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Conceptual Article

Less prescription, more brainstorming: Teaching science and risk communication as a research class

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Risk, Disaster, and Humanitarian Communication is a required undergraduate course for Philippine Communication majors, but the standardized curriculum implies the need to create materials for a homogeneous audience assumed to be ignorant about and in need of scientific information. However, science and risk communication research show that communication must first be cognizant of local cultures by studying local understandings of science and risk. The author, moreover, belongs to a Jesuit university, which focuses on social justice and bridging cultural divides. The author, therefore, created a communication course based on insights from previous research, consistent with Ignatian pedagogy, and drawn from her own work in community understandings of risk. The course, COMM 24: Science and Risk Communication, requires students to discuss the natures of science, risk, and science communication. They then have to work with different science-based issues for a specific public: each time, they must propose research to explore the public's understanding of a specific risk, as well as a project grounded in empirical research. This structure provides students a holistic view of communication as an independent scholarly field with many questions yet to be explored, and one that must inform practice, rather than simply act as handmaiden to any other field.

Keywords: Science communication, Risk communication, Tertiary pedagogy, The nature of science, Ignatian pedagogy

1. Introduction

The Philippines is filled with potential public conversations around science. It is one of the world's most vulnerable countries to the impacts of climate change, lies on the Pacific Ring of Fire, and comprises multiple dense coastal cities that can hasten the spread of diseases. The country, too, is filled with multiple cultures, with over 7000 islands speaking 100 living languages.

Given all these, science and risk communication contextualized to specific groups and sub-cultures should be a top priority. Sadly, the general population does not value science, the government does not allot funding for communication efforts, and the news media do not feature science (Navarro & McKinnon, 2020). The Philippine educational system is also in crisis. Despite efforts at changing the curriculum to improve learning, Philippine students rank extremely low internationally in reading, science, and mathematics standardized assessments (OECD, 2018). This has prompted the country's Department of Education (2019), in charge of the basic and secondary education sectors, to implement more aggressive reforms in the curriculum through updating and reviewing content, improving facilities, training teachers, and engaging more stakeholders.

The archipelago's diverse topography and vulnerability to varying hazards, moreover, should also push context-specific risk communication as a top priority. However, the government simply uses a dissemination model of early warning, with the country's weather bureau and disaster risk reduction council at the helm of a multi-office communication chain. This system purportedly ensures that scientific information is disseminated quickly so that people can act on the risk.

All these efforts at encouraging participation in and conversations around science and risk, however, are replete with unfounded assumptions. There are two of consequences here: first, the assumption that simply passing information constitutes communication; and second, the

assumption that people incorporate scientific information into their risk-related decision making. By extension, the second assumption highlights the supposed superiority of scientific information, whereby communication, as a field, simply waits on science as a mere servant, a receptacle of information absent independence as a scholarly field.

These assumptions, intuitive but not empirically based, are also indicative of an ideological approach that weaponizes and deifies science. That is, scientific information and scientists are prioritized as the first, if not only source of information in crafting messages, which excludes and therefore oppresses groups that have their own understanding of reality and therefore their own capacity for dealing with hazards (Abbot & Wilson, 2015; Feyerabend, 1975). Indiscriminate use of these assumptions replicates social norms that also oppress people, even scientists, based on constructs such as age and gender (Blackie, 2023). Such an approach is inconsistent with the nature of today's problems, which are multi-pronged, necessitating input from all societal sectors, of equal power in a peer community (Funtowicz & Ravetz, 1993) where all forms of knowing and being are recognized (Blackie, 2023).

The country has its own ways of understanding, practicing, and framing science and risk (Navarro & McKinnon, 2020), and efforts at practicing science and risk communication have to work from the community level, rather than the top-down mechanism that is assumed to encourage action. For example, recent research into communities that were affected by typhoon Haiyan show unique and developing disaster sub-cultures (Ponce de Leon, 2023a, 2021a, 2021b, 2020a, 2020b). In general, local government units expect people to obey their government and intuitively connect information about a storm to action. It is therefore rare for citizens to take initiative on risk measures or evacuation because they always wait for their local government to send out orders. They also cannot imagine worse case scenarios even as they have some form of indigenous knowledge of storms. In some cases, they want to discuss media messages, rather than act immediately based on orders sent through broadcast media channels.

The top-down approach to risk communication practiced by the Philippine government is implicitly replicated in the college-level mandated course on Risk, Disaster, and Humanitarian Communication, which is prescribed by the Commission on Higher Education (CHED, 2017) for all college communication majors. In its implementation (as benchmarked in various Philippine institutions), the course appears to be a way to teach students how to define information needs, communicate in different media formats, prepare a media plan, produce communication materials, conduct evaluation research, and orient risk communication toward a development perspective in order to communicate effectively with vulnerable groups that might encounter disaster or emergency situations (Adventist University, n. d.; St. Dominic College of Asia, n. d.; University of Perpetual Help System, n. d.). In some cases, the classes are explicitly about how to create video outputs for different cases (St. Dominic College of Asia, n. d.). At the De La Salle University (n. d.), the course examines media representations of disasters, and the role that media can play during disasters.

To reduce communication to the CHED-mandated Risk, Disaster, and Humanitarian communication model would be to shortchange the richness of science and risk communication literature. Communication, when framed for risk, disaster, and humanitarian work, is extremely narrow in scope. It is also in danger of using science, alone, to populate messages, once again reinforcing scientific norms as superior to local knowledge. A required course might have to work from a more generalist perspective, using science and risk communication, which are grounded in principles in the social sciences. This required course would also have to directly address the Sustainable Development Goals of the United Nations (UN-SDG, 2024), specifically Goal 4, which ensures that all learners will have both the knowledge and skills to promote and implement sustainable development and lifestyles that are cognizant of diverse cultures. Such a course would first need a review of the literature to examine paradigms of practice, critiques of the assumptions underlying practice, and calls for further research, all of which lend insight into the breadth and evolution of science and risk communication, including their applications in risk, disaster, and humanitarian communication.

2. The Pedagogical Context

The researcher belongs to a Jesuit educational institution, which uses Ignatian Pedagogy (named in honor of St. Ignatius of Loyola, the founder of the Jesuit Order). The Ignatian brand of education is in-depth and in context (St. Ignatius College Adelaide, 2020), where students must clearly see themselves, social structures, and the world, so that they can identify structures of oppression and therefore work toward a greater good (ICAJE, 1993; Trinidad, 2017), and thereby truly become men and women for others (ICAJE, 1993). Such a pedagogy centers on the learner, is driven by reflection, and oriented toward action (Go & Atienza, 2019).

This pedagogy has been studied for its use in teaching business strategy courses, since it emphasizes experience and reflection (Mauro et al., 2015) but it has the potential to support interdisciplinary courses as well, as it addresses multi-pronged problems (Trinidad, 2017).

In this pedagogy, teachers must first meet learners in their context. Teachers begin by making students reflect on their knowledge, giving space for students to examine where knowledge is lacking or needs nuance, and then providing the venue for students to exercise their knowledge (Go & Atienza, 2019). Ignatian pedagogy is also focused on social justice: the classroom is a space where students can study how they can best reach out to those in need while considering other people's standpoints.

In general, the pedagogy involves a cycle of context, experience, reflection, action, and evaluation (Go & Atienza, 2019; ICAJE, 1993): students remember their experiences so they can connect what they are learning to what they already know and understand; they then learn more so that their current knowledge is refined via reflection; they then work so that they can imagine how what they study connects to the rest of the world, sometimes via projects or papers (Pousson & Myers, 2018), and using real-world situations (ICAJE, 1993; Mauro et al., 2015; Pousson & Myers, 2018; St. Ignatius College Adelaide, 2020).

Ignatian pedagogy has undergone updating in recent years, though the core tenets of learning by doing and reflection paired with action remain. One of the latest, and most pertinent to the context of this research, is the book by Go and Atienza (2019) which has been used by this researcher's institution to conduct instruction both offline and online. Go and Atienza enrich Ignatian pedagogy through the concept of refraction, both a portmanteau of "reflection" and "action", as well as a description of the process of learning: students are not simply reflecting on what is presented to them or repeating what they read, but make the knowledge their own through connecting it to their lives, acting upon it, an appropriating it. For such refraction to occur, the modern Ignatian classroom must incorporate engagement, excellence, expertise, enthusiasm, empathy, and empowerment, which represent the three interacting spheres of the instructor, the student, and the world that must be learned. The teacher must empathize with students but must also empower them to be self-reliant. The teacher must know the subject matter as an expert that can make connections among ideas and facilitate learning processes so that students can realize these connections as well, and such teachers must be enthusiastic in the enterprise. The students should attain excellence in learning about their topic, but they must be engaged in it so deeply that they wish to learn more of it and take their knowledge beyond the classroom. Teachers, therefore, are not lecturers, but guides for the students; students are not merely receptacles of information, but they can take on varying roles, as inquirers, meaning-makers, and creators.

This pedagogy's focus on the learner as creator would not be philosophically and logically consistent with a Risk, Disaster, and Humanitarian Communication course that advocates for dissemination and appears to teach everything through lectures. The Ignatian focus on social justice, moreover, would not work with a course that does not recognize the diversity of local cultures, and erases such diversity through advocacy of single sources of legitimate knowledge. A Science and Risk Communication course would therefore need to advocate for social justice while respecting the students' ability to learn and create on their own.

The researcher belongs to the university's Department of Communication. In this department, all classes are tightly aligned with the principles of Ignatian Pedagogy, and all syllabi are created

with the principles of Outcomes-Based Education (OBE), which are prescribed to organize curriculum design, as well as to ensure that any assessment is meant to measure learning in concrete ways. OBE is an education model that shifts the focus to students and what they can do. In such a model, there are clear standards that are used to grade measurable outcomes which, when met, allow the student to move on to more complex courses (The British International School Kuala Lumpur, 2023).

The Department of Communication aims to produce graduates that can engage with the constantly changing field of communication and its issues in the public sphere. The students are grounded in both research and theory, but are enjoined to use this rootedness in exercising creativity. They should critically use media and communication perspectives, analyze communication and media phenomena at a variety of scales, conduct research to respond to issues, design communication interventions, and produce content that is responsive to needs while exercising ethical and social responsibility in their work.

Communication majors at the department are required to take multiple foundational courses: two theory courses in their freshman year, a course in creativity in sophomore year which introduces them to design thinking, a social change course in their junior year which introduces them to the role of media in society, and two research courses in their junior year that each tackle the basics of quantitatively-driven and qualitatively-driven research. When the students take the required CHED Risk, Disaster, and Humanitarian Communication course, therefore, they should already be equipped with ample theoretical and research foundations. As expected, and from previous literature, the students are technology-savvy, are accustomed to interactive learning, and are not engaged in material if they are simply lectured to (Go & Atienza, 2019; Ponce de Leon, 2023b)

Simply creating a course to make students communicate in such contexts, without linking the contexts to previous classes, and without considering the characteristics of the students themselves, would make the class look like a course out of place in the students' plan of study. An exclusively practice-driven approach, moreover, would render the course inconsistent with Ignatian Pedagogy, and would be deaf to the call to remove the ideological force of science (Feyerabend, 1975) and consult with multiple groups (Funtowicz & Ravetz, 1993). A course in Science and Risk Communication, therefore, would also need to connect to the students' existing skills and knowledge, as developed by previous courses, and under the principles of Ignatian Pedagogy and Outcomes-Based Education. In keeping with the university's aim for sustainability, the course would also have to be aligned with the tenets of UN-SDG4, which recognizes the role of local knowledge and culture in sustainability and sustainability education.

To create the Science and Risk Communication course, the researcher united previous research and critiques of practice in science and risk communication, including philosophies of science that call for its true democratization; Ignatian Pedagogy, with its stress on social justice and reflexivity; and the program of the department, guided by OBE, with its stress on research and practice rooted in theory. Uniting these strands would allow the researcher to produce a course that was not only attuned to local needs and contexts, but integral to students' intellectual development as practitioners and scholars, and contributing to the aim to produce graduates that would move governance out of its top-down models and into models that genuinely engage communities.

The course was first offered in 2019, before the COVID-19 pandemic, with minimal development on the theoretical front. Feedback from the first offering of the course was also useful in re-writing it so that it met pedagogical requirements and conventions, and so that it dovetailed with previous research in science and risk communication while being responsive to the context in which communication is set. The systematic process detailed in this paper allowed the researcher, as instructor, to address inadequacies in the existing course.

This paper is structured as follows: the researcher will synthesize previous research and practice in science and risk communication; and will unite these strands of research with the tenets of Ignatian pedagogy and the Department of Communication's program to show how the required course was designed. What resulted is a class that rebels against the notions of science and risk

communication as mere dissemination, science as the sole source of legitimate knowledge, and the concentration on creating messages based entirely on facts and information without first considering the audience that one aims to serve.

3. Science Communication as Both Research and Practice

Early research and practice framed science communication as a simple process of an expert conveying their research results to an audience, usually to clearly and effectively transmit information for the purpose of national development (AGTR, n. d.; Dohaney et al., 2016; Hebets, 2018). Science communication as an endeavor, especially when started early in a child's development, was meant to produce a scientifically literate society (Shivni et al., 2021). The messenger was often an academic, revealing that scientists equate communication with teaching and dissemination (Hebets, 2018; JHU, 2019; Longnecker, 2022). The message was often a shortened, "simplified" version of scientific reports (Aurbach et al., n. d.), which might incorporate the use of visual language, narratives, and metaphors to persuade people to specific action (Ruao & Silva, 2021).

Central to the practice of this older form of science communication was the supposed superiority of scientific knowledge (Baram-Tsabari & Osborne, 2015; Brown University Science Center, 2014) and the framing of social advancement as increased interest in STEM careers (Hebets, 2018). Older definitions of science communication, therefore, assumed that the public is homogeneous, ignorant of science (Baram-Tsabari & Lewenstein, 2017; Ruao & Silva, 2021), and needs only facts that will help them trust in science and act even without understanding the facts completely (Ruao & Silva, 2021; Shivni et al., 2021).

When put into practice, this older form of science communication measured effectiveness based on the message and messenger, not on whether the listener understood the information. If anything, listeners were expected to simply obey orders in a largely one-way process (Brown University Science Center, 2014).

To carry out science communication, messengers were expected to identify and understand their target audience, but know the appropriate language to use, curate facts, and stylize their work (Mercer-Mapstone & Kuchel, 2015). In such a model, science communication was easy to reduce to acronyms and slogans. Some examples include ABC, or accurate, brief, and clear, with a focus on simplifying facts and designing an "effective" message (AGTR, n. d.); the 7Cs, or comprehensible, contextualized, captivating, credible, consistent, courteous, and addressing concerns, which accompany a supposed dialogue with stakeholders (Dohaney et al., 2016).

Even while scientists were encouraged to reach out to and engage with the public in the early days of science communication, most projects were still about using the medium of dialogue to convey knowledge from scientific experts to a lay audience (Hebets, 2018; Brown University Science Center, 2014). The act of listening was not so much genuine engagement, but the act of appearing as though one were truly listening to encourage audience trust (Baram-Tsabari & Lewenstein, 2017).

The persistence of the deficit model carried over to how audiences were framed as lay groups that simply needed information (Brown University Science Center, 2014). Research, therefore, did not consider the audience or public, but focused on effective strategies to spread information through the media to make people learn science and therefore take action (Hebets, 2018).

Training in this older form of science communication therefore carried the same assumptions as practice. While some scientists recognized the pitfalls of being solely cheerleaders for science (Longnecker, 2022), others persisted in framing science communication as often the most important, if not the only way to respond to a crisis. For example, courses have used exercises such as experiential learning (Dohaney, et al., 2016); correcting badly written articles or poorly delivered presentations (AGTR, n. d.); and translating information into videos, infographics (Mercer-Mapstone & Kuchel, 2015), or comics (Robin et al., 2021) to popularize science. If there was any engagement with the audience, it was through the media that the audience was assumed to

patronize: through analyzing materials, students were asked to intuit who the audience was and its demographics (Mercer-Mapstone & Kuchel, 2015) – hardly a step into engagement territory.

More recent research, however, has shown that the problems of science communication are manifold and complicated. School might provide a way for people to learn science, but students are not engaged in its actual practice (Strauss et al., 2005) which alienates them from the field of science itself. The deficit model of communication is overused and problematic, and laden with assumptions about the public and its attitude to science (Spoel & Barriualt, 2011), as well as burdened by the notion of science as the sole source of legitimate information, which then makes indiscriminate use of such a model oppressive and exclusionary (Feyerabend, 1975; Funtowicz & Ravetz, 1993).

As a field, science communication is under-theorized and interdisciplinary (Baram-Tsabari & Lewenstein, 2017; Metcalfe, 2022): it must be informed by scholarship in communication, which is not merely about conveying information (MacArthur et al., 2020; Shivni et al., 2021; Stern, 1991) but is also a holistic, multidisciplinary field that considers culture, society, audience, and context (Dohaney, 2017).

Today's science communication draws from the fields of the natural sciences, social sciences, philosophy, and education (Dijkstra et al., 2020; Ragragio, 2021). It works with a science that is inclusive of all forms of knowledge (Ragragio, 2021), and that acknowledges that it is embedded in systems of power, where accurate and zero-bias information is unrealistic (Stern, 1991). Science communication, therefore, must be strategic: it must target a specific audience with clear objectives, a practice both unknown to and sometimes opposed by those using the deficit model (Ruao & Silva, 2021).

Science communication has evolved from being a cheerleader for science, to being a watchdog (Dijkstra et al., 2020). The intended results of communication are also more nuanced: understanding science, for example, must be parsed into skills such as understanding scientific information, understanding the processes of science, or understanding connections between science and society (Burns et al., 2003). Also more prevalent is an engagement model of communication, where both policy makers and scientists must find ways to work closely with the public in genuine partnership, beyond one-way flows of information (Burns et al., 2003; Dijkstra et al., 2020; Hebets, 2018; MacArthur et al., 2020; Metcalfe, 2022; Robin et al., 2021; Stern, 1991).

Any science communication approach should be designed according to the needs of a specific situation and group (Dijkstra et al., 2020), which necessitates partnering bench and social scientists to cooperate on strategies before engaging in any communication project (Hebets, 2018). Science communication can take place in any location in which a specific public can be found, such as schools or locations where the youth congregate (Hebets, 2018) as well as social media, public deliberations, and museums (Baram-Tsabari & Lewenstein, 2017).

Science communication is also distinguishing itself from science education, the latter of which enforces science as the frame through which the world must be understood, and prioritizes passing on information with the assumption that people will know what to do with the knowledge (Baram-Tsabari & Osborne, 2015; Hebets, 2018). Science communication, in contrast, welcomes different forms of knowledge and examines diverse ways of understanding the world. Even as the two fields learn from each other, their objectives and target audiences are distinct.

Training new science communicators, therefore, requires training in multi-sectoral communication to allow budding science communicators to interact with various publics (MacArthur et al., 2020). Such training should encourage the growth of skills such as focusing on an audience's needs, acknowledging the cultural underpinnings of communication, recognizing the legitimacy of different sources of knowledge and expertise (Longnecker, 2022; Shivni et al., 2021); using theory and practice in multiple types of media (Shivni et al., 2021); and employing systems thinking (MacArthur et al., 2020). Such science communicators might be trained in a variety of learning outcomes, including being excited and encouraging discussion about science; executing the actual project; reflecting on the intertwined roles of science, communication, and

society; participating in science communication activities; and developing their identities as science communicators (Baram-Tsabari & Lewenstein, 2017).

Knowing one's audience is not confined to looking at the audience from a distance. It entails recognizing the diverse groups to which science must connect (Burns et al., 2003) and acknowledging that each skill one has in science communication is determined by the nature of the audience, partner, or publics (Aurbach et al., n. d.). This knowledge must also be supplemented with empirical work: science communicators need to know how to check people's prior knowledge of a topic while integrating theory, context, social history, group structure, group culture, routines, and habits (MacArthur et al., 2020; Shivni et al., 2021).

This is not to say, however, that the deficit model has completely disappeared; no model of science communication is either perfect or all-encompassing. In fact, researchers critique all models for being classified based on who to blame for mishaps: the deficit model blames people for not being informed enough so that they do not obey science, the critical grassroots model blames scientists for failing to understand the nuances of society, and the conversational model blames both scientists and people for not working toward understanding each other (Metcalfe, 2022). Metcalfe (2022), therefore, advocates for the models co-existing in practice: for example, participatory models can allow people to incubate some trust in science and give scientists space to work on dissemination later if people demand it. Science communicators, therefore, must be trained in employing all models of science communication.

To carry out instruction in this multi-layered, multi-disciplinary brand of science communication also requires pedagogy that incorporates social sciences fields. There are some examples of programs that are developed as strands or minors for science majors (Longnecker, 2022) or junior high school students (Spektor-Levy & Bat-Sheva, 2009). However, the aims are still driven by assumptions of older science communication. Other programs nevertheless embrace new models of science communication by doing away with the intuitive, often wrong notion of equating communication with teaching, such as by stressing on public engagement, working with the media rather than in it, learning social sciences research methods and communication theory, and strategic communication for specific audiences in specific contexts (Hebets, 2018; Longnecker, 2022; MacArthur et al., 2020). Having a practical aspect to science communication is still paramount, as it helps students know what science is about while being able to practice what they propose (Baram-Tsabari & Lewenstein, 2017; Spektor-Levy & Bat-Sheva, 2009; Strauss et al., 2005).

To continue fostering inclusive and theoretically-sound science communication, educators have also been exhorted to teach science as inclusive. That is, science is not a producer of clear truths; rather, it is about uncertainty and debate, so that conflicting messages are interpreted not as way to sow confusion, but to provide varying perspectives of truth (Christensen, 2009; Stern, 1991). Those instructing future science communicators have also been enjoined to add a stronger base of communication theory to courses (Longnecker, 2022).

Research in science communication, though still showing paradigms in the deficit model, is also more open to newer models of communication. In particular, more research examines two-way flows, or an exchange of information between science and the public (Spoel & Barriault, 2011). More researchers and theorists, however, are calling for transdisciplinary collaborations among different fields and a stronger critique of science as practice (Longnecker, 2022).

Science communication instruction in the context of the Philippines, therefore, and given previous research, should teach students to appreciate and execute the various models of science communication; know how to reach out to varying audiences using the tools of social sciences research; and critically examine science as a field via its nature, rather than its facts.

4. Risk Communication as Both Research and Practice

Risk communication used to be framed as a field that communicated scientific information as a way to solve a crisis (Christensen, 2009; Dohaney et al., 2016) by using experts to reach out to an information-hungry public that had no agency (CDC, 2002; Ng & Hamby, 1997; Roislien et al. 2022; Spoel & Barriault, 2011), used science to make decisions (CDC, 2002), and obeyed multiple

warnings from multiple sources that repeated them from a template (Sansom et al., 2021). School classrooms became venues for disseminating information: various countries used classes to inculcate values and coach children as ambassadors, as it were, for communities at risk (Ratiani et al., n. d.).

Older forms of risk communication, therefore, defined the problem as people not understanding scientific information, which led them not to trust science, and which therefore led to poor risk management (Crick, 2021). This practice saw sound science as central to risk management, where science was presented as an objective, unchanging truth battling non-scientific emotions and opinions (Crick, 2021), and where scientists were the sole heroes and experts of risk solving (JHU, 2019) who would identify the situations of risk so that risk communication experts could later be employed to sell a decision to the public (Spoel & Barriault, 2011). This was most apparent in the latest COVID pandemic, which was framed as a problem of attitude change that could be solved by experts who explained the pandemic using only scientific terms (Roislien et al., 2022).

Governments that ran on such a risk management platform also assumed that because people could not understand policies, then they would not agree to a policy – which does not take into account local knowledge, trust, emotions, understandings of the concept of risk, and the fact that having all the information does not necessarily lead to people being more empowered to make a decision (Abbot & Wilson, 2015; Chess et al., 1988; Crick, 2021; Ng & Hamby, 1997; Ponce de Leon, 2021b). Older models focused on bringing a "low" public to the "high" and "rational" science, where messages were simply designed to suit a general public's tastes (Campbell et al., 2020; CDC, 2002; Spoel & Barriault, 2011). If there was any dialogue, it was designed to manipulate an audience to receive information later in a rational, unemotional way (Spoel & Barriault, 2011).

Early forms of risk communication training reflected the top-down nature of risk communication itself. Some researchers recommended that people receive a deeper understanding of science, while scientists could simply be trained in the principles of risk communication (Crick, 2021). Risk communication was also not widely taught. Doctors require it in their practice, for instance, but the topic is hardly tackled in medical school; if it is, students are instructed mostly through seminars or lectures, with no mentoring on how to interpret research data for patients, or how to talk to patients in real life (Baessler et al., 2020).

Teaching risk itself is a challenge, since science instruction provides an image of science that is static and authoritarian: scientific knowledge is uncertain, but school science reduces it to variables; science itself is one among many fields that share power in society, but school science puts scientific knowledge on a pedestal; science functions on negotiations and discussion, but school science is lecture rather than discussion based. Risk should therefore be taught as something context driven and socio-cultural, rather than simply measured through scientific and mathematical means (Christensen, 2009).

The mathematical approach to risk communication has been heavily criticized for its assumption of people perceiving technology in homogeneous, predictable ways, so that simply presenting them with technology's benefits will lead to them accepting it without question (Stern, 1991). The approach has also been criticized for its implicit definition of risk as objective, rather than embedded in democratic systems (Stern, 1991) so that people's assessment of what is risky will also be widely divergent, even contradictory to what scientists might assess (Chess et al., 1988). Research does show that the public does not define risk based on knowledge; rather, risk has to do with a perceived lack of control, such that the hazard can be isolated from the outrage that it creates (Chess et al., 1988; Sandman, 2012; Sansom et al., 2021).

The dissemination, science information-based approach to risk communication is still in use today. Even when authorities ask for feedback from their constituents, they still seem to operate in a one-way process masquerading as two-way because the burden of providing knowledge still falls on the scientists (CDC, 2002), and is still contingent upon the centrality of science (Spoel & Barriault, 2011). The community being dealt with is often referred to as a stakeholder, but this term also denotes privilege, as stakeholders are often assumed to follow orders rather than be engaged

with (Spoel & Barriault, 2011). These are consistent with the weaponization of science as ideology, so that risk is reduced to variables rather than placed in its context in everyday life.

There is a slow change in risk communication in practice. Information is now defined as being distinct from influence (Ng & Hamby, 1997). Risk communication is gradually becoming about public participation and calming rather than a top-down transmission of knowledge for higher science literacy (Sandman, 2012; Spoel & Barriault, 2011).

In its newer form, risk communication still acknowledges the disadvantage of excessive use of jargon, but also recognizes that oversimplification of information is equally bad (Chess et al., 1988). In addition to scientific information and trustworthy sources, messages need local knowledge, storytelling, and a chance to clarify information and ask questions (Campbell et al., 2020; Crick, 2021). Because people read a risk against their lives and realities, interpersonal relationships become important in ensuring mutual understanding among all parties involved in a risk (JHU, 2019).

The public is increasingly being seen as diverse, requiring consultation rather than mere information, from different demographics that have to be understood, and with their own frames of knowledge and experience through which they understand risk messages (CDC, 2002; Chess et al., 1988; JHU, 2019). The public is now one to be engaged with in closer quarters, so that the conversation is more political and specific, rather than large-scale information conveyance from the so-called experts to the so-called non-experts (Allen et al., 2017; Chess et al., 1988; Ng & Hamby, 1997; Stern, 1991). Risk communication is not how to speak better, but how to listen better to find out what people fear, what they think they can or cannot control, and who they trust; cultures and their symbols, therefore, need to be investigated further (Sandman, 2012).

Risk communication researchers and scholars alike now spend time understanding local understandings of risk. This might take the form of identifying local needs (Chess et al., 1988), using publicly available data to examine community identity, starting partnerships with communities, listening to stakeholders, and identifying who people trust (Campbell et al., 2020). Both scholars and practitioners also work in community consultation, such as by encouraging community involvement and engagement, working with community leaders to relay information to hard-to-reach places, and even allowing people to define the causes of a problem so that they can take ownership of their solution (Campbell et al., 2020; CDC, 2002; Chess et al., 1988). Whatever the case, research should be at the helm so that risk communication efforts fit the needs of specific groups or communities, country culture, and local perceptions and knowledge of a specific risk (Abbot & Wilson, 2015; Allen et al., 2017; JHU, 2019; Sansom et al., 2021).

All good risk communication, however, always occurs in the context of good policy (CDC, 2002; Chess et al., 1988) and citizen cooperation (Sansom et al., 2021). There, too, are still unresolved issues in risk communication research, such as how to convey the uncertainty of science (Chess et al., 1988; Ng & Hamby, 1997); the use of social media and smartphones (Allen et al., 2017); and fake information (Allen et al., 2017).

Newer forms of risk communication require new forms of education. Classroom techniques might include brainstorming (Baessler et al., 2020; Ratiani et al., n. d.) and risk communication embedded in the context of different subjects (Baessler et al., 2020). Students are now given more practical contexts to work with, whether online or offline; and they engage with the subject through groupwork, role playing, and case studies (Baessler et al., 2020; CDC, 2002; Dohaney, 2017; Han et al., 2016). Researchers likewise recommend an atmosphere, both in instruction and practice, of interdisciplinary science (JHU, 2019), and to teach students about the contemporary nature of science, which accepts uncertainty and the interdisciplinary nature of valid knowledge (Christensen, 2009).

Research into risk communication hitherto focused on best practices and the aim of instilling control into a public perceived to be ignorant and panic-driven (Allen et al., 2017). Newer research challenges these assumptions as findings show that the publics of risk are diverse, and, in some cases, do not base their risk decisions on information from the mass media. Instead, they factor in trust, source credibility, even the decisions and orders of their family or social media (Sansom et

al., 2021). Today, research in risk communication relies on feedback from direct interaction with publics, such as through surveys and focus groups; it discourages a "just the facts for the public" approach and advocates for longitudinal studies (Campbell et al., 2020; Roislien et al., 2022). Demographics, audience knowledge and needs, and context are of greater concern (Ng & Hamby, 1997). Poverty, for instance, changes the communication approach: in disadvantaged, vulnerable communities, trust in the government is much lower, and the density of people can make disease-related risks much harder to contain (CDC, 2002; Sansom et al., 2021).

Risk communication instruction in the context of the Philippines, therefore, and given previous research, should teach students to appreciate the social embeddedness of risk, and how appraising it is dependent upon factors outside of knowledge and education; know how to reach out to varying audiences using the tools of social sciences research; and appreciate the uniqueness of different risks.

5. Creating Science and Risk Communication as a Course

When the AB Communication curriculum was first created, students were envisioned to be both scholars and practitioners in the field of communication. The department's version of Risk, Disaster, and Humanitarian Communication would not train students to be mouthpieces for science; rather, in its abstract form, the course would be a place for students to start learning about how research, creativity, and social change intersect, but how this intersection must be systematic. These aims were part of the first iteration of the course; but following deployment, the researcher found that the course needed even deeper grounding in social justice, the Ignatian Pedagogical Paradigm, and previous research into science and risk communication to make it more consistent with the department's goals, attuned to the students' identities, and responsive to social needs.

Teaching such a course would require a strong grounding in social justice, leaning toward Freire's Pedagogy of Solidarity (in Gaztambide-Fernandez, 2012), where students are taught about sitting with the marginalized, understanding them, and helping them see how they are slaves to circumstances and power; as well as in a radical philosophy of science, where science is stripped of its monopoly on legitimate knowledge, and where all forms of capacity are given consideration (Blackie, 2023; Feyerabend, 1975; Funtowicz & Ravetz, 1993). These philosophies, consistent with Ignatian Pedagogy, would therefore allow students to see communication not as a simple act of information transmission, but sharing of meaning, community empowerment, acting on community feedback – and an acknowledgement that all these paradigms are rightfully called communication, and should be used only following well-planned, strategically-created research. The course therefore had to be more all-encompassing, hence its conversion into Science and Risk Communication.

In this sub-heading, the researcher will walk the reader through the process of creating COMM 24: Science and Risk Communication, incorporating previous research, Ignatian pedagogy, the department's aims, and the logistics of modules and lessons within the OBE framework.

5.1. Previous Research, Ignatian Pedagogy, and the Department's Aims

The researcher projected a course that would teach science and risk communication as strategic fields. Here, research would play a role in allowing students to ask specific questions about a public, recognize diversity in their publics, and seek to meet communication needs. Such a course would reinforce the systematic nature of social sciences research, and in doing so, help students acknowledge the broad base of communication possibilities in science and risk communication.

The course would need to be diverse in its treatment of issues and publics. It would have to tackle different science-related issues, where each issue would be examined as a communication problem that has to be understood, and that can benefit from a research-based communication intervention. The previous version of the course examined case studies, with some proposals on improving communication. This updated version of the course would have to allow students to systematically "learn by doing" using their research and theory backgrounds.

The course would have to provide students the scholarly tools to deal with the issues besetting science and risk communication: the expectation that simply providing scientific information is enough; the notion that dissemination is all that is needed; the assumption that all publics are the same and need only the same message to be compelled to take action; and the mindset of scientists that all shortcomings of science and risk communication can be remedied with either more scientific knowledge, or more research that is broad-based rather than contextualized and deep.

To do this, the researcher would need to weave the nature of science and risk into discussions by introducing philosophers of science and risk. The researcher would then need to introduce the diverse ways of practicing communication, via their guiding paradigms: dissemination and its post-positivist base, grassroots efforts and their links to critical theory, and conversational models and their roots in constructivism.

Once these philosophical pieces were introduced, they would then figure heavily in subsequent discussions regarding the Philippine context and the role of science and risk communication. The course, therefore, had to be richly immersed in the Philippine context, where there are multiple issues to be studied, and multiple publics to be examined and catered to, given the low volume of research on Filipino cultures and sub-cultures. This context should include natural hazards (volcanic eruptions, flooding, rain, climate change, pandemics) but these diverse hazards should not be treated as a single hazard for which the same communication approach should be used.

The science and risk communication course would also have to be distinct in its treatment of the two fields of science and risk communication. Without any distinctive treatment, students would be in danger of subscribing to the notion that simply sharing scientific information is enough to address risk concerns. This would entail having a separate module on science communication, as well as lessons on how risk and science are separate constructs.

Finally, the course would have to fit within the principles of social justice, as embedded in Ignatian pedagogy. It would require students to reflect on their work and practice, acknowledge the multiplicity of voices and cultures, and then work with this multiplicity rather than ignore it. The course would also have to be consistent with the aims of the program in forming critical, creative leaders and practitioners in the field. Such a course would therefore meet the UN-SDG4 of recognizing, studying, and incorporating local knowledges and cultures as part of sustainability education, and to equip all learners with knowledge and skills to exercise such techniques in their lifestyles and professions.

5.2. The Learners

The department's Communication majors belong to a generation raised on technology, social media, and a world that is interactive online, though with not as much social activity offline (Go & Atienza, 2019; Ponce de Leon, 2023b; Pousson & Myers, 2018). They would have had some experience with science as coursework as well as through online media, which would have been thick with news on the COVID-19 pandemic, typhoons and flooding, earthquakes, volcanic eruptions, and other science-related issues. Because they come from diverse locations, they would also have had some experience with the many natural hazards that the Philippines faces. And because some of them have actually stepped into the campus, they would have some acquaintance with the laboratories and the rich biodiversity of the campus' green spaces.

The students would already have taken communication theory, creativity, social change, research, and philosophy and theology classes by the time they take the Science and Risk Communication class in their third year. They would not yet have embarked on their internship, so they might not have the sensibilities of the workplace and will need an introduction to systematic thinking that can help them navigate the communication industry as professionals. They would not yet have worked on their thesis, so the course could be a bridge between all their coursework and the synthetic work that goes into the undergraduate thesis.

The course would therefore have to be designed for learners who are well-acquainted with technology and are digital natives, and who learn best when there are varied methods of teaching course content. The course would have to incorporate their previous learning while preparing

them for the foundational courses to come. Such a course would not be confined to lectures, but should engage students in discussion, allow them to bring their experiences and previous coursework to the classroom, and allow them to use technology as a way to both encourage social presence in the online classroom (Ponce de Leon, 2023b), and as a resource to find and critique science and risk communication ventures outside of their known contexts. In this manner, the students' online participation is used as a means to teach them, but their class discussions are also meant to develop in them a capacity to carry out the same enthusiasm and lucidity of discussions in face-to-face conversations – a skill that they will need in the communication workplace later.

By incorporating the students' context and focusing students' attention on the voices of diverse publics, the course could allow students to reflect on their own experience as part of a society rather than as individuals simply examining a hazard. This reflection would hopefully lead to creation of public-specific, hazard-specific communication that incorporates the students' ability to both reflect and create in the Ignatian pedagogical paradigm (Go & Atienza, 2019).

5.3. The Course Learning Outcomes

Given the need to work within a context of risk and natural hazards, science and risk communication in need of supporting research, and a need to understand multiple publics, the researcher formulated the following course learning outcomes:

1) Students should be able to articulate the varying paradigms and theoretical frameworks that underlie research and practice in science and risk communication – Students can work with concepts in the nature of science, the nature of risk, and the nature of communication, so that they can think conceptually and conduct social sciences research.

2) Students should be able to critique efforts in science and risk communication practice through the use of paradigms, theory, and the nature of science – Students can critique research and practice using the tools of philosophy and logic (especially in democratizing science, consistent with Ignatian pedagogy).

3) Students should be able to design research to improve science and risk communication for specific issues – Students can help address the need for contextualized science and risk communication research and practice, especially in the Philippines, where risks are high but regard for, funding for, and engagement in research is low.

4) Students should be able to develop proposals for projects to improve science and risk communication for specific issues – Students can link projects in science and risk communication with research, so that students always link their projects to a context and a specific public.

5.4. Teaching and Learning Assessments Arising from the Outcomes

Given the learning outcomes, the researcher crafted specific teaching and learning assessments that would allow students not only to learn about theory, research, and practice, but work in the Ignatian pedagogical paradigm of active learning:

1) Students should be able to articulate the varying paradigms and theoretical frameworks that underlie research and practice in science and risk communication – Students are required short essays that articulate a research problem following a review of research literature. They should be able to imagine how a specific scientific and/or risk issue can be widely communicated through live exercises in class that engage their creative faculties, but that also make them consider paradigms and philosophy.

2) Students should be able to critique efforts in science and risk communication practice through the use of paradigms, theory, and the nature of science – Students are required short essays that critique existing Philippine-based science and risk communication projects by elucidating the target audience and apparent objectives. They should also be able to critique their own practice by presenting, at the end of the semester, their best research or project proposal, so that their classmates and instructor can give them constructive criticism.

3) Students should be able to design research to improve science and risk communication for specific issues – Students are required to develop capsule research proposals specific to a public for a specific science or risk communication issue.

4) Students should be able to develop proposals for projects to improve science and risk communication for specific issues – Students are required to develop capsule research-based project proposals specific to a public for a specific science or risk communication issue.

5.5. Involving Scientists

This course did not directly involve scientists, but they were, in a manner of speaking, resource persons for students to examine science as a field of study and practice. The resource persons did not lecture students on information, which would have led students to believe that their job was to simply disseminate the information. Instead, the researcher interviewed scientists on camera, and talked to them about their research, but from the point of view of what they enjoyed doing and what they thought their role was in knowledge generation. This allowed the scientists to speak more candidly about their work, and gave students the chance to listen to the language of science without being burdened by the technical terms.

These experts included researchers in the fields of biodiversity, geology, climate science, and epidemiology. For the module on Typhoons and Flooding, the students were encouraged to look for their own science resources, with the hope that the remote encounter with scientists would also prompt the students not to be intimidated by the image of science. This approach, the researcher hoped, would allow the students to engage with science and scientists, rather than simply wait for science to provide information.

5.6. Arrangement of Modules to Address Assessments

The researcher designed online modules to address the assessments that were needed, taking into account Ignatian pedagogy and science and risk communication research, and using an approach putting social sciences research at the forefront. This approach would hopefully prime students into dismissing the notion that scientific information alone is necessary and sufficient for science and risk communication.

Each online module would open with a reflection question that would help the students remember what they had undergone as people exposed to risks and science. This reflection is consistent with Ignatian pedagogy, which begins from the experience of the learner. The professor would still meet the students, whether in an online or offline classroom, to welcome them to the module using a class brainstorming activity to ease them into the module topic.

The reflection question would be followed by a video of a scientist talking about their field, research, and the hazard. This is meant to introduce students to science as practice and culture, rather than static facts. This would help them see scientists as operating in a field with its unique culture, rather than people simply producing information.

The learners would then have to randomly choose a specific public to which they would cater for that module. This is done through online generators, which matched students with a public. These publics were unique to the Philippine context and, in catering to them exclusively in a unique way for each module, the researcher hoped that the students would understand and appreciate the diversity of Filipino publics. The following are the most salient publics from which the students could choose: elementary school age children, high school students, college students, out-of-school youth, urban poor, stay-at-home mothers, young adults in the workforce, senior citizens, fisherfolk, farmers, persons with disabilities, and local government units in a specific province.

The students would then be given time to:

1) Discuss a research problem in communicating with that public, always avoiding the idea that the public does not know enough – this allows learners to avoid assuming knowledge deficits and falling into the trap of the dissemination model without first conducting prior research. It also prepares them for a research proposal.

2) Demonstrate how that public has been addressed before for a specific risk – this allows learners to critique an attempt at communication by talking about what the attempt is, who the apparent intended audience is, and how the attempt represents science using a philosophical lens. This will allow the students to discuss science and risk communication from philosophical and conceptual perspectives, and give them ideas on how to proceed further with their own project.

The students propose research (with a specific flow: introduction, research problem, research question, theory, and methods) and a project (with a specific flow: introduction, communication problem, context, information on the chosen public, research design, creative decisions). Note that the research problem elucidated earlier can inform the research proposal, and that both the research problem and the pitfalls of previous projects can both be used to create the project proposal.

5.7. Larger Module Themes

The researcher's university operates on a 15-week semester with a recommended load of 6 learning modules. This necessitated the creation of modules built around the following topics:

1) The Theories of Science and Risk – This would acquaint students with the lenses through which they could view science and risk communication as scholarly fields. These lenses would then inform their analysis of a research problem and critique of a communication solution.

2) Science Communication (represented by a topic that is close to the students' location, in this case an initiative to document wildlife on campus as a representative of biodiversity initiatives)

3) Unpredictable Hazards (represented by Earthquakes and Volcanic Eruptions, for risks that cannot be predicted with certainty)

4) Current Hazards (represented by COVID, for risks that are in the public consciousness)

5) Long Term Hazards (represented by climate change, for risks with multiple causes and repercussions)

6) Normalized Hazards (represented by typhoons, for risks that might no longer be in the public consciousness because of their normalization and all-too frequent patterns of occurrence, but for which the public must nevertheless be prepared)

The main topics of the activity modules were chosen based on their proximity to the students' context, which would better allow them to critically reflect on their environment and, possibly, the science in their everyday lives that they unknowingly take for granted. The researcher therefore chose risks that are salient to the students' immediate context (campus events, COVID) and the Philippine topographical context (earthquakes/volcanic eruptions, climate change, typhoons), all of which, when parsed for their unique characteristics, would allow the students to also create nuanced research and projects for specific publics.

5.8. Creating the First Module

The students needed a strong foundation and review in theory. The researcher therefore devoted the first module to philosophy in science and risk.

In this module, students must read and discuss seminal texts by Karl Popper, Thomas Kuhn, Imre Lakatos, Silvio Funtowicz and Jerome Ravetz, and Paul Feyerabend to see the evolution of philosophy through time, as well as to discuss the theoretical basis of all the different paradigmatically-driven methods of science communication (derived from Trench's 2008 seminal work).

They then must discuss the concept of risk, as both a mathematical and social construct. These discussions should lead them to appreciating how the different models of science communication can also be applied, to some extent, to risk communication practice; but this should also help them realize that risk communication is distinct from science communication in practice and theory.

This module will form the basis of the students' critique of science and risk communication attempts in the activity modules later, so the students are drilled in discussions which, though not written, hopefully prime conceptual rather than design-level critique.

5.9 Brainstorming Activities

To both facilitate discussions and encourage students to interact online (when the revised course was first introduced), the researcher provided multiple brainstorming activities that would allow students to work in groups or as a class toward a goal that had to be completed during class time.

Brainstorming involved students either discussing what they knew to produce a final project or idea, or giving each student the chance to speak up during class, and under a set time. Such an approach helps students reflect on what they know, since they cannot come to brainstorming sessions without first reading about a topic; reflect on what their knowledge can be used for; and then develop a project, so that they learn by doing. This would allow the class activities to be further aligned with Ignatian pedagogy and its cycle of learning and reflecting (Go & Atienza, 2019; ICAJE, 1993).

At the start of every module, students had to brainstorm the plot and story trajectory of a communication project, whether it was a radio show, soap opera, streaming drama, or film. These varying formats have been shown to be effective in science and risk communication in different contexts, but because students had limited resources to mount a production, the class time was used for the students to plan a story out for a specific audience, and then narrate their part of the story in class. Students would be called out randomly, and each student would be asked to keep adding to a story, or to plan out promotions for a production, or to even cast the production based on what they knew of the production's audience. Examples of such projects included a radio show that taught the importance of vaccination to teenagers who lived in urban poor communities, a Netflix series that would help Filipino housewives practice recycling at home, a soap opera about biodiversity set in pre-Hispanic Philippines for students to appreciate both history and nature, and a movie about climate change unique to the Filipino agriculture experience.

This took place at the start of every module to both ease the students into the work of the module, as well as to give them the chance to speak up and enjoy each other's presence (which was especially important during the pandemic). The brainstorming exercises were also opportunities for the students to see that they could be creative as a large team, even without technologies and equipment on hand.

Further on in each module, the students had to meet in class for formal brainstorming for each part of their proposals. Again, they could not come to class unprepared. They were placed in Zoom rooms with their groupmates, where they had to brainstorm each part of their proposal, in logical sequence, taking care that their research problem could be understood by a theory which could be measured through specific research methods (Research Proposal) and that their communication problem could be solved by a research-based communication intervention (Project Proposal). Each proposal was broken down into component parts so that the groups could discuss what they wanted to do for each part, without forgetting the logic of the previous part; and so that each group could see that they could work on individual parts of a proposal and come up with a large project that would not overwhelm them in its magnitude.

All these brainstorming sessions were strictly timed so that the students could finish their work within the class time. They simply needed to bring in their notes on the previous research they had read and what they believed was their research problem, so that they could contribute to the group discussions and help move a proposal forward. This brainstorming technique helped them bond online, and allowed them to move past the crippling sight of a blank page when starting a first draft.

At the end of the brainstorming sessions, the instructor went from one Zoom room to the next to take questions, but on limited time, so that the students could be sparing in their inquiries and could work toward self-reliance. This allowed the instructor to act as a guide and mentor, rather than a mere lecturer, consistent with Ignatian pedagogical principles (Go & Atienza, 2019).

5.10. The Varying Iterations of the Course

An early version of this course was tested in 2019, where it was first offered as an onsite elective open to all majors. There were more student presentations and guest speakers. However, there were fewer opportunities to practice science and risk communication that was theoretically-grounded and research-based. The communication majors liked how they were able to use communication theories, but also wanted more frameworks to show them how theories worked in science communication. Given the feedback from the majors, the researcher deemed it best to make theory more central to the research proposal process, as well as to make the class a union of both research and practice.

The course was offered as an online, foundational subject in 2021. The students were divided into groups and made to critique previous attempts in science and risk communication using the lenses of the philosophy of science, reflect on their experiences, articulate research problems, and develop research and project proposals. They were given a choice on the specific public to which they would cater. The students also had the brainstorming creativity exercise to open each module, where they could reflect on both their experiences and what they saw in the media by building a story around a specific hazard, using different modalities. The students found the course difficult at first and constantly negotiated deadlines, which the instructor did not allow. The students, moreover, had chosen to wait until the middle of the semester to begin working on their requirements, as the university faculty had been given the order to have lax deadlines. In response, the researcher decided to remove this laxity and impose strict deadlines, allowing students a structure around which they could work.

While the students still complained about the workload, they did say in exit interviews one year later that they had learned how to organize their thinking through their work in the course. They also wished that they could apply what they had proposed, because their proposals were ready for implementation. Strangely, the students complained about the course activities being repetitive (even as they had to investigate different publics, phenomena, and theories each time).

The course was re-evaluated and reoffered, still online, in 2022. The students were still divided into groups and made to critique previous attempts at science and risk communication, reflect on their experiences, articulate research problems, and develop research and project proposals. This time, however, they were assigned a public in a random sorter for each module, with no repeated publics throughout the semester. They still did their brainstorming exercises as a class, all for team building and social presence.

Again, the students found the course difficult and complained about the workload, but only less frequently, as the requirements were spread out in strict deadlines across the three months of the semester. In exit interviews one year later, the students said that COMM 24 helped them design communication interventions or programs that were rooted in theory and research, be critical about grassroots initiatives, appreciate locally grounded perspectives, see communication as a field covering a wider range of concepts such as sustainability and inclusivity, and prepare them for the thesis.

The course necessitated re-evaluation because it was offered onsite in 2022-2023, and the exercises that had characterized the online course might no longer be viable. The researcher also had to test the course's ability to be transferred to new instructors. This time, the instructors had more discussions in person, and proposals were written in bullet points, as a prompt to discussions with an adviser or mentor. One instructor also tried to prepare the students for thesis work by making them develop a full proposal that could be passed at the end of the semester.

Not all the instructors treated the course and the philosophies of science in the same manner. One instructor relied heavily on the dissemination model assumptions of science being a source of information, which was then applied in frameworks that considered local psychologies and sociologies of the Filipino. Another was more focused on the cultural studies aspects of science communication. This resulted in uneven treatment of the course material, though the research and project aspects remained. This allowed the course to still adhere to the principles of Ignatian

pedagogy, where students reflect on their experiences and allow it to power creations that help them refract their learning (Go & Atienza, 2019).

6. Lessons Learned from the Implementation of the Course

Implementing a work-heavy, theory-driven course taught this researcher the disparity between the online and offline learning modes. When the course was first offered onsite, there was an assumption that students needed to be given a lighter workload, with a stronger stress on practice. The students, however, had all had some experience with theory, though in a range of degrees for different fields of study. Their demand for a course that focused on frameworks and theory was a testament to their need for a systematic treatment of science and risk communication as fields founded on research.

When the course was first offered online, there was an assumption that students would read extensively, and apply conceptual thinking following classes in communication theory. However, students felt disengaged from online classes in general, so the researcher had to constantly make them participate in creative exercises in class. This allowed the students to experience social presence of both their groupmates and the instructor. Both the 2021 and 2022 cohorts appreciated these exercises, as well as the logical thinking that research and project proposal development had encouraged.

The onsite class could not work like the online class: there had to be more discussion so that the students could re-learn the social skills of engaging peers in conversation. Rather than working on several small proposals as major requirements throughout the semester, the students wrote bullet-point proposals, which guided their discussions with their instructor. The students then submitted a single proposal at the end of the semester, with chapters broken down into component parts during the semester, so that they had a longer time to "incubate" ideas. This helped the students think deeply about social justice as part of their proposals, rather than as a forced concept based on time limits.

While there is no way to measure it, the researcher hopes that the class helped students think of science as only one among many legitimate modes of inquiry. The researcher hopes that the students fully felt the immersion enabled by the Ignatian pedagogical paradigm, which stresses reflection and creation, rather than simply sitting and listening. The researcher also hopes that the course requirements helped students see how science and risk communication are not about the facts as espoused in a message, but as complex processes that must be understood against specific contexts.

7. Concluding Remarks

The Philippines' main government agency for higher education mandated a Risk, Disaster, and Humanitarian communication course, with the hope of providing future media practitioners the tools for communicating with an amorphous lay public. This mandate, however, was not suited to this author's specialization in science and risk communication: the fields have moved beyond mere dissemination and are now seeking to understand the multiple sciences and contexts of the many publics to which communication caters. The researcher, moreover, works as a faculty member in a Jesuit university, which seeks to carry out education to meet multiple UN-SDGs, and which operates on both OBE and Ignatian principles of pedagogy. Ignatian pedagogy veers away from lecturing to students, and instead treats them as learners who must first reflect on their values and knowledge (Go & Atienza, 2019; ICAJE, 1993); reflection and discernment are likewise techniques for reaching out to many publics.

The researcher, therefore, used multiple sources of science and risk communication critique and practice; her own research; and the principles of OBE and Ignatian pedagogy to create a science and risk communication course.

What emerged was a course rooted in social sciences research principles, whether the students would propose research or a communication project. The course would begin with lectures and discussions on the philosophy of science and risk, followed by modules on issues unique to the

Philippine setting. Each module featured a talk by a scientist, followed by critiques of previous science/risk communication attempts, uncovering problems unique to a specific public under the issue, then two major submissions: a research proposal and a project proposal. Within the course, students had to keep brainstorming with each other in groups or as a class, whether it was to create a story around a hazard or to develop their proposals based on social sciences principles.

After several iterations, the researcher found that students need to be taught to appreciate, uphold, and practice a stronger base of social sciences research to inform their practice. The class provided an environment for such research to be conceptualized, though students wished for more venues to practice what they proposed. The students also reported being more organized in their thinking, prepared to conceptualize and conduct research, and appreciative of the breadth of communication as a field.

The strategy of uniting mandated pedagogy with previous research can be fruitful for professors who want to teach transdisciplinary courses. This method can enrich classes that are required by higher government bodies by providing a scholarly basis for teaching and learning assessments, rather than simply following templates that might be based on intuition.

This paper provides an example of Ignatian pedagogy in action, in both online and offline classes, and for a subject that has suffered from intuitively, though erroneously designed curricula. In using Ignatian pedagogy principles such as reflection and action, and the current refraction (Go & Atienza, 2019), the researcher hopes that future classes in such a multi-dimensional, transdisciplinary field will also allow students to think and act beyond mere dissemination of scientific information. In using principles of Ignatian pedagogy, future instructors might be able to unearth in students a combination of creativity and systematic thinking, both of which are required to create communication that is grounded in the voices of the marginalized and that is responsive to their needs in specific hazard situations.

This paper provides, as well, a research-driven method of creating course materials. The researcher united her research findings, previous research on science and risk communication, and the principles of Ignatian pedagogy to first formulate learning outcomes. These learning outcomes were then used to create modules and specific assessments, and these modules were arranged in a logical manner.

The course, however, must be strongly aligned with a department's mission and vision, as well as previous courses. Students were not as well versed with theory and could not always engage research texts. Even as the scholarly base of the course was strong, the students' scholarly foundations were not as well laid. This means that previous courses must be stricter in their assessments to ensure that students can move to higher courses.

This paper also has implications for science and risk communication instruction. It is possible to root science and risk communication teaching in both theory and research, and such a practice helps learners organize their thinking so that they can conduct theory-based work regardless of topic. Such an approach can help learners appreciate the value of communication as a social sciences field of scholarship and practice, which can, hopefully, allow them to see the equal power that must be accorded those who work in these fields.

Future research into science and risk communication instruction should empirically examine the effectiveness of the learning outcomes. Students should be assessed on how they understand theory and its role in research, how well they understand the links between theory and method, and how well they link research findings to practice. These should be conducted in the long term as well, to see how the learning outcomes are both internalized and practiced.

The department will continue to offer this course as a required class for as long as the new curriculum is in effect. For onsite classes, however, COMM 24 must be more discussion-based, where discussions guide students' thinking toward designing research and project proposals, while encouraging creative work that can enhance social presence in the classroom. Nevertheless, the students' ability to harness technology as a learning tool should be utilized to help them in these discussions, develop research and projects that are responsive to the needs of specific publics for a specific hazard, and brainstorm projects that allow them to have a voice even offline.

Science and risk communication are rapidly growing fields, and they incorporate communication as practice, but root it in philosophy, sociology, and psychology. The transdisciplinary nature of science and risk communication, once incorporated in a course, can help students appreciate the complex nature of the world in which they live. When science and risk communication are freed from the shackles of the assumption that scientific information alone is necessary for reaching out to a single public, then communication and social justice will truly have served each other.

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