, measured by the number of Facebook activity logs.

Another study indicating positive potential educational value in the integration of Twitter focused on the implementation of social media into courses at university level (Gikas and Grant 2013). The following participant quotes are indicative of the study's overall findings, which were favourable towards the idea of integrating social media into educational processes:

> *"I mean with [our course management system], it's the thing you check into just to do school work. Twitter – it's a social media tool that you are on all the time anyway. And to have the education, the class, be intermingled with the rest of our lives. It means it's ever present and when those ideas, when they develop, they are there. And you are already with your classmates. You don't have to go 'Oh my God, I have to jump on Blackboard and post this right away'. The thought is there and it's more permeated into your regular life" (Ibid: 22)*

Indeed, the findings would seem to point in an optimistic direction about the potential for integrating social media into the participatory performance-based educational interventions like the ones developed during the PERFORM project.

> *"When I started taking this class though, I think I started understanding how Twitter can function as… a tool for learning. Following scholars for instance, that we've been reading in this class has been really neat to actually have a personal connection with them because almost because you see what they are doing in their day-to-day. They're posting some of their favourite articles, some of their favourite theorists." (Ibid.)*

These kinds of results suggest that social media would be a highly valuable tool for enhancing educational outcomes, and linking learning to young people's daily lives.

> *"You collected information as you were going about your life, snapping [a picture] or writing a post, tweeting somewhere, sending yourself a note to remember this or that… no matter where you are" (Ibid: 23)*

Overall, the findings indicated that the advantages most cited by participants were the ability to access information quickly, communicate with peers and academics efficiently, increasing the variety of ways learning can happen, and the opportunities for situated learning (Lave and Wenger, 1991; Gikas and Grant, 2013).

However, whilst these studies, and several others, indicate that social media can have a positive impact on student engagement and knowledge development, the advantages tend to be more focused on activities that *support* learning rather than directly

developing the learning. For example, social media served a supporting role by enabling communication with others and scheduling extra-curricular activities. This would appear to be in line with criticism that social media were never developed for formal education, and to adopt them into it as such simply because they are available is to employ a tool for a task for which it may be unsuitable (Friesen and Lowe, 2011).

Limitations in social media's role in promoting young people's learning

Despite their potential, social media have some known limitations as a medium for enhancing young people's learning. A US-based study by Dyson et al. (2015) attempted to use Facebook as an asynchronous discussion forum in an introductory Psychology class. A contemporary news story was posted to a shared Facebook group two days prior to class. Participants were required to post comments and discussion to foster better discussion in the actual class. There were three attractive features to this idea: Class-relevant content could be delivered across multiple time-points which promoted distributed learning; Discussing course content outside of the class-room was perceived as a resolution to the interpersonal issues that inhibited class discussion through anonymity; Using Facebook instead of a university Learning Management System (LMS) meant content was able to be brought to students instead of students having to seek out the content for themselves (Ibid: 305). The findings of this study were overall not favourable to the use of Facebook within education. Their data suggested that only a lack of interaction with the Facebook group lead to lower self-report scores in engagement, understanding, and appreciation of the relationship between online and in-class materials. They also found that "there is a tension between the use of Facebook for both non-academic and academic purposes, and it is possible that students are unwilling to integrate these two domains on the same social media platform due to… privacy issues" (Dyson et al., 2015: 311). This is consistent with the criticism that social media platforms are not designed to be adapted to formal education (Friesen and Lowe, 2011).

In Deed and Edwards (2011), the study involved testing if groups of three or four students on an Education Studies programme could explore an education-related theme through using a blog as their principle means of communication. Their goal was to

compile a five-minute presentation based on the collective analysis and interpretation conducted through the blog. After an initial face-to-face meeting, the majority of work was expected to be done through the blog, with little structure or scaffolding provided by the tutors. Once again, this study reveals that whilst social media can assist with activities that aid learning, such as peer communication, they are less effective at traditional knowledge accumulation. A frequent finding was that "there is very little discussion of an academic nature, and the language is characterised by the use of colloquialisms and SMS text language throughout" (Ibid: 16), such as in the following exchange:

> *"Heya guys – has everyone been working on what to say in the first slides… M... did u think of any questions? Does anyone want to run through tomorrow or do you think we're okay?*
>
> *Hey! I've read through it again and found some more things I could put into my slides. I haven't got any questions, but I got some things that relate to the question slide… I think we need to meet up so we can go through Z…'s bit… wot do u think?" (Ibid: 16)*

The participants appeared reluctant to engage in discourse that was above and beyond perfunctory levels. The writers also found that although the levels of communication in terms of encouragement, support and criticism were striking, there were practicality issues in terms of completing an entire assignment solely in a virtual environment. They conclude that overall "while the students appear to have wanted to complete the task efficiently, the process of critically constructing knowledge was not pursued with vigour" (Ibid: 18).

There is a notable dearth of similar studies carried out at the primary and secondary levels of formal education. One of the few examples to both conduct a study in a high school with teenagers, and present qualitative feedback from participants is Mao's (2014) US-based research. The study used a mixed methods approach of quantitative survey and qualitative focus group to discover high school pupil's affordances with social media, and their attitudes towards their use in an educational

context. Among their most prominent findings was the discovery that some of the most mainstream and successful social media sites, such as Facebook and Twitter were used the least in formal education, and if they were used, were used for getting pictures for projects and socialising with friends when pupils had nothing to do in class. The social media most cited for educational use were Edmodo, a form of LMS, and YouTube, for finding educational videos. The quantitative data is mostly positive, with 51-84% of pupils either agreeing or strongly agreeing they enjoy using social media, they are creative and can learn better when using social media, and they enjoy using social media for assignments or their own learning after school, and 49-60% agreeing or strongly agreeing that social media use encourages sharing, makes learning fun, meaningful and interactive, helps get connected to the real world, and extends learning (Mao, 2014: 217). However, the qualitative data reveals more mixed results, and confirms findings elsewhere that when it comes to formal education, social media is mostly helpful in aiding learning rather than being the direct cause of it. When asked if social media are better for socialising or learning one participant responded:

> *"I think it's 50-50 because I know when I get stuck on a question for homework, I post it on Facebook and – and my buddies who aren't in that class, who are in honours above me or something, they'll post on it and give me the answer. Well, you could go on WikiAnswers and the same question is going to be there with the answer. It's not – I don't feel it's cheating… I think it's just help" (Ibid: 218)*

This would seem to support the idea that social media could be most helpful to education in a flexible way, suitable to the needs and requirements of the learner. Concurrent to this idea, there is also evidence supporting the idea that social media could work as a Personal Learning Environment (Dabbagh and Kitsantas, 2011). Another respondent spoke of how she used Facebook not necessarily for tasks related to her formal education, but to satisfy personal curiosity, such as to "go on a ton of reading sites" and read "stories about random things or about like different perspectives of life" (Ibid: 218). In a similar vein, another participant noted: "with the social site, you can go on Facebook and see a thousand different conversations. You can

be part of any of those conversations" (Ibid.). Whilst these are not necessarily activities related to formal education, they certainly promote informal learning. Indeed, one participant was of the opinion that Facebook is an unsuitable format for the classroom:

> *"Although we allow Facebook for research purposes (such as finding quotes in a message for the school newspaper), some students abuse the privilege and spend their whole day on it […]. Because you don't really learn anything. I don't really use any social media other than Facebook and I don't know, I guess I learn some stuff, but nothing like school related from that" (Mao, 2014: 216, 220)*

Mao's study provides a valuable window into pupils' views about how social media can facilitate educational interventions, for example:

> *"I'm in a thing called Student Congress. (…) We get together on Facebook and we decide the docket beforehand (…) so we have extra time, the right speeches, questions and all that stuff" (Mao, 2014: 219)*

This study suggests that social media can play a positive supporting role in educational interventions, a finding that links to the present study for the PERFORM project. Just as with the studies conducted at universities, social media appear to be more helpful in activities which support formal learning rather than being the direct source of it. Nevertheless, many pupils in Mao's study also approve of the creative aspects of social media, and appear optimistic about the ways social media *could* be implemented successfully.

Overall, this section of the literature has revealed much about the relationship between social media and formal education. Although the criticisms made by Friesen and Lowe (2011) appear to have a lot of weight, they cannot be said to be universally true, as both pupils (Mao, 2014) and students (Gikas and Grant, 2013) alike have spoken about the educational potential of the growing social media presence in their lives. In these studies, social media have not been an entirely unsuccessful pedagogical tool, and there is evidence that they have aided learning in indirect ways. Rather, it appears that there are some incompatibility issues that may be specific to the institutions of schools and

universities, and the structure of formal learning which takes place at them. Jones et al. (2010) found a key distinction between how students in higher education perceive the use of technology and social media in personal spaces versus learning spaces. Although more than 70% of the students in the study had an active social media account, an overwhelming finding was that they rarely used social media for formal education. One of the biggest concerns raised was the desire by students to separate their social life, which is pleasurable, from their learning, which was considered painful. This divide is fairly summative of what this body of literature has revealed: social media do have educational and pedagogical qualities which can be harnessed, but the domain of formal education does not appear to be the most efficient space for this to happen. This literature review will now consider other educational spaces where the potential power of social media for education may be put to use. This helps to build up a picture of how social media might contribute to participatory learning processes within PERFORM.

3.1.2 Social Media in Informal Learning

While the PERFORM project focuses on the formal learning setting with the research taking place primarily at schools, the arts-based science communication techniques that are being employed are also used outside of the classroom in informal learning contexts. Moreover, the project findings are intended to shed light on the role of arts-based approaches in science education, an ecosystem that encompasses both formal and informal learning elements. As such, it is relevant to consider literature on the role of social media in young people's informal learning experiences.

Overall, there is evidence that informal learning institutions are seeing potential value in social media as a way to engage young audiences. For example, Madge et al. (2009) found that 46% of US-based students surveyed believed Facebook could be used for informal learning purposes alongside standard social purposes.

Existing research suggests the potential of social media within informal learning experiences. For example, research by Kelly (2007) indicates that young people visiting museums are interested in experiences which are relevant and authentic to them, and

showing such experiences to their peers is part of this picture. Miller (2010) suggests contemporary learning is shifting to a 'Just-in-time' model, especially in informal learning settings. That is, Miller describes a model where information is accessed instantaneously through the Internet and mobile devices. He notes how online maps and weather forecasts accessible from anywhere have quickly supplanted traditional methods of getting this information (2010: 192), and the same will apply to most other information accessible through mobile online technologies. Indeed, the available evidence suggests that mobile technology and social media are going to be increasingly central to the reception of science education experiences by young people outside the classroom.

Russo et al. (2009) argue that social media represent the new frontier for informal learning institutions to reach young people and develop future audiences, as well as enabling active, participatory learning. When young people share their experiences in a forum such as social media, they engage in editing and filtering information. Not only is one of the key components of learning (Green and Hannon, 2006), but Russo et al. (2009: 161) suggest that this is a whole new form of information processing as it makes new knowledge uniquely accessible and meaningful to young people and their peers because it is a "self-directed authentic learning process".

A study that looked specifically at this learning process for young people using Twitter as part of school-based learning found positive potential in social media. Charitonos et al. (2012) conducted a study with 29 Key Stage 3 History pupils from a secondary school in Milton Keynes on a school trip to the Museum of London to complement their studies on the history of social inequalities and civil rights movements. The pupils were divided into 8 groups of threes and fours and each group's aim was to carry out some museum activities with the use of iPhones (lent to them) and Twitter (notes, pictures and posts) in order to address an inquiry. They followed a pre-defined trail across the three Galleries of Modern London, and the activities for each gallery were given to each group in a booklet. Adopting a qualitative research frame, the empirical data collected were the pupil's posts on Twitter and photos they took, alongside face-to-face interactions (digital recorders were attached to a member of each

group) and observational data. Semi-structured interviews were conducted with 11 of the participants after the visit also. The aim of the research was to "capture a sense of how students interact with artefacts and how meanings are made and materialised" (Charitonos et al., 2012: 804). More specifically, their research questions were "How do young people's interactions on Twitter help them engage meaningfully with museum content and make sense of their experiences?" and "How are group postings translated into learning trails, which may have dialogic potential?" (Ibid.).

From the interviews, it became clear that prior to this visit, the pupils considered museums "formal" and "boring institutions" (Charitonos et al., 2012: 813). However, all interviewees agreed that this visit was a very positive experience. Using direct feedback from the participants, Charitonos et al. outlined five positive outcomes of using social media in informal education contexts:

1) It was noted that pupils could work at a pace which suited them individually. Participant Sara noted that on a previous visit "We didn't have much freedom, we had to be with a teacher, you were not allowed to go anywhere, to touch anything, to interact" (Ibid: 813). However, on this visit she commented:

   "we had lots of freedom, you could in your own pace and your own way […] It was good to get your point across" (Ibid.)

   This reveals one of the major benefits of social media that applies to informal learning, but not formal. As formal learning is nearly always conducted through a curriculum or syllabus, a specific pace must always be upheld, regardless of whether individual learners can always necessarily keep up with it. For the purposes of a museum visit, the more relaxed format means the individualised learning offered by social media is much more possible and effective.

2) Social media encouraged the sharing of opinions on educational content, as well as allowing shyer pupils a less pressured space to express themselves. Participants noted:

"[…] You got to see other people's opinions… I mean, if you look at something, as I look at something, I see different things, so you can see how they interpret it. I like the fact that you were staying in touch with everyone, even though they were not there…" (Ibid.)

"… some people don't have the confidence to put the hand up and talk about what they've seen. With the technology they could write it down… and I saw a lot of people write down some really good ideas and maybe the use of technology could help them get their point across" (Ibid.)

The authors concluded that using social media specifically in informal education creates an "interconnected opinion space" (Ibid: 815). This was multi-modal in terms of both the physical, by bridging the various parts of the museum into one virtual space, and social, by encouraging pupils to question their own and other's opinions and reinterpret meanings, both key to the learning process (Green and Hannon, 2006; Griffin, 2004), without even needing to be in the same social or physical space.

3) Use of social media promoted further inquiry and exploration of ideas by the learners. Participant Neil commented:

"With the tweeting […] you get lots of opinions on what you've posted, forming judgements, and the best part of it, even if you don't use it that much, you can get some more information, particular items you are interested in and search about it" (Charitonos et al., 2012: 814)

These sentiments were corroborated by participants Kevin and Nana, as indicated in the following quotations:

"When we saw the tweet about the carriage… we wanted to go and find it!"

"We read theirs [tweets] and we sort of learnt from that and from what we saw…"(Charitonos et al., 2012: 814)

Not only do these data extracts echo ideas of an "interconnected space", where pupils were helping each other learn without even occupying the same space, but it also resonates with the literature above on Personal Learning Environments (Dabbagh and Kitsantas, 2011). Through social media, the pupils potentially saw exhibits in the museum they may not have necessarily found on their own, or those that they want to know more about, encouraging them to change their trail to pursue the exhibits that interest them in line with the understanding of a PLE. It also accommodates Green and Hannon's (2006) first aspect of learning: seeking out information in the first place.

4) Social media extended informal learning experiences in time and space by archiving such experiences. Participants commented, for example:

   "Without technology, you wouldn't have remembered it and looking back at them when you can"

   "You could go back and look through it and then just see different opinions… that's the most important thing…" (Charitonos et al., 2012: 814)

   The authors noted that the pupil's learning was not bound by the time scales of the visit itself, because pictures, opinions and interpretations were posted and thus archived, able to be returned to by the pupils whenever they wished. Once again, this resonates with the idea of a Personal Learning Environment, and offers a way for young people to return to and reinterpret previous ideas, without them being lost, which is more likely with formats such as written accounts.

5) It was noted that the specific format of Twitter forced pupils to be more precise and concise with the new information they had learnt. Participant Neil claims:

   "[…] having to narrow it down and putting it into a straight point, it actually helped me… the thing is, the proof is, the point is, etc. Really quick,

really short and like, 140 characters […] that really helped me, it was an advantage"

Whilst accuracy and conciseness are values often appreciated in formal education, they are not always possible due to the varying nature of teaching methods and subject depth. The concise nature of exhibits, often presenting a unique 'snapshot' perspective on an issue or event matches the concise perspective of social media like Twitter, making them highly complementary formats, forcing learners to reinterpret and reproduce information more efficiently.

Overall, Charitonos et al. (2012) conclude that their research shows promise for the use of social media in science education. Whilst they note several drawbacks of using social media, and Twitter specifically, such as the adoption of informal language and 'internet slang' by participants, these were deemed to not pose a communicative failure to the overall learning potential of social media. They also noted that contrary to the popular discourse promoted by "media sceptics" (Ibid: 815), the teenagers in their study were not distracted using social media and mobile technology, but in fact made the most of it; nearly all tweets in the study were related to the museum and its discourse. This is important given the nature of the visit: unguided teenagers on a self-directed visit with internet-connected devices. Furthermore, this research provided valid empirical evidence of the potential for social media to act as Personal Learning Environments as well as an interconnected opinion space. The authors also noted that the tweets in and of themselves became objects of discussion and learning. Finally, the creation of a learning space that was both physical and social allowed pupils to switch between different contexts, notably individual/social, which enhanced the dynamics of the visit, and counters the social concerns raised by other museum mobile technology research, such as Lanir et al. (2013).

3.1.3 Synthesis perspective from the literature review

In summary, the literature review has revealed that whilst social media may not always be best suited to directly developing learning in formal settings in the current schools

context, there is potential for it to be successfully incorporated into learning experiences. This is due to its enhanced ability to provide a learning environment that encourages diverse discussion and debate outside of formalised learning spaces. It provides ways to re-contextualise information for the learner and to provide an 'archive' of what has been learnt. However, it is a sparsely researched field, particularly with young people (pre-university) and with people outside the United States.

3.2 Methods Section

The research questions above were addressed using qualitative interviewing and focus groups. Data collection was always conducted using native speakers for the language of the participants[2]. The most non-traditional aspect of the research was the WhatsApp-based qualitative interviews[3] conducted with the Spanish participants: Therefore, the methodological discussion below dilates on reflections about this part of the research more extensively than the more conventional interviews and focus groups conducted face-to-face in the UK and France. The data collection took place in May-June 2017.

3.2.1 Research Design

Background

[2] In France, the data collector was a native French (France) speaking researcher with a PhD in social anthropology. In the UK research, interviews were conducted face-to-face by two project researchers (Native English speakers from the UK and US) at the participating schools. In the Spain research, the data collector was a native Spanish speaker from Colombia with a PhD in cultural anthropology.

[3] Access to participants varied somewhat in the case of the Spanish data collection, where participants were recruited through the instant-messaging platform WhatsApp, which was used by the Spanish performance group during the participatory process (see *Method*). The Spanish-language data collector on the research team noted that this was more akin to snowball sampling, as students who were keen to engage with the research encouraged their warier peers to do the same.

In Spain, the PERFORM project participatory research activities took place at schools in Barcelona. Here, a performance group called The Big Van Theory (TBVT) conducted a stand-up comedy routine, performed by scientists. In France, performance group TRACES conducted theatre and mime workshops. Performers equipped the students with theatrical elements and skills to communicate the selected scientific topics and students chose scientific topics of interest for the performers to write plays on. In the UK, a science communication company called Science Made Simple conducted workshops in 4 schools in Bristol, where the pupils were developing busking skills for communicating science. Among other aims, all three performance groups aimed to help students to see that scientists are more fun and less stereotypical than they might have thought, to engage with Responsible Research and Innovation themes and to reflect on the potential of scientific careers and skills for their futures.

The present research contributed to the impact assessment research focusing on the Work Package 2 project activities described above, exploring the role of social media in the project, especially young people's reasons for using or not using social media to engage and discuss the project.

Method

This research adopted a qualitative approach, with the UK and French data collection conducted face-to-face and the Spanish language data collection conducted using the instant messenger platform WhatsApp. Focus groups and interviews were the main data collection method, with focus groups used in order to gain the perspectives of several students who had taken part in the PERFORM workshops around the first round of participatory interventions within the project (this was needed due to logistical constraints on the data collection). Focus groups were used in both the UK and France, although there were notable differences between the focus groups in each country: The UK data collection encompassed 4 focus groups, each of 4-5 students aged 15-16, whereas in the French data collection, 2 focus groups took place with the slightly larger size of 9-13 participants, all aged around 16 years old. Another difference between

these groups was their duration, which was much shorter for the French participants[4]. Peek and Fothergill (2009) argue that smaller groups can be smoother to run, and allow for greater opportunity for difference of opinion and debate, as well as allowing a greater chance for more hesitant participants to speak, as the possibility of dominating speakers is reduced. This was certainly the case for the smaller UK groups, in which all participants of all the groups spoke at some point during their interview. On the other hand, the benefits of larger groups were evident in the French data collection. Morgan (1998) recommends larger focus groups when the participants involvement with the topic may be low, or if the researcher wants briefer answers. This may be the case when conducting social research with children and young people, where the 'artificiality and strangeness of any interview process is likely to be heightened by adult-child power relations and the by fact that children are less likely than adults to have been exposed to analogous experiences' (Harden et al., 2000). Indeed, young people may be unwilling to share personal information about their social media usage with those they do not know, so it was important that in this research there was the possibility for participants to opt out of any question, or provide brief responses, which the larger groups in France allowed for.

The second method used in this research was semi-structured interviews, conducted over the instant messaging (IM) platform WhatsApp. 6 such interviews were conducted for the collection of the Spanish data, with the Spanish sample comprising 3 students from each of the Barcelonan schools. Given the focus of this research was social media, incorporating social media into the actual data collection seemed natural, offering a further opportunity to enhance understanding of how young people make use of social media in their everyday lives. Indeed, using social media platforms such as IM is not an unorthodox method in contemporary interviewing, and its advantages are well-documented. Fontes and O'Mahony (2008) note several practical benefits, such as

[4] This was due to preparations for the Brevet exam, thus making them unable to schedule extensive amounts of time for this research. However, the differences between these groups were not seen as a detriment to the overall data collection.

it being a cost-effective and time saving approach, which does not require the complex physical travel of multiple researchers. Furthermore, it provides a unique instant transcription. This can be more effective than the traditional interview transcription, which may be lengthy, tiresome, and subject to human error and inaudible recordings. Rather, saved IM conversations allow the researcher to focus on the interview without the distractions of note-taking, and instantly review what has been said by the interviewee. Moreover, saved conversations often include timestamps and other temporal data, allowing researchers to assess issues of participant hesitations and thinking time. Voida et al. (2004) suggest researchers can adopt the etiquette within IM of allowing a delay between receiving and responding to a message, in order to give themselves added time to properly analyse participant responses and prepare the next question. This can also work in the reverse, giving respondents more time to correct and modulate their responses to provide a more reflexive answer (Hine, 2001). In a similar vein, it has been noted elsewhere that the anonymity of online interactions may encourage participants to provide a more authentic self, as they are likely to be in a more comfortable physical environment, Hawthorne effect is reduced, and discussion of sensitive issues may be smoother (Janghorban et al., 2014; Ellison, Heino, and Gibbs, 2006). Many of these issues were evident in the present data collection. For example, the Spanish language data collector made note of the "typing…" icon which appears on WhatsApp when other parties are typing a response in order to assess participant involvement and hesitation. These IM interviews lasted for around an hour each, with varying levels of participant engagement. By incorporating IM interviews into the research design, some of the issues posed by focus groups can be countered. For example, although it was eventually abandoned, during an attempt to conduct IM interviews with one of the French participants (see *Ethics and Considerations*), it was noted that she spoke at a greater length, despite being shy and quiet, due to not having to compete with louder or more confident peers, and with less pressure to portray emotions in any particular way.

Interview Structure

The focus groups and interviews were divided into three principal areas. The first area was related to the students' general usage of social media in their everyday lives. This was to enable assessment of the levels at which social media had pervaded the lives of our respondents, in order to be contrasted about how much of this social media usage is directed towards science education. The second area explored the students' engagement with PERFORM and science in general. This acts as the reverse of the previous area: by establishing the students' already-existing scientific interest, it becomes easier to identify extraordinary cases where social media usage regarding science exceeds an individuals' existing science engagement. The third area focussed directly on the students' usage of social media to share information about PERFORM and science, in order to assess how participants themselves defined this exact relationship. In order to appropriately address these issues, the following questions were established before research began as an interview guide:

- What kind of social media do you use?
- Do you ever talk about science on social media platforms? (If not, why not; if so, please explain)
- Have you talked about the performances you have been working on with anyone outside of school?
    - What aspects did you talk about? (e.g. did you talk about RRI values, science, etc.?)
    - Did any of this discussion take place on social media? (if yes, please explain; if not, why not)
- Looking ahead, could you see yourself sharing any aspect of your PERFORM experiences with other people? If so, how do you think you would go about that? (and why?)?
- How would you describe your experiences on different social media platforms you use? (and why?)

- Any other thoughts on why you would or would not use social media to talk about science or this kind of performance activity?

This interview guide was kept deliberately brief with open questions in order to be able to maintain an inductive approach, following participants' views where they lead.

Ethics and Related Considerations

It should be noted that this research was carried out with the utmost consideration of established ethical principles within qualitative social research, universally understood as upholding on-going informed consent, privacy, and confidentiality, and eliminating potential harm to and deception of participants (Diener and Crandall, 1978). Informed consent was gained from all participants through a consent form prior to their interview in the case of the French and British participants. This differed slightly with the Spanish participants, who were contacted through WhatsApp by the researcher. Those who did not wish to take part were contacted no further, and those who did were informed about the research before proceeding. Fontes and O'Mahony (2008) note that an ethical advantage of interviewing via IM is that on-going consent is always assured: should the participant no longer wish to take part, they can simply stop responding without the social difficulties such an act would entail in a face-to-face situation. Focus group discussions were recorded, transcribed and anonymised with only the anonymised transcripts stored for data analysis. The original audio files and non-anonymous data were available only to researchers and their assistants, and have since been securely destroyed following data analysis and final results.

Whilst interviewing over an IM platform was relatively successful for the collection of the Spanish data, the same cannot be said for the French. The original intention was for these data to be collected from the participants via interviews on Facebook Messenger. When such interviews were attempted, it was discovered that it was difficult to get in touch with the few students who actually had a Facebook account; only 2 students responded to interview requests, likely due to Facebook screening

messages and friend requests from those not directly connected to an individual's network. 1 interview with a French student was attempted, but it was sporadic to the point of being abandoned. This reveals some of the disadvantages of using such a format for social research; even with in-built features which might be mistaken as an aid to efficient social research, such as message alerts, it would still have been necessary to set a specific time-slot to conduct a high-quality interview.

Whilst 6 successful IM interviews were conducted with the Spanish participants, this was not without complications. Researchers noted that differences in age and culture between themselves and the participants were more pronounced than originally imagined. Fontes and O'Mahony (2008) warn that any researcher wishing to conduct research over IM should become familiar with the software and its contextual colloquialisms before embarking on the research. This is true for the Spanish language researcher, who lacked the nuanced contextual understanding of the various emoticons used by the male participants (and perhaps familiarity with local expressions as he is not from Spain). Although language was modulated and a fluid conversation was maintained, this was a potential barrier to rapport.

Implementation of IM within qualitative interviewing represents a shift in the interviewer-participant power balance (Bourgois, 2002). Unlike in a face-to-face interview, the participant can postpone the interview, take as long as they please to respond, and rewrite and carefully modulate their responses. Deakin and Wakefield (2014) found that in their online interviews, the participant could often be in a disruptive or distracting environment, crucially impacting their concentration. This may have been the case for the present research, particularly as it employed an IM platform that is often used on mobile devices, meaning the participants could have responding from a range of distracting environments. The Spanish language data collector noted that 3 of the participants began to disengage after half an hour of interviewing, and responses became short, tautological, or non-explicative. This only seriously affected one of the interviews, and this lack of sustained engagement was counterbalanced by the sustained engagement of other participants.

3.2.2 Data analysis

The present report is based on a thematic analysis of semi-structured in-depth qualitative interviews and focus groups conducted with young people in the UK, France and Spain.

All of the audio recordings of the interviews and focus groups were transcribed and analysed using an inductive approach. This analysis was carried out by categorising data extracts using the computer-aided qualitative data analysis software Dedoose. This process and the use of the data analysis software were part of the quality assurance process, designed to establish an audit trail that enables tracing the lines between analytic interpretations and the original content as it appeared within the raw data.

The data analysis focused on gaining full value from these qualitative data by getting beyond the surface level to uncover drivers for participants' views and concerns by developing two types of depth through the data collection and analysis (Jensen & Laurie, 2016):

- *Digging deeper*: Dig deeper when the participant gives an informative response, but underlying concerns or motivations need clarification.
- *Digging wider*: Dig wider to gain a greater understanding of the participant's context, which may underpin surface-level responses.

The results are presented in this report using 'thick description'. Thick description involves the provision of detailed descriptions and quotations that are sufficiently elaborated to allow the reader to draw their own conclusions about what the participant has said.

3.3 Results

The results from the present study shed light on the status of young people's engagement with social media, and the implications for science education interventions like the ones developed by the PERFORM project. The findings presented below focus on the role of social media in participants' lives, the place for science in their social

media communications and how they talked about the PERFORM project specifically on social media. The implications of these research results for science education practice and research are taken up in the Discussion section.

3.3.1 Social media platforms in young people's daily lives

The interviews and focus groups first sought to discover the social media usage habits of participants in terms of duration and purpose varied greatly between the nationalities and ages of the participants. Among the French students, some of the oldest in the overall sample, around 90% reported using social media daily, whilst the remaining 10% do have social media accounts but use them less, or have had them in the past. Social media usage was seen as a social necessity by participants:

> *"When you don't have social media, some people will make fun of you. So having social media improves your social life" (French participant)*

Sharing music, YouTube videos and pictures and screenshots of entertaining content were among their most reported uses of social media.

There was a broader range of social media uses amongst the Spanish participants, who placed more emphasis on contacting and communicating with friends and family, alongside posting photos and watching videos. They notably also used different social media platforms for very specific purposes:

> *"Instagram to see the stories of my friends, Facebook to upload photos, Messenger to talk to strangers, WhatsApp to talk to friends and family" (Spanish participant)*

> *"WhatsApp is direct communication, Instagram is to publish photos that you like and Facebook in my opinion would be a mixture of them" (Spanish participant)*

Overall, Instagram was viewed as being for posting photos and consuming content, but WhatsApp and Facebook Messenger were used for interactive communication via instant message (despite the fact that Instagram and other mentioned platforms such as Twitter, have instant message capabilities).

A notable finding was the waning enthusiasm for social media by the UK students, who were notably the youngest of all those involved. Firstly, there was less mention by the students of using social media to keep in touch with others. Rather, it was used as an entertainment tool when bored, to find "funny" content and follow peers and celebrities.

> *"I don't really use social media, because I don't see a need… my current phone, it's not like a new phone, so I can't really take it around with me. That and I haven't really seen a need." (UK participant)*

> *"… once I deleted [social media], I didn't want to go back on… it's so much simpler without it. It's just sort of annoying" (UK participant)*

> *" I have a lot of friends from other countries, and it's good for keeping in touch… but in general we will just send text messages for keeping in touch with people rather than social media" (UK participant)*

This lower interest in social media applied most strongly in the case of views about the Facebook platform. Despite being the world's most populous and widespread social media platform overall, participants from all countries reported low usage of it. Among the UK students, their main complaints about Facebook were that it was "already old" or "too annoying":

> *"Facebook's annoying because I haven't been on it in like 5 days and I've got 150 notifications" (UK participant)*

French students echoed this opinion of Facebook being old or for older people, perhaps illustrated best by one student who did not have his own account, and instead used his mother's to occasionally view content. He had a notable wariness of the cyber-permanence of content posted to Facebook:

> *"I get the feeling that you have to be much more careful about what you put up on Facebook. Because if you put something up there, a photo, and someone likes and shares it, even if you delete it afterwards, it always leaves a trace." (French participant)*

These concerns were also reflected by the Spanish participants, with many citing privacy and personal safety issues as their reasoning:

> *"Personally, I don't like Facebook too much, because it is a social network vulnerable to information extraction and besides there are many false things" (Spanish participant)*

> *"I stopped using Facebook because it seems to me that it is very unsafe" (Spanish participant)*

Instead, social media which can provide quick and easy updates, and have ephemeral- or instant messaging capabilities were the most popular with participants.

Some of the most enthusiastic social media usage reported by the participants was from the French students for Snapchat, an exclusively-mobile social media platform where posts disappear either when viewed or after 24 hours. The students saw it as an advantage that the things they post will not remain online forever, unlike Facebook, where an injudicious comment or photo can remain online indefinitely and potentially damage the user's reputation:

> *"We like talking about our lives so that other people can know about them, and we also like seeing what they're up to. For instance if they're out, we like knowing where they are… it lasts 24 hours, no longer than that." (French participant)*

> *"With Snap[chat], what's great is that at a certain point, you feel safe… not exactly safe but you know you can let go, and if the person doesn't like it, it's ok, afterwards it's done. But… on Facebook… personally, we're more worried that someone is going to make a screenshot, whereas with Snapchat, we can let go" (French participant)*

This belief comes with an implicit social contract amongst the students. Snapchat alerts users if a friend has taken a screenshot of their snap, and one participant noted that if a friend were to do this, it would earn them an 'unfriending'.

Overall, the intense privacy norms around social media developed by this generation of users, in a specifically intentional juxtaposition to the Facebook over-sharers of the one before, poses major issues for its use as either an informal educational space or a domain for social research:

> *"The last thing you want is to talk about school. I mean, school's pretty boring. You just want to leave it when you get home." (UK participant)*

The general feeling is that their social media is a space where they go to escape schoolwork and parental oversight, and where they do not have to think about things they find stressful.

3.3.2 How and when participants talk about science on social media

The interviews and focus groups investigated the explicit relationship between the participant's interest in science, both in their general lives and on social media. Students across all the countries demonstrated a lukewarm connection between science and their personal lives. In terms of social media, the two only converge in three events. Firstly, students suggested they may post about a science lesson if it was particularly fun, such as in lessons that involve exciting or interesting practical experiments.

> *"[I would post] maybe something fun that happened in a lesson, but not really homework" (UK participant)*

Secondly, they may share their exasperation about studying for an upcoming test, but his would not likely involve much actual educational content. Finally, many students expressed an interest in 'pop experiments', originating on specific platforms such as YouTube, but which have also been adapted in shorter, more easily shared clips which can be more easily consumed on other social media platforms:

> *"On YouTube there used to be the whole one thousand degree knife against… bars of soap or a toy or something. They use a blowtorch to heat up the knife and cut through things" (UK participant)*

"On YouTube there's this series I watch which is probably quite a lot to do with science, where they… show practical things… loads of different things like… a similar thing to the knife one where they superheat a knife… a gas bomb where it fills up a room… so they use like chemistry and physics… they explain why it works" (UK participant)

The use of social media to follow scientific accounts that they trust was particularly pronounced amongst the Spanish students. One participant told us he followed accounts such as *CienciaClip*, *CienciaDivertida55*, and *Cincienciainfinita*, another told us he followed *National Geographic* and *Cosmo Caixa*, and another follows an Instagram account called *Sabías que?*

The UK participants also mentioned some specific sources from which they have consumed scientific content, including the popular YouTube channel 'AsapSCIENCE' and website 'Corbettmaths'. Another point which arose in this discussion was the use of social media to find clips of personal interest or need: one French student had used a YouTube video that instructed how to take apart the engine of a lawnmower, and a Spanish student had researched scientific facts he found on YouTube, and contrasted them with information from video-blogs and television documentaries. However, this relative popularity of pop experiment videos was met with an emphasis by the students that these were enjoyed for their entertainment value and exciting aspects, and they avoid thinking of these videos as science or educational:

"I don't think people would care that it's science. I think they just care that they see fire. I don't think people will actually be ending up taking pictures of themselves doing science… there's no point" (UK participant)

"If there were an explanation [of the science aspect], you would listen to it but you wouldn't hear it. The question is just 'Does it look cool?' If it does then yeah, if it don't, then no" (UK participant)

The Spanish participants highlighted some further issues with such videos. Firstly, many of the students peruse these accounts privately, and rarely share their content amongst their social network as they would with other content:

Interviewer*: "why don't you share it?"*

Participant: *"dunno"*

"to be honest I read it and I find it interesting but do not share nor I share other things"

Interviewer: *"but is there a reason not to share?"*

Participant: *"No"*

Interviewer: *"do you think your friends will not read it, you find it boring to share, or would you rather share other things?"*

Participant: *"I think my friends will not read"*

(Spanish participant)

Another Spanish participant highlighted issues about the trustworthiness of content which is designed specifically to go viral, such as a story he found about the world's first head transplant. Another Spanish student suggested that she rarely discusses scientific topics over social media, and that she and her friends prefer to discuss such things in person as it means they can explain themselves better than the plain text format of social media platforms.

Many of the issues discussed regarding this intersection between science education and social media usage reflect that of the previous discussion about broader social media use, in that students and younger people generally reserve them as stress-free spaces for casual entertainment. This explains why pop experiments tend to be science's biggest foray into this space, with mixed results as to whether it provides tangible education or not.

3.3.3 Talking about PERFORM project activities on social media

The PERFORM project activities provided a way of researching how the students responded to a specific science learning experience via social media. The majority of participants in both the UK and France reported that they enjoyed the performances,

and that they enjoyed them more as time went on. Some students (particularly in the UK group) were embarrassed by the public aspect of the events and being forced to approach people they didn't know to involve them in a performance / experiment. Yet quite a few of the students, including some shy teenagers, came out of their shells as a result of participation. For the Spanish students, there was even evidence that PERFORM changed their perception of science overall. That is, these participants expressed they felt science was boring before their participation on the project, but after getting involved they enjoy science learning. Furthermore, most of the Spanish participants expressed an improvement in their understanding of science and a desire to keep learning about it. Indeed, it was amongst the Spanish students that PERFORM gained the most social media reception. This was largely from those who spoke about the project with friends over WhatsApp. WhatsApp was also used as both an organisational and educational tool by participating students based in Spain (where this was encouraged by the Spanish project partner, The Big Van Theory):

Interviewer: *"And speaking of the PERFORM project. Have you used [social] networks to talk about the project?"*

Participant: *"Yes WhatsApp"*

Interviewer: "What aspects did you share using WhatsApp?"

Participant: *"The meetings and different information about perform"*

Interviewer: *"Could you dig a little about it?"*

Participant: *"My group mainly talked about the information we found on the Internet. We then had the perform group in which we were all the students and the scientists or in that group we talked about the days that we were left and information"*

(Spanish participant)

Another group used WhatsApp to share information so they could collaboratively construct the monologue for their performance, whilst another Spanish participant used WhatsApp to send a script for their performance to other group

members. However, it is notable that there was little sharing about PERFORM on any other social media platforms. The Spanish students also discussed PERFORM the most outside of the realm of social media, with many mentioning that they had told friends and family members about it and had encouraged other students to take part.

There was no sharing of their PERFORM experiences on social media by the French participants, however, many of them agreed that they would have been happy to do so had they been asked to explicitly as part of a formal assignment. Although this has the potential to bridge the gap between education and social media, it may be somewhat at odds with the participatory learning aspect of the project if social media has to be formalised into the activity. These attitudes were reflected in the UK participants, who said they did not share about PERFORM on social media, and only discussed it elsewhere with family members who had asked about it as they had signed permission forms for the students to participate and were curious.

Overall, very few students felt that the PERFORM events were interesting to discuss on social media, despite the enjoyment they got out of them. Students feel that some things are *share-worthy* and others are not, and science and schoolwork is not share-worthy. More specifically, they felt that the PERFORM events did not meet the criteria they deem of each social media:

> *"It would never be on Instagram because Instagram's for special moments, not just anything, and then Snapchat's literally just anything, just to keep the streets going" (French participant)*

Some of the French students added that they would be more likely to share these events if they were not so explicitly associated with school and took place outside of school hours. Some UK students also mentioned that to make science more shareable, it would have to be similar in nature to the pop experiment videos. Once more, these sentiments reflect the overall finding that young people intentionally keep social media as a space free of education and the daily stress of school.

A further element of this is the extent to which social media is a space influenced by peer pressure. Students commented that they would be afraid of being mocked by

their peers if they shared something about the performances. They would be seen, essentially, as 'nerds', too enthusiastic about a school-related event:

> *"I feel like… we'll get made fun of. Like, oh, you do theatre, that's a bit ridiculous, it's for old people" (French participant)*

> *"It can be ok and cool if you have tolerant friends… if we did it we would get pushed back" (French Participant)*

This is reflected by how the only way in which the events were shared by the French students on Snapchat; brief and non-specific to the task, such as through a blank image with the simple caption 'I did theatre'.

3.4 Discussion

This research has sought to uncover the connection between contemporary young people's usage of social media and the participatory arts-based approach to science education developed through the PERFORM project. Important challenges have been revealed by this research. Firstly, participating young people did not perceive science-related topics in general (not specific to PERFORM) as 'share-worthy' for their social media accounts. This is linked to the sharply defined boundary between school and non-school spheres delineated by participating young people. This boundary is particularly noticeable the more closely tied the educational content is to formal education, with schoolwork being deemed amongst the least share-worthy events for participating young people. Young people clearly locate schoolwork and education in the 'boring' realm, while events that take place outside of school hours, or those that are particularly personally relevant are located in the 'exciting' realm shared with other social media contacts, where social media offer a protected space from authority figures such as teachers and parents.

This pattern of boundary work excluding science/school content (including PERFORM activities) from social media communications was especially clear in the case of the Snapchat platform, where young people made strong efforts to create a 'safe' space which excluded adults. On a logistical level for the research, there is a major hurdle to access Snapchat to gather data, despite its burgeoning popularity amongst the newest generation of social media consumers. Researchers interested in the potential of social media in science education should therefore take note of the different characters of each social media platform as sites for research. Facebook, Instagram, Snapchat, Twitter, and YouTube are all considered to have vastly different characterisations and uses by their audiences. That is, there is a layer of norms and values associated with each platform by young people that sharpens the distinctions between them, beyond their objective structural differences. In terms of research, any messaging and data gathering conducted over social media does need to be carefully tailored to each platform.

The sharply defined divide between the school and non-school spheres within social media drawn by young people does not mean that social media should be ignored by future science education research and practice. The present research confirms that social media are most definitely a major feature within young people's lives, even if their precise usage varies across nations, cultures and ages. The strongest evidence of the potential for science engagement via social media is the voluntary incorporation of scientific content into social media newsfeeds by the students themselves, in the form of watching pop experiment videos, following science-related accounts and using social media to research areas of personal interest or need. These examples of informal, self-generated, curiosity driven science engagement are likely to be the most promising starting point for future interventions aimed at the interface between social media and science education (including education pertaining to responsible research and innovation principles).

Some participants in this research thought it would be possible to make science and wider-STEM subjects more share-worthy through more visually-appealing experiments and active participation projects. For example, clearly inspired by the pop experiment videos mentioned frequently throughout the interviews, participants in one of the focus groups discussed the idea of an Instagram live video feed where a science teacher shows experiments demonstrating scientific principles, and indicated their increased likelihood of engaging with science presented in this way through social media.

However, this kind of intervention did not necessarily appeal to all students (indeed, elements like this were already present in the Science Made Simple busking activities with students). The idea of actually building social media into educational projects and programmes was also discussed. Some students simply believed that STEM subjects would never be 'cool' enough to be share-worthy through social media, and the only way to make projects like PERFORM more social 'mediatised' would be to build discussing them on social media into the project itself. Whilst this would not be ideal, as it would somewhat defeat the purpose of exploring and developing the naturally-occurring crossovers between social media and science education, it could be a

necessary first step in bridging the gap between these fundamentally differing platforms of science education and social media, leading to more innovative ways for young people to engage with future research and projects on their terms and in their comfortable spaces. Either way, the social construction of social media 'share-worthiness' is clearly worth further investigation by science education researchers, given the potential effect on the reach and impact of science education both inside and outside formal education structures.

Social media may be difficult to incorporate into such environments as the PERFORM project activities because they are small-scale, temporary, and explicitly associated with school work, hours and environment. However, other science education environments such as museums, zoos and science festivals may find this engagement easier as they already occupy both an educational and entertainment context, and already have a social media presence which can be geared toward this purpose. Regardless of exactly how this takes place, it is evident that social media engagement needs to be a planned-out strategy in science education initiatives aimed at young people, ideally developed in consultation with the students, who are the best placed to say what they want to share online.

This research reveals great potential in the role of social media in science education. However, for this potential to be realised in reality, it will quickly become necessary for researchers to adapt to the social media platforms employed by their target groups, including the changing and varying attitudes these groups take to each platform. For example, it would be easy to jump to the conclusion that Facebook is the most sensible platform for conducting research, due to its seeming ubiquity. However, as young people's attitudes towards Facebook have changed, expecting them to become enthusiastic and authentic Facebook users is not realistic when they view this as an undesirable platform. Researchers also must keep in mind young people's reluctance to open up to adults on these platforms may hinder data-gathering efforts.

Other platforms such as Instagram and Twitter may provide a kind of 'third space' when engagement through young people's preferred platforms such as Snapchat

is not feasible for educational interventions or for research purposes. These two platforms are not nearly as popular as formats like Snapchat amongst participants, nor as widely recognised as those like Facebook. However, neither of these platforms hold the strong 'old person' status that young people have bestowed on Facebook, nor do they have the specifically-formulated privacy that Snapchat has gained popularity for. Both are geared toward sharing content to wider audiences, and are regularly used in both personal and professional capacities, allowing for the greatest likelihood of crossover between purposes. Furthermore, both have instant-messaging capabilities wherein messages are time-stamped, stored, and can be returned to, making them much more methodologically suitable for research than the ephemeral messaging of platforms like Snapchat. However, ultimately integration is key. If social media are integrated into informal learning collaboratively with young people, there is no reason that the potential of the link between these seemingly different platforms cannot be more fully realised.

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Acknowledgements

The author would like to thank the research participants for this study, PERFORM partners who provided logistical support and peer reviews, and other individual contributors to this research, including:

- Dr Maya Kaiser
- Scott Lampon
- Dr Carli Rowell
- Dr Catalina Silva-Plata
- Dr Andres Vargas
- Demi Mentink
- Jose Bergolla
- Luis Diaz
- Rokas Labeikis

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