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學術對談

科技傳播：跨越學科與文化之塹

對談人：邁克．舍費爾、宋韻雅、徐妙

邁克．舍費爾教授
（Prof. Mike S. Schäfer）

「科技傳播研究在很早以前就已經具備了跨學科的特點，並且在長期的兼收並蓄之下，逐步形成了一個更統一、規模更大的跨學科學術社群。不過，隨著科技傳播的日臻成熟，近年也顯現出往

邁克．舍費爾，瑞士蘇黎世大學傳播與媒體研究系科技傳播方向教授，傳播與媒體研究系聯席主任。研究興趣：科技傳播、環境與氣候變化傳播、公眾對科學和技術的看法、科學相關民粹主義與陰謀論。電郵：m.schaefer@ikmz.uzh.ch
宋韻雅，香港浸會大學傳理學院教授，人工智慧與媒體研究實驗室主任。研究興趣：國際傳播、線上社會網絡、新聞學研究。電郵：yunyasong@hkbu.edu.hk
徐妙，北京師範大學—香港浸會大學聯合國際學院講師、香港浸會大學傳理學院博士候選人。研究興趣：社交媒體研究、政治傳播、科技傳播。電郵：miaoxu@uic.edu.cn

獨立學科發展的趨勢。儘管跨學科的方式能夠採其他學科所長、受益於各領域的研究成果，學者們也始終面臨著一項考驗，那就是，如何能夠持續開展學科間的對話。」

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Dialogue

Science Communication: Across Disciplines and Cultures

Discussants: Mike S. SCHÄFER, Yunya SONG, Miao XU

Abstract

Science communication is a maturing field of research that is increasingly institutionalized. The COVID-19 pandemic has brought unprecedented heights to the relevance of science communication. As a leading figure in science communication, Professor Mike S. Schäfer elucidates the way in which science communication is as pluralistic in its research as it is in practice. In this dialogue, Professor Schäfer shares his views on the status quo and future directions of science communication, which concern its research paradigms, theory building, interdisciplinarity, contextualization, and communication practices. He also surveys the state of the discipline including emerging and

Mike S. SCHÄFER (Professor & Co-Director). IKMZ—Department of Communication and Media Research, University of Zurich. Research interests: science communication, environmental and climate change communication, public perceptions of science and technology, science-related populism and conspiracy theories.

Yunya SONG (Professor & Director). AI and Media Research Lab, School of Communication, Hong Kong Baptist University. Research interests: global communication, online social networks, journalism studies.

Miao XU (Lecturer & Ph.D. Candidate). Beijing Normal University-Hong Kong Baptist University United International College, School of Communication, Hong Kong Baptist University. Research interests: social media research, political communication, science communication.

cutting-edge areas, such as digital media, computational methods, politicization, and polarization. Finally, he provides valuable advice to students and junior scholars about the makings of a good researcher in science communication.

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邁克．舍費爾教授簡介

邁克．舍費爾教授是瑞士蘇黎世大學（University of Zurich）科技傳播教授，現任傳播與媒體研究系（Department of Communication and Media Research）聯席主任、高等教育與科學研究中心（Center of Higher Education and Science Studies）主任。與此同時，他還擔任瑞士藝術與科學院（Swiss Academies of Arts and Sciences）專家團發言人、瑞士國家科學基金會（Swiss National Science Foundation）–AGORA計劃委員會主席，以及德國國家科學與工程院（German National Academy of Science and Engineering）成員。此外，他也是六本科技傳播期刊的編委會成員。他的研究領域包括科技傳播、環境與氣候變化傳播、公眾對科學技術的看法，與科學相關的民粹主義與陰謀論等等。他近期的研究主題包括在線和社交媒體環境下的科技傳播、科技傳播的組織轉向、科學新聞業的危機等等。他參與編寫過22本專書，並曾經發表過82篇同行評審的學術文章。邁克．舍費爾教授在科技傳播領域的貢獻使他獲得德國傳播與傳媒研究協會（German Association of Communication and Media Research）第三屆最佳期刊論文獎、瑞士國家科學基金會（Swiss National Science Foundation）科技傳播獎。

MS：邁克．舍費爾
YS ：宋韻雅
MX：徐妙

YS： 科技傳播已經成長為一個重要的交叉研究領域，是多個學科相互滲透、融合形成的新興方向。科技傳播的許多研究都整合了不同學科的理論框架和分析方法。但由於科技領域發展迅速，先前建立的很多理論模型似乎不再能夠對現實作出充分的解釋。有跡象顯示科學界對公眾參與的看法也在逐漸轉變。有學者將科技傳播的模型分為兩種範式——散播範式，即專家向公眾單向傳遞科學信息；公眾參與範式，即公眾、專家和決策者之間的對話式、協商式交流，並認為這是切合傳播科學的方式。您同意這樣的範式劃分嗎？

MS：科技傳播本身以及對科技傳播的研究至今已有悠久的歷史。在這一過程中，傳播者和利益相關者對科技傳播的看法都在發生變化。其中，科技傳播之目的、目標群體以及渠道日趨多樣化，而相關研究也讓人更好地了解：在科技傳播中是甚麼因素，在何種條件下，對甚麼樣的受眾起作用。因此，科技傳播總體上正在向多樣化邁進，像 Akin 和 Scheufele（2017）、Bucchi（2008）、Trench（2008）等學者試圖通過理想化的模型捕捉這種多樣性。通常有三種模型：第一種模型被稱為「散播」（dissemination）模型，類似概念的還有「公眾對科學的理解」（public understanding of science）和（信息）赤字模型（deficit model），第一種模型在本質上假定公眾對科學的了解不夠充分，科技傳播應該以單向傳播的方式向公眾傳播信息，提高公眾對科學的接受程度。雖然研究表明，科學信息的散播仍有諸多局限性，比如許多科學信息都未能最終抵達公眾，但在不少科學家心目中，這種模型仍然佔據主導地位。

第二種模型是「對話」（dialogue）或「公眾參與」（public engagement）模型，它強調科學與社會之間更加平等的雙向交流。公眾被視為對話的夥伴，在對話中，科學和社會都應該相互學習，相互理解，相互信任。

第三種模型被稱為「情境下的傳播」（communication in context）或「（自由）市場」（marketplace）模型，試圖解決的是有爭議和政治化的議題，諸如氣候變化、基因編輯或疫苗接種等，處理這些議題涉及到科技傳播的不同取徑。

我認為這些模型各有千秋：它們幫助我們理解特定場景下專門的科技傳播類型。例如，我不認為「對話」總是最好的傳播模型。在疫情大流行的情境下，迅速散播信息是適當的做法，但在其他情況下不能一概而論。

YS：隨著博客、在線視頻和社交媒體等參與式數字媒體的湧現，科技傳播過程似乎能產生很大的民主化潛力？

MS：當然，潛力是存在的。這一直是在線媒體和社交媒體的優勢所在，不單只是在科技傳播領域。支持這些觀點的學者——或被

稱之為「網絡樂觀主義者（cyber-optimists）」——強調了網絡和社交媒體的信息分發潛力，並強調借助數字媒體，科學主題的內容分發可以超乎以往的速度、範圍和頻率。而多模態和交互式的傳播模式使得公眾直接參與話題討論成為可能。

此外，在線媒體和社交媒體可以讓公眾參與科學的方式更廣泛、真實和有效。我們也發展了新型的專家與公眾互動形式：公民科學、科學眾包等等（Schäfer, Metag, Feustle, & Herzog, 2018）。

但這種潛力也有缺點：網絡媒體允許公眾設置接受媒體信息的個人偏好，這可能導致更分明的數字鴻溝，即關注科學的人能藉此提升信息獲取的質量和個人信息素養，但不關注的人則更容易屏蔽與科學相關的話題。

另外，有些支持偽科學甚至反科學的人，更有科學民粹主義者（Mede & Schäfer, 2020）也假借網絡媒體的民主潛力，在新冠疫情、氣候變化或進化論這些議題上，獲取巨量粉絲，並營造出相當「專業」的表象。公眾可能很難辨認信息是否可靠。所以民主潛力是存在的，但需要善加利用，才能實現其價值。這需要科學界和許多利益相關者的努力，也需要監管機構和公眾敦促大型科技公司負起平台監管的責任。在過去的幾個月，我們看到了一些積極的跡象，公眾力促Facebook、YouTube和Twitter將有問題的內容和用戶從平台移除（de-platform）了——但仍然前路漫漫。

YS： 人們越來越關注科技傳播的應用和實踐問題。美國國家科學院發起了「科學傳播中的科學研討會」（Science of Science Communication Colloquium）。他們整合了社會科學家的一系列研究成果，這些研究成果提出了具體的傳播策略和實踐，並做了實證檢驗。您怎麼看待這種趨勢？傳播學學者如何在科技傳播研究中更好地將理論與實踐相結合？

MS： 這確實是一個非常重要的問題，也是一個重要的挑戰。我看到了向好的趨勢：科技傳播學界越來越以身作則，開始更多地與公眾和利益相關者進行交流。不同的國家都有科技傳播報告發表，向利益相關者提供建議， 例如我們在瑞士剛完成的一項研究

（Schäfer et al., 2021）。還有關於氣候變化傳播或COVID-19的傳播手冊（Lewandowsky et al., 2021）。如你所言，很多科研機構都在與外界交流。

定期地對科技傳播研究現狀進行總結則更有裨益——比如領域專家在《科技傳播年度評論》（*Annual Review of Science Communication*）上定期回答相關問題。他們可以就一些問題撰寫概述：譬如「我們怎樣才能更好地提高對科學的信任？」、「科學家個人應該如何處理社交媒體上的爭議性評論？」等等。我認為這種形式會非常有用。

我認為，作為這一領域的學者，我們還可以做得更好的是，更多地傾聽公眾和從業者的需求。他們到底需要甚麼，他們想知道甚麼？我們需要做更多的科技傳播項目評估。令人驚訝的是很少有人這樣做，即使有人這樣做了，他們的工作往往流於表面，或有一定目的性，只是為了讓資助者相信研究項目可以取得成功。我們尚需更嚴格的評估準繩、更具體的評估尺度和更優質的實踐成果。

MX：科技傳播近年來受到廣泛的關注，但是尚未形成類似健康傳播或者政治傳播這樣較大的學科分支，您如何看待這一現象？

MS：可以這麼說。「政治傳播」這樣的學科領域比「科技傳播」發展更為成熟，也覆蓋了更多的研究主題。但如果關注到過去25年間科技傳播研究的發展歷程，我們就會發現，科技傳播領域的興起非常迅速，學科領域本身也日漸體系化。比如，現在可以看到越來越多的國際學術期刊和科技傳播有關， 如《科技傳播》（*Science Communication*）、《公眾對科學的理解》（*Public Understanding of Science*）、《科技傳播學刊》（*The Journal of Science Communication*）等等，還有許多關於科技傳播的入門教科書、知識手冊、百科全書等等。此外，科技傳播的專業協會也逐步建立起來了，如「公眾科學技術傳播網絡」（Public Communication of Science and Technology Network, PCST）。當前，科技傳播藉由COVID-19疫情，在全球範圍內顯示出其重要的研究價值。

MX：科技傳播作為一個學術研究領域，其理論、模式和方法都是由一系列學科衍生出來的。這使得該領域具有多樣性，但也可能意味著學科內容分散。您如何看待科技傳播的跨學科性？

MS：我認為，要想全面地理解任何事物，就應當從多學科角度對它進行分析。科技傳播研究也是如此。我的同事Rauchfleisch和我分析了科技傳播相關學術文章的共同引用情況（Rauchfleisch & Schäfer, 2018）。我們發現，科技傳播研究在很早以前就已經具備了跨學科的特點，並且在長期的兼收並蓄之下，逐步形成了一個更統一、規模更大的跨學科學術社群。不過，隨著科技傳播的日臻成熟，近年也顯現出往獨立學科發展的趨勢。儘管跨學科的方式能夠採其他學科所長、受益於各領域的研究成果，學者們也始終面臨著一項考驗，那就是，如何能夠持續開展學科間的對話。

YS：您曾經主持過許多覆蓋全球範圍的跨國研究。您認為跨情境的比較研究有何優勢？

MS：我做過不少跨國項目來研究具有跨文化性質的議題。氣候變化、基因工程或人工智能等全球性問題往往尋求跨國的解決方案，也需要得到各國法律框架下的支持。因此，我們需要釐清這些議題在不同情境下如何被看待，以及如何找到應對這些問題的辦法。第二點是，社會與傳播現象往往受到社會文化情境的影響，例如，國家文化、地區規範或社會準則。當研究這些傳播現象時，需要考慮到這些因素。在驗證預判或假設的時候，也必須考慮到它們是否適用於本國內部的不同情境，或是否適用於不同的國家。這一點在科技傳播研究中尤其重要。在國際期刊上發表的科技傳播研究幾乎有一半都以英語國家為研究背景，但是，我們掌握的基於美國的氣候變化傳播模式就一定在中國或歐陸國家中適用嗎？通常情況下，答案可能是否定的，因為美國有著極為特殊的社會環境，在許多方面有別於其他國家。為了弄清哪些研究發現是否適用於不同國家，我們需要進行比較研究。

MX：框架研究為社會中不同的行動者如何定義科學問題提供了豐富的解釋。例如，學者們已經應用框架理論來解釋關於氣候變化、轉基因生物和生物技術的傳播動態。「框架」為科學家、媒體和公眾

提供了共同的參考點和意義。您如何看待框架分析在科技傳播研究中的價值？

MS：框架分析方法在科技傳播研究中確實很常見。最常見的應用是分析新聞媒體的報導方式，以及新聞受眾如何受其報導的影響。雖然框架分析比較實用，但一味地增加不同主題的「框架」數量不一定會體現太大的學術價值。其實，早在30年前，框架分析已經被認為是一種相對「碎片化」的研究範式。學者們得出的「框架」主題繁多，但是這些「框架」之間並沒有太大承前啟後的關聯性。這樣不僅不利於比較和整合以往的研究成果，也阻礙了學科知識的累進式發展。

YS：在科技傳播領域，越來越多的學者開始關注「傳播策略」或採取「議題導向」，卻往往忽視了科技傳播的「理論建構」。您如何看待這種現象？

MS：一方面，理論建構的相對缺失不是科技傳播領域獨有的。學界過度看重學刊發表，論文發表壓力迫使研究者偏重實證分析，而通常來說理論研究需要更多的研究精力，發表形式也較為不同。另一方面，這也跟科技傳播研究特有的研究基礎和社會因素有關。首先，科技傳播研究往往是在特定情境下進行的，比如，專注於農業、氣候變化或生命科學等自然科學領域的研究中心。隨之而來的利益和激勵因素驅使研究者會更偏向實證研究，聚焦單個的具體議題。這並不一定是件壞事：因為公眾接觸科學領域的方式往往都是在應用層面，包括技術、醫藥、流動、農業等方面。換句話說：公眾是通過具體議題而非抽象理論來認識科學。其次，科技傳播研究的覆蓋面廣，整合了不同的研究領域和研究問題。在這樣一個領域建構統領性理論更具挑戰性。

YS：對於現下計算方法在科技傳播領域的應用，您有何評價？應用數據分析這一類新方法有何前提？

MS：科技傳播涉及面廣，跨越不同學科，所採用的研究方法也非常多元。就研究嚴謹度而言，科技傳播在過去數十年間取得了很大進步，現在許多出色的研究都採用了不同研究方法。總的來說，我很欣賞「方法」。我認為方法就是工具，我們需要根據研究問題採

用各種各樣的工具。這包括深度訪談、問卷調查或內容分析等傳統方法，也包括自動化內容分析、網絡分析或主題建模等計算方法。固然並非所有人都一定要採用新方法進行研究，但它們確有巨大的潛力，是回答重要研究問題的強大工具。例如，在大型網絡中進行信息流建模、實時跟蹤受眾行為、重構支持某種觀點的社群等等。我們現在可以大規模地觀察傳播行為，可以進行跨國、跨平台、跨主題和縱貫性的數據分析，這在20年前是無法實現的。當然，在使用計算方法時，我們也應該了解它們的諸多局限。譬如，數位數據通常是專有數據。學術研究人員不像科技巨頭擁有可以分析關鍵問題的大型數據。這就導致了所謂的「路燈效應」(streetlight effect)。也就是說，人們只知道在看得清的路燈下尋找丟失的物品，卻忽略了其他看不清的暗處。Twitter就好比我們學界的「路燈」，許多學者分析Twitter數據，不是因為Twitter有那麼重要，而是因為它的數據相對容易獲取。但實際上，Twitter的數據也存在不少問題，比如通過Twitter API獲取的數據並不完全具有代表性。

MX：現在，許多科技傳播研究都關注到了政治行為體的傳播方式，您是否同意科技傳播在逐漸變得「政治化」? 您之前的一篇著作中提到過，科技傳播研究正在經歷「組織轉向」("organizational turn", Schäfer & Fähnrich, 2020)，您覺得這種「轉向」是否暗含著一種「去政治化」的進程？

MS：以往在歐洲國家，政治行為體沒有受到特別強烈的關注。相反，很多研究都關注到科學家、非政府組織、媒體和記者等在傳播過程中產生的作用。然而，大規模的COVID-19疫情導致政治行為體在科學決策中發揮了更重要的作用，因此它們的傳播方式才會變得至關重要。〈組織轉向〉一文提出，在科技傳播領域，組織正變得越來越重要。比如，就瑞士而言，科學研究機構(如大學、研究中心)、公司和非政府組織等不斷利用專業化的傳播方式增進對外交流，通過交流來提升公眾形象、改善公共關係。相比之下，傳統的科技傳播研究常常忽視了這些組織的力量。儘管如此，我不會將這種轉向與「(去)政治化」聯繫起來，我個人更願

意將「政治化」理解為科技傳播、科技傳播者、以及科學家所可能受到的政治影響。

MX：近年來，社交媒體上的科技傳播調動了越來越多公眾的參與積極性，但也引發了一些關於傳播效果的批評，比如公眾的意見極化、迴聲室效應（echo chamber）等等。您如何看待在線科技傳播中出現的這些問題？

MS：我認為重要的是，我們要認識到科技傳播中的「公眾」不是同質的、單一的群體。公眾對科學的興趣程度、對科學的認識觀念、媒體與信息的使用方式千差萬別。當公眾面對不同類型的科技傳播方式時，受眾的解讀和受到影響的程度也會有所不同。儘管網絡和社交媒體賦予人們隨時隨地獲取大量信息的自由，同時也造成了一定的後果。人們現在可以量身定製他們所需的媒體信息、設置他們慣用的新聞推送方式（Feed 或是 Timeline[1]）、精選他們想要關注的資訊、評估他們認為可信的信息來源等等。這種個性化配置導致了受眾的進一步多樣化，最終造成「潛在受眾分化」（potential audience fragmentation）或「社會兩極分化」（societal polarization）的現象。然而，這種兩極分化可能有些被高估了。大量的相關研究都是在美國的社會背景下進行的，而這是一個在政治體制、文化、社會層面都存在明顯兩極分化的社會環境。以我所在的瑞士為例，社會中兩極分化的情形並沒有那麼嚴重。在瑞士，一部分人對科學感興趣也信任科學，另一部分人則對科學持懷疑態度，但這兩種群體都是社會中的少數群體。我們做的一項關於公眾科學觀念的研究（Schäfer, Füchslin, Metag, Kristiansen, & Rauchfleisch, 2018）發現，大多數的公眾屬於中間派，我們稱其為「被動支持者」（passive supporters）。他們支持科學，但對科學並不是那麼感興趣。他們認為科學很重要，應該得到資金支持和社會信任，但卻看不到科學與他們個人生活的緊密聯繫。此外，很多其他領域的研究結果也表明迴聲室效應和過濾氣泡（filter bubble）的負面影響被誇大了。這些現象大多發生在特定的社會環境下，而不一定具備全球普適性。

YS： 科技傳播領域接下來會有什麼發展？在氣候變化、疫苗接種和轉基因生物等各種問題上，專家知識和公眾認知之間似乎一直存在分歧。您如何看待未來的發展方向？

MS：科技傳播研究有許多亟待解決的挑戰。其中一些問題屢見不鮮，即使我們取得了進展，它們仍然未被徹底解決：我們如何有效整合和鞏固加深跨學科的科技傳播研究，產出並鼓勵更多關於「全球南方（"Global South"）」國家的科技傳播研究，找到與科學實踐者更好的契合之處？還有一些更為新近的挑戰：我們如何找到最合適的辦法來應對社交媒體上充斥的錯誤信息（misinformation）、虛假信息（disinformation）或陰謀論？社交媒體已經成為最重要的科技傳播媒介，我們如何獲取並深入分析社交媒體平台的數據？我們如何整合和概括來自不同國家和領域的知識，同時不喪失某些區域或者主題的特殊性。當然，還有更多的挑戰。有很多事情要做，我期待解決其中一些問題。

YS： 您如何定義自己的學術身份？

MS：就學術訓練而言，我是一個傳播學學者和社會學家。我最初在德國萊比錫和柏林從事社會學研究，由此開始了我的學術生涯。之後我在德國漢堡的Federal Cluster of Excellence工作，這是一個專注於氣候科學的跨學科研究中心。中心的主要成員是自然科學家，但也包括幾個社會科學的研究小組，這其中就有我領導的氣候變化傳播研究小組。目前，我在瑞士蘇黎世大學擔任傳播和媒體研究系的教授。當我向別人介紹自己時，我通常會說自己是一名科技傳播學者——這很切合我研究的跨學科性。

YS： 近來您的研究興趣是甚麼，主要在關注甚麼問題？

MS：我一向嘗試拓寬自己的研究領域，因此我的研究團隊非常多元化。我們分析科學家個人和科學組織如何開展公共傳播；其他利益相關方如何就科學問題進行策略溝通；記者、意見影響者和其他中間人如何擴大科學信息聲量；新聞媒體和社交媒體上出現的科學爭論有何特徵、有哪些參與者、產生了何種影響。

具體來說，我的研究團隊正在開展五大科研項目。第一個是建立「瑞士科學認知指標」（Science Barometer Switzerland），這是

一項社會調查研究，我們試圖分析瑞士人對科學的看法，了解他們從何渠道獲取科學信息，並且觀察其中的歷時性變化。我們的第二個項目分析了高等教育機構是如何與公眾進行溝通的，並且同樣採取了縱貫研究的思路。第三個項目聚焦在線的科學類陰謀論，我們與巴西的合作者試圖評估科學類陰謀論在不同的社交媒體平台上是如何傳播的，以及有哪些可能的應對策略。第四個項目分析Jasanoff及Kim（2013）提到過的「社會技術幻想」（sociotechnical imaginaries）：我們將重構不同國別的公眾對於人工智能的描述或「想像」，並分析這些「想像」對人工智能的監管和治理有何影響。第五個項目則關注氣候變化的傳播，我們分析不同國家對氣候變化的媒體報導的歷時性變化。

YS： 對科技傳播來說，研究發現背後的實際意涵似乎非常重要。您在選擇研究主題時，在多大程度上會考慮到選題的現實應用或實際意義？

MS：作為研究人員，特別是受到公共資金資助的研究者，我認為首先應該回饋社會。我們有義務將研究成果服務於社會發展。因此，當我看到有契機能為社會出力的時候，我就會努力嘗試，把我的研究發現傳達給政界和利益相關者，並且通過社交媒體、網站、宣傳冊、各類活動等方式傳達給公眾。前面提到的陰謀論項目就是一個例子，但這並不意味著我所有的研究從初始就著眼於應用或策略層面。我同時也做基礎研究、發展相關理論，並通過實證方法來檢驗理論。這也同等重要。

YS： 您對有志於從事科技傳播研究的學生和青年學者有甚麼建議嗎？

MS：科技傳播研究非常重要。不僅僅是研究如何傳播科學，更要去研究何種傳播方式更可行。我個人的信條是：科技傳播的全部意義在於通過科學實證幫助個人、組織和整個社會作出更好的決策。這是科技傳播的希望所在。我們在進行科技傳播研究時應該貫徹這一原則。換言之，我們應該釐清科技傳播中可行的要素、可能實現的目標，可採用的傳播方式，以及可能面向的公眾等等。總之，科技傳播需要以實證為基礎。儘管科技傳播處於發展階段，

它仍然是一個初現雛形的新興研究領域，還需要進一步完善。我也認為，COVID-19後疫情時代是絕佳時機。科技傳播現在正處於一個十字路口：包括政客、資助方和利益相關者在內的許多人都已經看到了科技傳播的重要性。我們應當借此機會推動科技傳播，促進相關研究工作的發展。

註釋

1 Feed和Timeline推送模式：一般來說，Facebook採用Feed模式，是一種「pull」的推送算法，而Twitter採用的是Timeline推送模式，以「push」推送算法為主。

邁克．舍費爾教授著作選

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Academic Dialogue with **Mike S. SCHÄFER**

Science Communication: Across Disciplines and Cultures

MS: Mike S. SCHÄFER
YS: Yunya SONG
MX: Miao XU

YS: As a multidisciplinary field, science communication has been developing rapidly. It has become a distinct and dynamic field that brings together various theoretical approaches and practical experience. Previously established theoretical models appear out of step with the reality of the sciences. There are signs of a gradual shift in how the scientific community views public engagement. Some scholars have divided models for science communication into two paradigms — the dissemination paradigm which refers to the one-way transmission of science information from experts to the public, and the public participation paradigm, which refers to dialogic, deliberative communication between the public, experts and decision-makers as the appropriate way to communicate science. Do you agree with such a categorization?

MS: Science communication itself, and the research on it, has a long history by now. Over this journey, the views of communicators and stakeholders about science communication have changed. The aims they pursue with science communication, the target groups they address, and the communication channels they employ have diversified. And research on science communication has provided a better understanding about what works, under which conditions, for which audiences etc. So science communication has diversified overall, and scholars like Heather Akin and Dietram Scheufele (2017), Massimiano Bucchi (2008), Brian Trench (2008) and others have tried to capture this diversification in ideal-type models. Often, they end up with three models:

The first model has been labeled the "dissemination", "public understanding of science" and "deficit model", and essentially assumes that the public is not sufficiently informed about science and that science communication should, in one-way communication, disseminate information to the public to raise the public acceptance of science. This model is still pretty prominent in the minds of many scientists, even though research has shown that it has many limitations and does not reach a majority of the population in many countries.

The second model is the "dialogue" or "public engagement" model, which emphasizes a more egalitarian, two-way communication between science and society. The public is seen as a partner in dialogue, and in this dialogue, both science and society should learn from one another, develop a better understanding for each other and increase mutual trust.

The third model has been called the "communication in context" or "marketplace" model, and it tries to capture that issues like climate change, gene editing or vaccination are often the objects of contentious and politicized debates that require a different approach to science communication.

I think all of these models have their merits: They help us understand types of science communication that are appropriate in certain settings. I don't think, for example, that under all circumstances, dialogue is the best option. The recent pandemic has shown that in some situations, the quick dissemination of information is the appropriate way to go. But in many others, it is not.

YS: With the advent of new forms of participatory digital media such as blogs, online video, and social media, there seems to be a great potential to democratize the science communication process?

MS: The potential is there, absolutely. And this has always been the promise of online and social media, in and beyond science communication. Scholars advocating for these position — some have called them "cyber-optimists", have emphasized the distributive potential of online and social media, and stressed that in these channels, science-related content can be distributed to the public faster, more widely and potentially more effectively than ever before. Multimodal and

interactive possibilities can be used, direct discussions with the public are possible.

In addition, online and social media could allow for more wide-reaching, substantial and effective participation of the public in science. We have new science-society interfaces, and formats like citizen science, the crowdfunding of science, etc. (Schäfer, Metag, Feustle, & Herzog, 2018)

But there's a downside to this potential as well: Online media, where members of the public can configure their media diets more individually, may result in more pronounced digital divides, where some people are still interested in science, get quality information and are more scientifically literate, whereas others are not and can more easily avoid science-related topics entirely.

In addition, people supporting pseudo- or even anti-scientific positions, or science-related populists (Mede & Schäfer, 2020) can use the potential of these media as well — and some of them, on issues like the COVID-19 pandemic, climate change or evolution, have a substantial followership and a highly professional online appearance. And many members of the public might find it difficult to distinguish reliable from unreliable information. So the potential is there, but it needs to be carefully nurtured to be fulfilled. This requires efforts from the scientific community and many stakeholders, but also regulator and public pressure on the big tech companies to design their platforms responsibly. We have seen some positive signs in the past months, when public pressure led Facebook, YouTube and Twitter to "de-platform" problematic content and users — but it is still a long way.

YS: There has emerged a more applied and practical focus in science communication. The U.S. National Academy of Sciences launched the Science of Science Communication Colloquium. It was followed by a synthesis of the research in which social scientists develop and empirically test specific communication strategies and practices. What do you think of this trend? How could communication scholars better bridge theory and practice in science communication research?

MS: This is indeed a highly important question, and a crucial challenge. And I see positive signs: the research community that analyzes science communication is increasingly applying its own principles to itself and starts communicating to the public and to stakeholders more. In different countries, we have reports on science communication with recommendations for stakeholders; we just did one in Switzerland (Schäfer et al., 2021). We have hands-on communication handbooks on climate change communication or Covid-19 (Lewandowsky et al., 2021). Many academies have done this work, like you mentioned.

So this is all good. But a more regular summary of the state of science communication research would be helpful — like an *Annual Review of Science Communication* in which experts in their fields regularly answer relevant questions. They could write overview articles on questions like "How can we best improve trust in science?", "How should individual scientists deal with controversial comments in social media?" etc. I think this would be a great and very helpful format.

What we can also still do better as scholars in this field, I think, is to listen more to the needs and demands of the public and of the practitioners' community. What exactly do they need, what do they want to know? And we need to engage more in evaluation of science communication projects. This is surprisingly rarely done, and when it is done, it often remains superficial and is done instrumentally, to convince the funders that the project was a success. We need more standards, more joint instruments and tools, and a proliferation of best practices.

MX: Nowadays, wide attention has been put on science communication, but it has not become a big research field like health communication or political communication. How do you think of this phenomenon?

MS: I think your observation is fair. There are fields like political communication that are more established and bigger than the study of science communication. But if you look at the development of research on science communication in the last twenty-five years, you also see a clear rise and an institutionalization of the science communication field. There are many indicators for this: an increasing number of international research journals like *Science Communication*, *Public Understanding of Science*, *The Journal of Science Communication*

etc., or the publication of introductory textbooks, handbooks, and encyclopedias about science communication. There are professional associations like the Public Communication of Science and Technology or PCST Network. And the COVID-19 pandemic has catalyzed the rise of the field, and has shown that research on science communication is of utmost and global importance.

MX: As an academic field of research, science communication derives its theories, models and methods from a range of disciplines. This gives the field a multifariousness, but may also imply fragmentation. What do you think of the interdisciplinarity of science communication?

MS: If you want to analyze practically any object properly, you have to analyze it from different disciplinary perspectives. This is true for research on science communication, too. And it is happening. With my colleague Adrian Rauchfleisch, I did a co-citation analysis of scholarly articles on science communication (Rauchfleisch & Schäfer, 2018). It showed, first of all, that the field of science communication has been interdisciplinary from the start. But it also showed that the field has emancipated itself over time, to become a more coherent, larger and interdisciplinary scholarly community. It still is influenced and inspired by many fields, but has also grown stronger and more independent in recent years. Integrating different perspectives is important and fruitful for the field, but also leads to a constant need for dialogue across perspectives — a typical challenge in interdisciplinary work.

YS: You conducted research with a global focus, and across countries. What advantages of cross-context comparison are in your eyes?

MS: I have often done cross-national research for issues that are cross-cultural in nature. For such issues, like climate change, genetic engineering or artificial intelligence, we need transnational solutions that also find national support and legitimization. Therefore, we need to figure out how these issues are seen in different contexts, and how ways of dealing with these issues may be found. That can be one aim of cross-national research. Second point: Social and communication phenomena are often influenced by sociocultural contexts, e.g., by national cultures, regional regulation, or social norms. If you research communication phenomena, therefore, you need to account for these

factors. If you want to test assumptions or hypotheses, you have to see if they travel across contexts within countries or even across countries. This is especially in research on science communication. Almost half of the science communication studies published in international journals focus on English-speaking countries. But if we know how climate change communication works in the U. S., is this actually also true in China or continental Europe? Very often, the answer may be no, because the U. S. is a particular and exceptional context that differs from other countries in many ways. But in order to figure that which results hold true across countries and which not, we need comparative research.

MX: Framing research provides a rich explanation for how various actors in society define science-related issues. Scholars have applied framing theories to explain the communication dynamics of debates over climate change, GMOs, and biotechnology, for example. "Frames" afford common points of reference and meaning between scientists, the media, and the publics. What do you think of the values of frames in science communication research?

MS: Framing approaches are indeed quite common in the study of science communication. Especially when scholars analyze how news media cover science-related issues, and what the effects of this coverage on different audiences are, many employ a framing approach. And while framing is certainly a useful perspective, I don't think that each additional framing study adds as much value as it could. A related problem is that framing approaches are rather diverse and incoherent. Thirty years ago already, framing had been described as a fractured paradigm, and this has not gotten much better. The diversity of framing approaches often makes it difficult to compare and integrate their results, and to build a cumulative body of knowledge.

YS: More and more science communication scholars have paid attention on how to refine "communicative strategies" or "issue-oriented" but neglected the "theory building". How do you think of this observation?

MS: On the one hand, the relative lack of theory-building has generic reasons that apply to fields other than science communication, too. The strong, maybe overtly strong, focus on journal publications

and the pressure to publish a lot leads to an emphasis on empirical analyses rather than theoretical and conceptual work, which can need more time and other formats for publication. On the other hand, there are infrastructural and social reasons specific to research on science communication. First, it is often done in specific contexts, e.g., embedded in research centers that focus on certain fields of the natural sciences like agriculture, climate change or the life sciences. And with these contexts come certain interests and incentives that can nudge scholars towards more empirical research focusing on a specific issue. Which is not necessarily a bad thing: The broader public usually encounters science via its applications in technology, in medicine, in mobility, in agriculture and elsewhere. In other words: They encounter science via issues rather than as an abstract system. The second point is that research on science communication is very broad, integrating very different fields and research questions. Building overarching theories in such a field is more challenging.

YS: How do you evaluate the status of applications of computational approaches now in the field of science communication? What are the premises of applying new methods like data analytics?

MS: Being broad and interdisciplinary, research on science communication applies a diversity of methods. In terms of rigor, the field has made great strides in past decades; there is a lot of strong work out there now that uses different methods. In general, I appreciate that. I think methods are tools, and that we need a variety of tools depending on our research questions. This includes traditional methods like in-depth interviews, surveys or content analyses, but also computational methods like automated content analyses, network analyses or topic modeling. So I don't think everybody has to do computational analysis now. But that said: They have enormous potential. They are powerful tools to answer important questions, e.g., to model information flows in large networks, to track audience behavior in real time, or to reconstruct social communities supporting certain views. We can now observe communicative behaviors on a large scale. We can do cross-national, cross-platform, cross-topic and longitudinal analyses in a way and on a scale that was impossible twenty years ago. But when using computational methods, we also have to keep their considerable limitations in mind. Digital data is usually proprietary, and as

academic researchers, we often don't have the data we need to analyze crucial questions, unlike the big tech platforms. Which leads to what is known as the "streetlight effect", where a drunk person, at night, searches for his lost keys not in the park, where he's actually lost them, but under a streetlight, because that's the only place where he can see something. One equivalent of these "streetlights" in academia is Twitter: Many scholars analyze Twitter, but not (only) because Twitter is so important, but because its data is fairly easily available. But even Twitter data has its problems. The Twitter API that many scholars use, e.g., provides data that is not fully representative.

MX: Many science communication researches now focused on communication methods of political actors. Do you agree this is one kind of politicization? In one of your previous works, you wrote that science communication research is taking an "organizational turn" (Schäfer & Fähnrich, 2020), do you think it implies a process of de-politicization?

MS: My perception would not be that the focus is very strongly on governments in European countries. I think we have lots of scholarships focus on individual scientists, nongovernmental organizations, media, and journalists, etc. COVID-19 pandemic gives importance to political actors in making a decision, so communication addressed to political actors became crucially important. What our argument in the "organizational turn" article is in the field of science communication, organizations are becoming increasingly important. Scientific and research organizations (e.g., universities, research centers) have intensified and professionalized outside communication. Many of them communicate to boost their public profile and ramp up their public relation. Fewer and fewer science journalists in Switzerland could properly deal with that. And other organizations, like companies and non-government organizations, also increasingly communicate on science-related issues. They also have professionalized outside communication. Organizational turn in science communication research needs more attention, because traditionally research and science communication did not look so much in organizations. I would not relate it to politicization. I would personally associate the term politicization with a political influence on science communication, science communicators, or scientists themselves.

MX: In recent years, science communication on social media draws on public engagement. There are also some criticisms like opinion polarization, echo chamber phenomenon. How do you view these problems in online science communication?

MS: I think it's important to recognize that the "public" in science communication — and in general — is not a homogeneous, monolithic group of people. There are many public out there with different interests, attitudes towards science and varying patterns of media and information use. These public encounter different kinds of science communication, interpret them differently and are, therefore, influenced by it in different ways. And even though online and social media give people the opportunity to get a lot of information immediately, everywhere and mostly free of charge, there are challenges as well. People can now individualize their media diets, configure their feeds and timelines, handpick the sources they want to follow, assess whom they trust etc. This leads to a further diversification of audiences, and it has even been described as the source of a potential audience fragmentation or societal polarization. This polarization, however, may be somewhat overestimated because a lot of research is conducted in the U.S., i.e., in a country with a strongly polarized political system, culture, and society. If we take Switzerland as an example, where I work, the picture looks less polarized. A segment of the population is interested in and trusts science, and people on the other side of the spectrum are very skeptical and doubtful about science. But both of these are minority groups. There is a big middle group which we have called "passive supporters" in one study (Schäfer, Füchslin, Metag, Kristiansen, & Rauchfleisch, 2018), as they do support science, but are not all that interested in science. They think science is important, should be funded and trusted — but don't see strong connections of science to their personal life. Research in other fields has also shown that the danger of echo chambers and filter bubbles have been exaggerated. They have shown that such phenomena mostly occur in very peculiar situations, and are not a general societal trend across the globe.

YS: What's next for science communication? There seems to be constantly a gap between expert knowledge and public perception on various issues such as climate change, vaccinations, and

genetically modified organisms. What do you think are the promising directions?

MS: Science communication research has a number of challenges it needs to tackle. Some of them have been known for a while now, and even though we made progress, they still stand: Find ways to integrate and consolidate the highly interdisciplinary science communication research fruitfully. Produce, or encourage, more research on science communication in the Global South. Find better interfaces with the practitioners community.

Other challenges are younger: How do we deal best with mis- and disinformation or conspiracy theories that abound in social media? How can we get access to, and thoroughly analyze, social media platforms that have become the most important intermediaries of science communication? How can we integrate and generalize knowledge from different countries and fields while not losing track of regional or topical specifics.

And there are more challenges, of course. There's a lot to do, and I am looking forward to working on some of these questions.

YS: How do you position yourself as a researcher?

MS: I am a communication scholar and sociologist by training. And I started my academic career as a sociologist in Leipzig and Berlin. Then I worked in Hamburg, Germany, in a Federal Cluster of Excellence, an interdisciplinary research center which focused on climate science. It mostly consisted of natural scientists, but also included a couple of social scientific research groups. I headed a group doing research on climate change communication there. Then I came to Zurich and am a full professor there now in the department of communication and media research. When I introduce myself to others, though, I usually say I am a science communication scholar — so I identify with my interdisciplinary field of study.

YS: What are your recent research interests or the issues that you focused on?

MS: I try to do it as broadly as possible, so my research team is pretty diverse. It analyzes how individual scientists and scientific organizations communicate in public, how other stakeholders

communicate strategically on science-related issues, how journalists, influencers and other intermediaries amplify this, how news media and social media debates about science can be characterized, who uses them and what their effects are. Currently, my team is engaged in five bigger projects. The first is the "Science Barometer Switzerland", a regular survey trying to find out what people in Switzerland think about science, where they get their information about science from, and how this develops over time. In the second project, we analyze how higher education institutions communicate to the public, and how this has developed over time. The third project focuses on science-related conspiracy theories online. With partners in Brazil, we try to assess how conspiracy theories are communicated on different social media platforms and what potential counter strategies could be. The fourth project analyzes what Jasanoff & Kim (2013) had called "sociotechnical imaginaries": We reconstruct how artificial intelligence is described or "imagined" by the public in different countries, and what the implications of these "imaginaries" for the regulation and governance of AI are. The fifth project focuses on climate change communication, where we analyze media coverage about climate change across countries over time.

YS: The implications of research findings seem to be very important for science communication. When you first choose a research topic, to what extent do you care about strategies arose out of a project?

MS: I think that we as researchers, particularly if we are publicly funded, should give back to society. We have an obligation to allow society to make use of our findings. So when I see the opportunity to contribute, I try to do it, to communicate my findings, to make them available to politicians and stakeholders, to communicate them to the public via social media, websites, brochures, events etc. But this does not mean that all my research focuses on applications or strategies from the beginning. Some does, like the above-mentioned project on conspiracy theories. But I also do basic research, where I develop theories, or try to figure out if they hold true empirically. That's also important.

YS: What advice would you give to students and young scholars about their careers in the study of science communication?

MS: It's very important to study science communication. Not just to communicate about science — but to actually study what works and what does not work. My personal mantra is the following: The whole point of science communication is to help individuals, organizations and society as a whole to make better decisions by providing scientific evidence to them. But if that, in a nutshell, is the promise of science communication, we should also apply this principle to science communication itself. In other words: We need to figure out what works in science communication, which aims can be achieved, with which kinds of communication, with which audiences. We need an evidence-based science communication. And because this is still a small, albeit growing and emerging field, we still need help here. I also think it's a great time to start with this right now, after the COVID-19 pandemic. We are at a crossroads right now: Many people have seen that science communication is important. Politicians, funders and stakeholders too. We have to use this to improve science communication, and research on it.

Selected Works by Mike S. Schäfer

Please refer to the end of the Chinese version of the dialogue for Mike S. Schäfer's selected works.