SCIENTISTS AND THE SOCIAL NETWORK

Giant academic social networks have taken off to a degree that no one expected even a few years ago. **A *Nature* survey explores why.**

BY RICHARD VAN NOORDEN

In 2011, Emmanuel Nnaemeka Nnadi needed help to sequence some drug-resistant fungal pathogens. A PhD student studying microbiology in Nigeria, he did not have the expertise and equipment he needed. So he turned to ResearchGate, a free social-networking site for academics, and fired off a few e-mails. When he got a reply from Italian geneticist Orazio Romeo, an international collaboration was born. Over the past three years, the two scientists have worked together on fungal infections in Africa, with Nnadi, now at Plateau State University in Bokkos, shipping his samples to Romeo at the University of Messina for analysis. "It has been a fruitful relationship," says Nnadi — and they have never even met.

Ijad Madisch, a Berlin-based former physician and virologist, tells this story as just one example of the successes of ResearchGate, which he founded with two friends six years ago. Essentially a scholarly version of Facebook or LinkedIn, the site gives members a place to create profile pages, share papers, track views and downloads, and discuss research. Nnadi has uploaded all his papers to the site, for instance, and Romeo uses it to keep in touch with hundreds of scientists, some of whom helped him to assemble his first fungal genome.

More than 4.5 million researchers have signed up for ResearchGate, and another 10,000 arrive every day, says Madisch. That is a pittance compared with Facebook's 1.3 billion active users, but astonishing for a network that only researchers can join. And Madisch has grand goals for the site: he hopes that it will become a key venue for scientists wanting to engage in collaborative discussion, peer review papers, share negative results that might never otherwise be published, and even upload raw data sets. "With ResearchGate we're changing science in a way that's not entirely foreseeable," he says, telling investors and the media that his aim for the site is to win a Nobel prize.

The company now employs 120 people, and last June it announced that it had secured US$35 million from investors including the world's richest individual, Bill Gates — cash that came on top of two earlier rounds of undisclosed investment. "It was really a head-scratcher when we saw that," says Leslie Yuan, who heads a team working on networking and innovation software for scientists at the University of California, San Francisco. "We thought — who are these guys? How are they getting so much money?"

> "WE'RE CHANGING SCIENCE IN A WAY THAT'S NOT ENTIRELY FORESEEABLE."

Yuan is not the only one who has been taken aback. A few years ago, the idea that millions of scholars would rush to join one giant academic social network seemed dead in the water. The list of failed efforts to launch a 'Facebook for science' included Scientist Solutions, SciLinks, Epernicus, 2collab and Nature Network (run by the company that publishes *Nature*). Some observers speculated that this was because scientists were wary of sharing data, papers and comments online — or if they did want to share, they would prefer do it on their own terms, rather than through a privately owned site.

But it seems that those earlier efforts were ahead of their time — or maybe they were simply doing it wrong. Today, ResearchGate is just one of several academic social networks going viral. San Francisco-based competitor Academia.edu says that it has 11 million users. "The goal of the company is to rebuild science publishing from the ground up," declares chief executive Richard Price, who studied philosophy at the University of Oxford, UK, before he founded Academia.edu in 2008, and has already raised $17.7 million from venture capitalists. A third site, London-based Mendeley, claims 3.1 million members. It was originally launched as software for managing and storing documents, but it encourages private and public social networking. The firm was snapped up in 2013 by Amsterdam-based publishing giant Elsevier for a reported £45 million (US$76 million).

WINNING FORMULA

Despite the excitement and investment, it is far from clear how much of the activity on these sites involves productive engagement, and how much is just passing curiosity — or a desire to access papers shared by other users that they might otherwise have to pay for. "I've met basically no academics in my field with a favourable view of ResearchGate," says Daniel MacArthur, a geneticist at Massachusetts General Hospital in Boston.

In an effort to get past the hype and explore what is really happening, *Nature* e-mailed tens of thousands of researchers in May to ask how they use social networks and other popular profile-hosting or search services, and received more than 3,500 responses from 95 different countries.

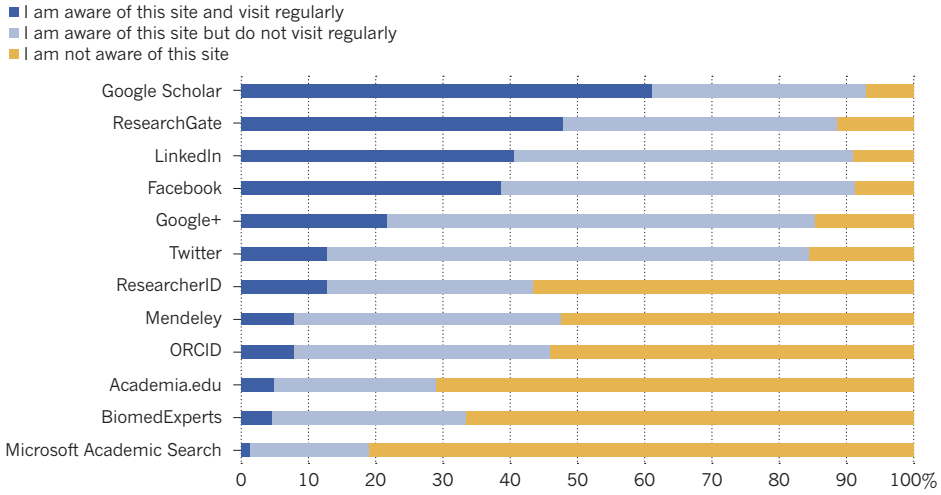
The results confirm that ResearchGate is

certainly well-known (see 'Remarkable reach', and full results online at go.nature.com/jvx7pl). More than 88% of scientists and engineers said that they were aware of it — slightly more than had heard of Google+ and Twitter — with little difference between countries. Just under half said that they visit regularly, putting the site second only to Google Scholar, and ahead of Facebook and LinkedIn. Almost 29% of regular visitors had signed up for a profile on ResearchGate in the past year.

This does not surprise Billie Swalla, an evolutionary biologist and director of the University of Washington's Friday Harbor Laboratories. Swalla says that she and most of her colleagues are on ResearchGate, where she finds the latest relevant papers much more easily than by following marine-biology journals. "They do send you a lot of spam," she says, "but in the past few months, I've found that every important paper I thought I should read has come through ResearchGate." Swalla admits to comparing herself to others using the site's 'RG Score' — its metric of social engagement. "I think it taps into some basic human instinct," she adds.

REMARKABLE REACH

More than 3,000 scientists and engineers (below) told Nature about their awareness of various giant social networks and research-profiling sites. Just under half said that they visit ResearchGate regularly. Another 480 respondents in the humanities, arts and social sciences were less keen on ResearchGate — see charts at go.nature.com/fjvxxt.



TACTICAL BREAKDOWN

Some irritated scientists say that the site taps into human instincts only too well — by regularly sending out automated e-mails that profess to come from colleagues active on the site, thus luring others to join on false pretences. (Indeed, 35% of regular ResearchGate users in *Nature*'s survey said that they joined the site because they received an e-mail.) Lars Arvestad, a computer scientist at Stockholm University, is fed up with the tactic. "I think it is a disgraceful kind of marketing and I am choosing not to use their service because of that," he says. Some of the apparent profiles on the site are not owned by real people, but are created automatically — and incompletely — by scraping details of people's affiliations, publication records and PDFs, if available, from around the web. That annoys researchers who do not want to be on the site, and who feel that the pages misrepresent them — especially when they discover that ResearchGate will not take down the pages when asked. Madisch is unruffled by these complaints. The pages are marked for what they are, and are not counted among the site's real users, he says, adding: "We changed many things based on the feedback we got. But the criticism is relatively small, relative to the number of people who like the service."

Academia.edu seems less well-known than ResearchGate: only 29% of scientists in the survey were aware of it and just 5% visited regularly. But it has its fans — among them climate scientist Hans von Storch, director of the Institute for Coastal Research in Geesthacht, Germany, who uses the site to share not only his papers, but also his interviews, book reviews and lectures.

NATURE.COM
For an interactive graphic and more on profile-managing, see: go.nature.com/fjvxxt

Price points out that Academia.edu has much higher web traffic than ResearchGate overall, perhaps because — unlike its rival — it is open to anyone to join. And for the 480 social science, arts and humanities researchers included in *Nature*'s survey, usage of the two sites was more closely matched.

> "WE HAVE TO BUILD BETTER FILTER SYSTEMS TO EXPLAIN WHAT RESEARCH YOU CAN TRUST."

High numbers by themselves do not mean much, says Jan Reichelt, a co-founder of Mendeley (which scored 48% awareness and 8% regular visitors among scientists in *Nature*'s survey). "We've moved away from mentioning 'start-up vanity metrics' as the key number," he says. "It doesn't tell you about the quality of interaction."

To get a rough measure of that quality, *Nature* asked a subset of the most active respondents what they actually do on the sites they visit regularly (see 'Idle, browse or chat?'). The most-selected activity on both ResearchGate and Academia.edu was simply maintaining a profile in case someone wanted to get in touch — suggesting that many researchers regard their profiles as a way to boost their professional presence online. After that, the most popular options involved posting content related to work, discovering related peers, tracking metrics and finding recommended research papers.

"These are tools that people are using to raise their profiles and become more discoverable, not community tools of social interaction," argues Deni Auclair, a lead analyst for Outsell, a media, information and technology consulting firm in Burlingame, California. By comparison, Twitter, although used regularly by only 13% of scientists in *Nature*'s survey, is much more interactive: half of the Twitterati said that they use it to follow discussions on research-related issues, and 40% said that it is a medium for "commenting on research that is relevant to my field" (compared with 15% on ResearchGate).

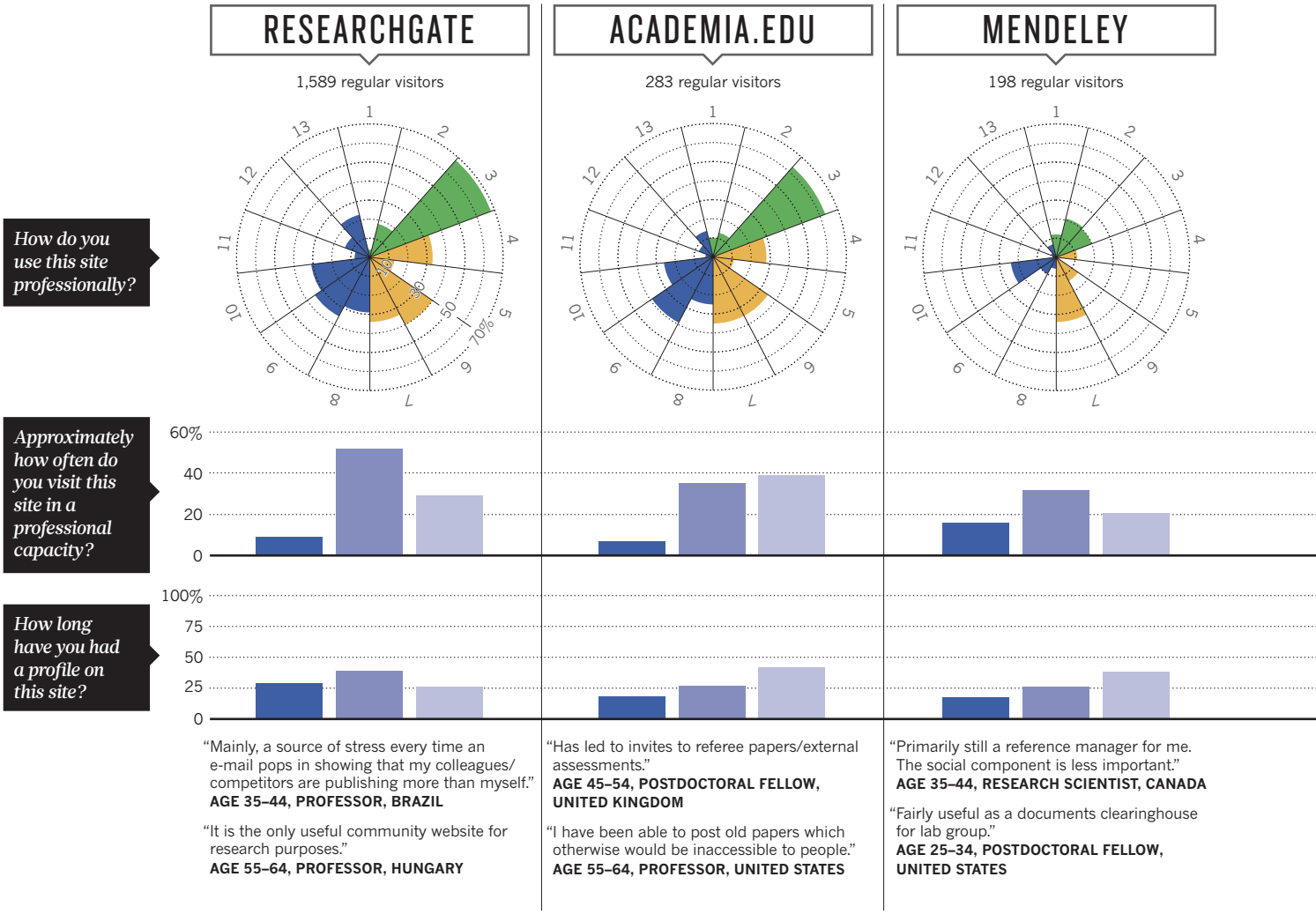
PAPERS PLEASE

Laura Warman, an ecologist at the University of Hawaii at Hilo, echoes the views of many when she says that she has uploaded papers on Academia.edu to keep track of how often, where and when they are downloaded. "I find it especially intriguing that my most downloaded paper is not my most cited work," she says. "To put it bluntly, I have no idea if these sites have any impact whatsoever on my career — I tend to doubt they do — but I enjoy knowing that my work is being discussed."

Price says that 3 million papers have been uploaded to Academia.edu, and Madisch says that 14 million are accessible through ResearchGate (although he will not say how many of those have been automatically scraped from freely accessible places elsewhere). An unpublished study conducted by computer scientists Madian Khabsa at Pennsylvania State University in University Park and Mike Thelwall at the University of Wolverhampton, UK, suggests that by August this year, the full texts of around one-quarter of all molecular-biology papers published in 2012 were available from ResearchGate. That said, these days papers are easily found on many sites: a study conducted

IDLE, BROWSE OR CHAT?

Nature asked a subset of regular visitors to social networks how they used the sites professionally. (Each person was asked to tick all activities that applied.) The results suggest that Facebook is not widely used professionally; that researchers on Twitter are very active and social; and that many users of Academia.edu and ResearchGate signed up in case someone wants to contact them — but are not chatty themselves. Full results are available at **go.nature.com/jvx7pl**.



for the European Commission last year found that 18% of biology papers published in 2008–11 were open access from the start, and said that 57% could be read for free in some form, somewhere on the Internet, by April 2013 (see *Nature* **500,** 386–387; 2013).

Publishers are worried that the sites could become public troves of illegally uploaded content. In late 2013, Elsevier sent 3,000 notices to Academia.edu and other sites under the US Digital Millennium Copyright Act (DMCA), demanding that they take down papers for which the publisher owned copyright. Academia.edu passed each notice on to its users — a decision that triggered a public outcry. One researcher who received a take-down request did not want to be named, but told *Nature*: "I hardly know any scientists who don't violate copyright laws. We just fly below the radar and hope that the publishers don't notice."

These concerns are not unique to large social networks, says Price; the same issue surrounds content posted in universities' online repositories (to which Elsevier also sent some DMCA notices last year). "This is really part of the wider battle where academics want to share their papers freely online, whereas publishers want to keep content behind a paywall to monetize it," he says, noting the nuance that many publishers allow researchers to upload the final accepted version of a manuscript, but not the final PDF. He has seen fewer take-down notices this year.

OPEN INTENTIONS

Giant social networks could also disrupt the research landscape by capturing other public content. In March this year, ResearchGate launched a feature called Open Review, encouraging users to post in-depth critiques of existing publications. Madisch says that members have now contributed more than 10,000 such reviews. "I believe that this is just the tip of the iceberg," he says. He wants users to upload raw data sets too — including, perhaps, negative results that might otherwise never be published — and says that 700 are appearing on the site each day.

At Academia.edu, Price is planning to launch a post-publication peer-review feature as well. "We have to build better filter systems to explain what research you can trust," he says.

Few would argue with these goals, but many wonder why researchers would deposit their data sets and reviews on these new social networks, rather than elsewhere online — on their own websites, for example, in university repositories, or on dedicated data-storage sites such as Dryad or figshare (see *Nature* **500,** 243–245; 2013 — figshare is funded by *Nature*'s parent company, Macmillan Publishers). To Madisch,

Each wedge in the circular charts corresponds to a question on the right. The answers are grouped by the intensity of user engagement they imply: low (green), medium (yellow) and high (blue).

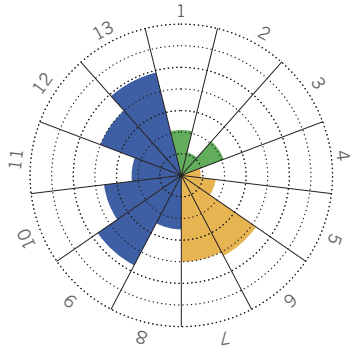
1. Do not use professionally
2. Curiosity only; not maintaining profile
3. In case contacted

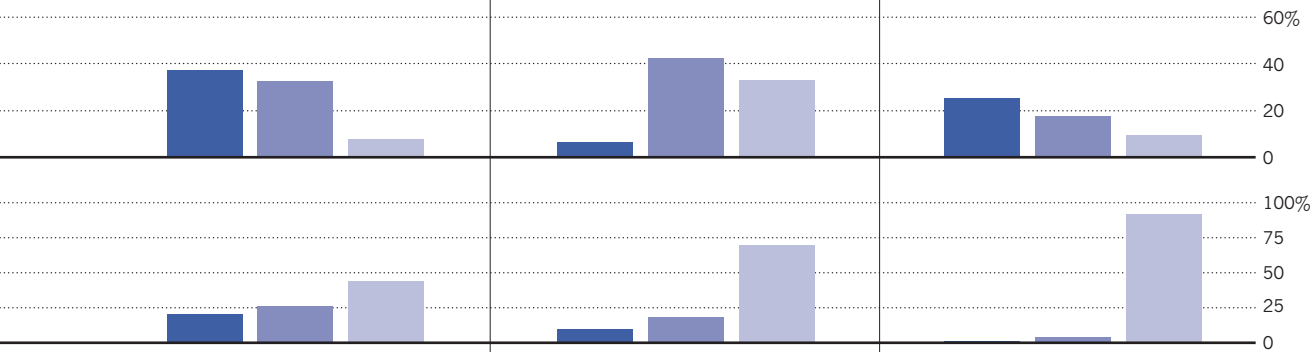
4. Track metrics
5. Discover jobs
6. Discover peers
7. Discover recommended papers

13. Follow discussions
12. Comment on research
11. Actively discuss research
10. Share links to authored content
9. Post (work) content
8. Contact peers

TWITTER

330 regular visitors



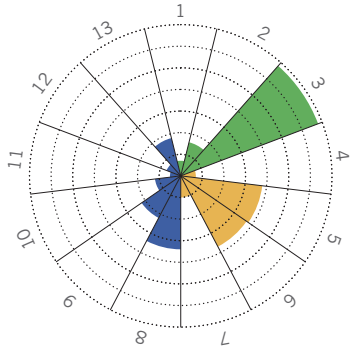


"Extremely useful in conference settings."
AGE 35–44, RESEARCH SCIENTIST, UNITED STATES

"Great way to keep up-to-date on what is happening NOW in the research community."
AGE 45–54, HEAD OF ACADEMIC DEPARTMENT, UNITED STATES

LINKEDIN

389 regular visitors

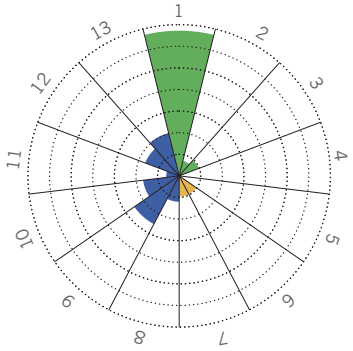


"Mainly useful for job hunting."
AGE 25–34, PHD STUDENT, UNITED STATES

"It is too much like Facebook — fluffy forwards and such that are not scientific or related to professionalism."
AGE 45–54, ASSOCIATE PROFESSOR, UNITED STATES

FACEBOOK

340 regular visitors



"Facebook has zero credibility in my professional life."
AGE 35–44, STAFF SCIENTIST, UNITED STATES

"The (invitation-only) groups for professional astronomers and pulsar astronomers have become vibrant discussion fora."
35-44, RESEARCH SCIENTISTS, UNITED STATES

the answer lies with the social sites' burgeoning communities of users — the famed 'network' effect. "If you post on ResearchGate, you are reaching the people who matter," he says. But Titus Brown, a computational scientist at Michigan State University in East Lansing, is concerned about the sites' business plans as they seek to survive. "What worries me is that at some point ResearchGate will use their information to make a profit in ways that we are uncomfortable with — or they will be bought by someone who will do that," he says.

Madisch says that ResearchGate will not sell its user data, and that it already makes some money by running job adverts (as does Academia.edu). In the future, he hopes to add a marketplace for laboratory services and products, connecting companies and corporate researchers to academics (28% of the network's users are from the corporate world, he says). Price talks about providing institutional analytics to universities as well. But analysts including Auclair argue that the sites have limited earning potential, because they are targeted at a much narrower demographic than Facebook or Twitter. "What's most likely is the networks that have critical mass get acquired and those that don't will die," she says (although Madisch says that being bought out "would be a personal failure").

Mendeley's acquisition by Elsevier last year left the site better placed to become a global platform for research collaboration, says Reichelt, because it intersects with other Elsevier products such as the Scopus database of research articles. Much of the collaboration done using Mendeley is private, but the firm does allow other computer programs to automatically pull out useful anonymized public information — such as which papers are viewed most by which researchers. Neither Academia.edu nor ResearchGate yet offer this service, although Madisch says that he is developing it.

"I think at some point there will be one winner in this race," says Madisch. Or — as *Nature*'s survey suggests is already happening — different disciplines might favour different sites. Some analysts argue that despite their millions of users, massive social academic networking sites have not yet proven their essential worth. "They are nice-to-have tools, not need-to-have," says Auclair. But Price says that the networks are on the front line of a trend that cannot be ignored. "We saw the changes in the market, and we could see that academics wanted to share openly. The tide is starting to turn in our direction." ■

Richard Van Noorden *is a senior reporter for* Nature *in London.*