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Communicating Science, Technology, and Environmental Issues: A Case Study of an Intercultural Learning Experience

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This science communication case study analyzes an online international co-taught course where students practiced blog article conceptualization and production covering a wide variety of science and technology related issues. Students had an international experience during the COVID-19 pandemic, and gained experience in communicating science and technology to intercultural audiences. Through student article reviews, course evaluations and project reflections students demonstrated an adoption of new science communication skills and some key examples of changing perspective on issues such as environment and technology. They also enjoyed the opportunity to learn about new cultures, reflect on their own, and bond over life experiences.

Keywords: science communication, technology communication, environmental communication, intercultural training, undergraduate training, graduate training, blogging

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INTRODUCTION

The study of science has played a pivotal role in the development of the human species. Scientific inquiry has advanced all facets of understanding of both human and biophysical systems, including medicine, astrophysics, war, and ecology. Science focuses on empirical studies to gain knowledge (Morrison et al., 2008). The concept of truth in the positivist philosophy of science is often seen as one without the taint of the subjective, which seeks truth through objectivity and logical empiricisms (Lincoln and Guba, 1985; Morrison et al., 2008). Though the positivist paradigm is still present in the scientific community, others have adopted research paradigms more suited to their field of study, including the postpositivist philosophy of science (Lincoln and Guba, 1985). This paradigm attempts to rectify the problems of the positivist paradigm by recognizing an absence of a single, shared reality. Therefore, the scientific method has gone through many incarnations (i.e., inductive, deductive, and retroductive reasoning) to the now widely accepted hypothetico-deductive method, the scientific approach developed by Karl Popper (1902–1994) which includes hypothesis development, usually through the process of retroduction, and hypothesis testing to determine if it can be falsified (Morrison et al., 2008). With an ever more rigorous approach to conducting research, scientific findings are more difficult to dispute by those outside a specific area of knowledge and are therefore given higher value in decision-making processes. This tendency toward trust of expert knowledge by outsiders does not, however, eliminate political debate or general speculation of scientific findings (Cox, 2006), using climate change and COVID-19 as two unfortunate examples.

Science as a multifaceted institution consisting of various fields and approaches is not monolithic, but is sometimes treated as such (e.g., not recognizing disciplinary boundaries or the presence of different research paradigms). Furthermore, it is spoken in tandem with other disciplines such as technology, engineering, and math, hence the common usage of STEM (Science, Technology, Engineering, and Math) to describe fields of similar thought and structure. While a generalized public might have vague conceptualizations of science, the scientific process and the various fields included, studies have shown that levels of scientific knowledge on a variety of topics differ (Takahashi and Tandoc, 2016). Interdisciplinary fields such as science and technology studies as well as science and environmental communication face the problem of translating the ever evolving research and states of knowledge to diverse audiences, some of which might question scientific findings because of value systems, politics or worldviews (Cann and Raymond, 2018). Science, including climate change science, calls for action upon what is a problem with anthropogenic causes. This science is the harbinger of change through policy and personal action, carrying the baggage of chances and gains as well as risks and threats on local and global level (Dunlap and McCright, 2011; Cann and Raymond, 2018). Hence, such scientific findings are called into question.

While science communicators struggle to break down the intricacies of scientific thought and research for the public, some sectors of society feel "left out" by science communication and not a part of scientific discussions (Dawson, 2019; Humm et al., 2020). As Humm et al. (2020) state, "Science communication only reaches certain segments of society. Various underserved audiences are detached from it and feel left out, which is a challenge for democratic societies that build on informed participation in deliberative processes" (p. 164). Attempts to rectify this include increased efforts in research dissemination, outreach, and public participation. Organizations such as the U.S. National Science Foundation (NSF), the ninth European Research and Innovation Framework (Horizon Europe Strategic Plan, 2021), and the German Federal Ministry of Education and Research have attempted to bolster actions around science communication in the hopes of greater social impact (U.S. National Science Foundation, (n.d.); Wissenschaftsbaromenter, 2020; Handlungsperspektiven, 2021).

In an attempt to meet these challenges head on, university curriculums are putting forth classes that are designed to teach and give practice to students communicating about science, technology, and environments (Rose et al., 2020). Traditionally, researchers and students in science-based disciplines focus on writing according to scientific requirements and styles (Martinez-Conde, 2016). Writing for the public is not part of most science education programs (Brownell et al., 2013) and understandable so, regarding academic career-paths that are highly specialized, competitive, and based on peer-appreciation, not publicity. However, communicating effectively with and conveying scientific findings to the public is obviously a major challenge for political systems based on deliberation, participation, and democratic processes. Communication about climate change, risk assessment for new technologies such as artificial intelligence, and COVID-19 (e.g., Honora et al., 2022) are examples for this challenge. Thus, efforts have been made worldwide and in a broad variety of formats to train science students to engage with non-scientific audiences and communicate more actively and effectively (Mercer-Mapstone and Kuchel, 2015; Baram-Tsabari and Lewenstein, 2017). But despite these efforts, a recent experimental assessment of science communication formats indicates that even well-developed and proliferated trainings do not match expectations, suggesting that "trainees need more repetition putting what they have learned cognitively into practice" and "require more opportunities to apply their conceptual knowledge to a greater diversity of communication tasks" (Rubega et al., 2020, 25).

Rubega et al. (2020) suggestions as well as Kappel and Holmen's screening and evaluation of science communication aims (Kappel and Holmen, 2019) indicate that one-time trainings and the provision of tool boxes do not suffice to make public communication of science and technology part of researcher's routine. The overarching goal of the international editorial board as classroom-format was to allow students to experience the challenges and opportunities of writing for laypersons and to encourage them to perceive it not as additional demand, but as integral part of their professional and academic work. In detail, objectives regarding students' development of communication competencies included: (1) introducing undergraduate students to standard processes of science writing and journalism including a possibility for "real" publication; (2) forming interdisciplinary (technical writing and environmental science) and intercultural (US-based and Germany-based) teams in times of restricted mobility; (3) gathering experiences in communicating to intercultural audiences and motivating students to continue their efforts in publicly accessible science communication beyond the course. In addition (4), we included objectives toward organizational and curriculum development.

CASE STUDY DESCRIPTION

Program Description

The "techtalkers"-editorial department as an international classroom-format was part of the pilot phase of the "UAS7 Virtual Academy", whose objective is to bring together students from the seven leading German Universities of Applied Sciences (UAS7) and from the State University of New York, USA, in joint teaching experiences. Due to the COVID-19 pandemic, virtual teaching was used to collaborate, teach, and provide students with an international learning experience. The overall goal of the Virtual Academy was to lay the foundations for future digital collaboration formats. Modules within the Academy covered a broad range from six academic disciplines, including Business Administration, Agricultural Sciences and Landscape Architecture, and Computer Sciences.

All courses were facilitated by a shared Collaborative Online International Learning (COIL) Design Framework and instructor coaching sessions. Courses were integrated in existing programs and curricula of the participating universities. Thus, organizational and administrative hurdles were significantly reduced. Students received credits and grades from their home

universities. Entry barriers were reduced, as they enrolled themselves using familiar systems.

Teaching Technology

We took advantage of an existing blog (techtalkers.hm.edu) that uses Wordpress as a Content Management System (CMS). The blog was established as both a framework for professional training for students of science writing and technical communication and as a medium for publication for young scientists and science authors at HM.

Zoom was used for the editorial meetings and Miro-board for creative sessions. As both universities are using different platforms for class activities and collaboration (ESF: Blackboard; HM: Moodle), Google-tools were chosen to collaborate. This decision was based on the self-organization efforts and individual consent of the participating students. These platforms do not fulfill legal and General Data Protection Regulation (GDPR) requirements and hence are supplementary. All relevant class materials were also available on the official platforms. GDPR obligations—such as information about procedures and conditions associated with publication and a declaration of what students wanted to happen with their login and data entered into the CMS in English and German—have been satisfied.

Student Demographics

Participating students were either from or currently living in the United States or Germany. The experience included 41 students from ESF (from two mandatory undergraduate level classes) and 7 HM students in a mixed elective undergraduate/graduate class. ESF students were mainly from the Department of Environmental Studies, a department that focuses on environmental issues and their societal impacts, including communication. The HM students have a background in technical communication, a program with a very broad spectrum of subjects from Data Sciences, Engineering to Photography, Video Production, and Journalistic Writing.

US-based students outnumbered Germany-based participants. Therefore, only three publishing teams were composed as balanced international teams (**Table 1**). Two publishing teams and the managing team consisted only of US-based students. The managing team was supported by a Germany-based undergraduate assistant for the CMS, for web-administration and search engine optimization (SEO). Thus, only publishing teams 1 and 2 worked and functioned as truly intercultural groups. Two teams displayed a pronounced minority. The single Germany-based student in publishing team 3 was at the same level as the US-based students regarding experience and study phase, whilst the German student assistant in the managing team had previous experience working with the platform and a solid background in web-administration and SEO. Hence, publishing team 4 and 5 might be seen as control-groups compared to the other teams.

Interaction Model

In this experimental setup, US- and Germany-based students worked together in synchronous sessions twice a week and additionally in self-organized asynchronous teams over 5 weeks. This intensive course structure reflects the limited overlap of teaching periods at ESF and HM due to the different academic calendar systems (trimester vs. semester).

Each of the five publishing teams consisted of two editors, two illustrators, and four authors. The sixth team took responsibility for process management, workflow, technical support, and assisted the authors in SEO (**Table 1**). All teams engaged in shared class activities, including the initial discussions about possible topics, the development of the publication plan, introduction to the usage of the CMS, or trouble-shooting interventions. Each synchronous session started with an editorial meeting for all. The main objective of these meetings was to introduce students to the procedures and structures of a collaborative working editorial department. In-between, students worked in their teams, supported by the instructors, who joined the teams and provided feedback to texts and illustrations.

METHODS

To reach the objectives of this study, three colleagues from Munich University of Applied Sciences (HM) and SUNY College of Environmental Science and Forestry (ESF) co-taught an online, international experience on science, technology, and environmental journalism with students from Germany and the United States. Students from ESF and HM formed an editorial department for a blog on science, technology, and environmental topics (techtalkers.hm.edu). This experience took place in spring 2021, during the height of the pandemic. The editorial department introduced in this case study set out to engage students in the Environmental Studies program at ESF and students specialized in stakeholder-oriented communication at HM in science and technology communication for diverse, but mainly non-academic audiences. During this 5-week experience, students wrote, illustrated, and edited texts for the blog Tech Talkers.

The texts and illustrations produced during this collaboration and the instructor's observations during the collaboration, create the data material for this study. A qualitative analysis of the 40 drafted articles (8 per team) and 14 finally published blog posts (text + artwork) were conducted through close reading of the texts by the instructors/authors of this study. Instructors met after each synchronous session and reflected students' interaction in class, in breakout-rooms, and the outcomes of self-regulated team work. The sum of these qualitative observations was discussed with the entire research team to come to common conclusions.

The authors also engaged in observation of the themes, issues and questions occurring during the 5-week collaboration. These observations were also discussed as a research team, and common conclusions were made.

Observations

General Observations

The collaboration let students creatively cover issues that they were passionate about. The international teamwork, with an illustrator and a writer working as a team, shone light on the different perception one could have on issues. The writers

TABLE 1 | Team structure and composition.

1. Publishing team		2. Publishing team		3. Publishing team	
Editor	Editor	Editor	Editor	Editor	Editor
Author	Author	Author	Author	Author	Author
Author	Author	Author	Author	Author	Author
Illustrator	Illustrator	Illustrator	Illustrator	Illustrator	Illustrator
4. Publishing team		**5. Publishing team**		**6. Manging team**	
Editor	Editor	Editor	Editor	Editor in Chief	
Author	Author	Author	Author	Webadmin	
Author	Author	Author	Author	SEO	
Illustrator	Illustrator	Illustrator	Illustrator	Undergrad. assistant	

US-based students *Germany-based students*

For 5 weeks 6 student-teams formed an editorial board for a blog on science, technology, and environment; 4 teams consisted of US- (blue) and Germany-based (yellow) students. The purpose of each publishing team was to produce 8 texts and illustrations for the blog. The managing team coordinated the work of the 5 publishing teams, worked on the content management system (CMS) and on search engine optimization (SEO).

worked to explain what they had in mind for the article and what illustrations would go well with it. The illustrators were investigating options for visually representing what the writer had in mind. The editors, acting as conductors orchestrating teamwork, kept an eye on deadlines and work ready for publication. The open call for contributions resulted in opinion pieces, scientific texts, and critical articles.

We observed that writing for an international audience required students to think about what is common knowledge "here" and what people elsewhere might not understand. For US students, this meant avoiding commonly used abbreviations without explaining them, avoiding slang, and backtracking to explain the significance of issues covered. Germany-based students, being in the minority, had to overcome their inhibitions to talk and discuss in English and their insecurities to assess team members and cultural subtleties. For example, one German writer stated: "First of all, I am shy and do feel uncertain speaking English. This often stops me from talking. Additionally, I had problems to size-up my team colleagues. A lot of trends come from the US. So, I was afraid to come up with ideas that the others might already have known for a long time and that may even be already obsolete." Related to that, we observed surprisingly that the US-based students had more of a precautionary risk perception, whereas Germany-based students were more enthusiastic. All in all, these experiences led students to gain a more nuanced perspective on things.

Cross Pollination in the Choice of Topics

The coming together of students from different universities, cultures, and backgrounds provided a fertile soil where diverse perspectives cross pollinated each other and influenced the thought process as well as the end product. During the topic brainstorming session, students in the German class chose topics—like electromobility, crypto currencies, and Formula 1—that were rather technical in nature, whereas students from the US wanted to focus on topics—ocean deoxygenation and hypoxia, community land planning, and light pollution—that had a stronger environmental and social justice perspective. Given that the students worked in mixed teams, some foci changed in nature. One example for this was a Germany-based student who wanted to write about crypto currency from a technical perspective: which graphic cards are best suited for crypto mining, are they affordable, is it possible to mine successfully with a private PC? Through team discussions this morphed into an article about the heavy energy use that crypto currency mining requires. This experience, we think, clearly widened the students' horizons.

Critics vs. Enthusiasts

Students also influenced and sometimes completely changed the focus of an article through their collaboration. One such example was a student who was interested in writing about Formula 1. A true sports enthusiast, the student focused strongly on the decisive importance of the pit stall crew. The published article however turned into a piece focusing on the environmental damage that this sport causes. Another observation was that Germany-based students seemed to have a more optimistic stance on their topics, whereas the US-based students had a more pessimistic outlook. This was obvious for example in the several articles US-based students wanted to write about water access, how to correctly recycle, and about a highway in Syracuse, NY that causes social justice issues in the city. US-based students' strong focus on environment and justice issues inspired one Germany-based student and fashionista to research and write about the environmental issues of fast fashion and detriments that are not mentioned on the clothing tag.

Communication Styles

Students' writing strengths took different shapes. Germany-based students had great knowledge of how to write for a general audience, whereas the US-based students were great at a more scientific writing style. ESF students focused on scientific research and data for their articles, whilst students from Munich often started with a screening of current debates. One Germany-based student pointed this out in the final reflection: "I have been very surprised to learn how the US-based students wrote their articles.

I think they wrote in a very sophisticated style, very differently from what I am used to reading in journalistic writing." Since texts published on the blog need to speak to a wide audience but be scientifically sound, the texts needed to balance these two writing styles. Through the team set-up, the end results met in the middle of these two styles and managed to strike a balance providing texts that are easily understood, correct as regards content, supported by evidence, and citing science. Another aspect is the use of terminology and abbreviations, e.g., some of the US-based students took knowledge about agencies and current topics in the United States for granted. One student expressed: "Again, this idea that people from Germany and other countries may not know about topics that are prevalent in the United States helped to change my worldview." On the other hand, Germany-based students sometimes overestimated the technical knowledge of possible readers. Both groups took the opportunity to practice explaining background information and to make seemingly self-evident contexts explicit.

DISCUSSION

There were several lessons learned during this collaboration. One important point is that someone cannot just take one class on science communication to become an effective communicator of scientific information. We argue that we need to encourage a cultural shift in academia (and teaching) to strengthen the culture of science communication and offer more options in its practice. Students (and scientists in general) do not only need to learn about the tools to communicate science, science communication also needs to become part of their identity (Baram-Tsabari and Lewenstein, 2017). We compare this to when scientists also call themselves advocates or activists. Scientists (and students) need to more often identify as science communicators, not only to an academic audience.

Case Study Limitations

This case study and the experience itself were too short; 5 weeks was not enough. The actual impact of the texts produced would need to be put in a broader context to enable studying how they diverge or converge with other science communication, in e.g., legacy mass media. Experimental designs could observe the effect these texts have on their audiences. For example, the attitude of students toward science communication for diverse audiences could be compared before and after the experience. To investigate whether reflecting on the interests and needs of laymen became a new habit, students should be re-approached in later phases of their studies and their career.

Lessons Learned

The objectives of this joint teaching and learning experience were to (1) develop students' competencies in the communication of science and technology through practicing the conceptualization and production of online texts; (2) offer an intercultural experience in times of restricted mobility that at the same time reflects current structures of collaborative work; and (3) to gather experience in communicating to intercultural audiences with diverse educational backgrounds. We also sought to (4) lay the foundations for future digital collaboration between our institutions. In this respect, we found six learning outcomes particularly important:

Time Allotment

The time span of 5 weeks was too short to allow for learning, implementing, and setting in practice the complex structure and processes needed. The tight timeline limited the leeway for more intense exchange between students, the development of shared interests, topics, socializing, and creating connections. Perhaps contra-intuitive at first glance, we decided to spend even more time on socializing and fun activities ("ice breakers") in the first meetings, even against students' explicit wish to "hit the ground running."

Group Size and Composition

In this case, 48 students were a much too large group for three professors. To make an intensive intercultural course like this work, the student-teacher ratio should not extend 10:1. The distribution of Germany- vs. US-based students was uneven as the US group was much larger. This too decreased the international exchange experience for some students. One US-based student expressed: "Although my group did not consist of any German students, the two German staff I worked with were amazing and very helpful." Another student said: "As I did not get a chance to work with any students from Germany, I would like to explore actually being able to work with them; I feel that working with other students from another country would help to broaden my perspectives on the environment."

Self-Organization

Due to their diverging academic backgrounds, students from Germany and from the United States had very different experiences with self-organized workflows. Whereas, the students from Munich have been trained in project management and already run through at least three self-organized projects, students from Syracuse had to do their first steps in project management whilst running a rather complex, intercultural project. Thus, self-organizing an agile publication setup, preparing own publications (texts and illustrations), and fulfilling legal requirements (for example regarding GDPR obligations) seemed to be overwhelming at first. One US-based student expressed: "It felt like the German students were a little more cautious of the deadlines given, whereas the American students were more lax considering the situation." Against this background, it is important to make sure that the managing and coordinating team consists of students from both programs. However, in the second half of the experience, processes and routines had been developed and established well.

Role Requirements

We experienced students needing detailed instructions about the roles they were filling, especially some editors who were unsure about their role. Some editors and illustrators might have underestimated the intense work that fell on this role. Functions, expectations, and team dependencies need to be

explained in detail before choosing their roles. For example, as the objective of the blog is to produce professionally adequate articles, including illustrations of quality, illustrators need a certain level of experience, at least basic knowledge of graphic design or photography, and familiarity with standard software applications.

Peer Feedback

Pivotal for the experience was extensive peer feedback: Editors provided feedback for authors and illustrators; authors and illustrators conversed about the convergence of text and image; the SEO-expert gave advice about how to make the pieces traceable for search engines and accessible and appealing for human readers. Especially at the beginning of the course, students were quite hesitant to provide "real" feedback and tended to leave it to the instructors. It is important to make clear that constructive peer feedback will lead to better grades for both the writer/illustrator and editor. Essentially, the less instructors have to intervene, the better the grade.

Intercultural Experience

What some teams might have experienced as struggles (e.g., understanding things differently or having a different perspective on things, such as bitcoin mining), we saw as something very positive and a learning experience on multiple levels. Students learned how to put into words a concept or idea to an international partner and juggled different time zones and deadlines. Unanimously, students from the US and from Germany mentioned that this class shifted the way they think about something.

Next Steps

We plan to offer this course again and to create other course offerings using the same US-Germany collaboration. At the undergraduate level, we will continue to offer the described experience, but modify the timeline to fit the overlapping time between the semesters. On graduate level, we are planning another course that will continue to train students in communicating science, this will be targeted more at scientists (students working on their MA, MS, and Ph.D. theses), needing to communicate their work to diverse audiences. We think this additional offer will help address the issue that a one-time course is not enough, and will aid in creating an academic culture around science communication, especially public science communication of scientists' own work. With these two different offerings we will also address the issue of mixing students with different academic maturity in one class.

The issues "group sizes" and "composition" will be addressed in future offerings to ensure crosspollination can take place in all groups. The described control-group setup made a strong argument for how different the experiences were for students in international vs. national teams. We will focus stronger on guiding students in language (e.g., the use of slang) by adding more opportunities to get to know each other in a non-strict class environment. We plan to ask permission to contact students after some time to inquire about if and how the collaboration sustainably changed their perspectives on issues and scientific writing.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

AK, SK, and AF-P: conceptualization, methodology, formal analysis, investigation, data curation, visualization, writing—original draft, supervision, and project administration. AK: funding acquisition. All authors contributed to the article and approved the submitted version.

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