

Frontiers for Young Minds: Communicating Passion and Excitement About Science

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There is a growing recognition within the scientific community that to do the most good, science needs to be accessible to everyone, from politicians and voters, to doctors and patients, and the general public. To facilitate this access as early as possible, the journal *Frontiers for Young Minds* (FYM) (<https://kids.frontiersin.org/>) has taken the innovative approach of involving kids and teenagers, as young as 8 yr old, in the peer-review process as reviewers. Scientists submit articles presenting their research in an easily understood, accessible format, and kids, aged 8 to 15, provide in-depth reviews with point-by-point feedback on how authors can improve their articles. The process helps demystify the scientific process for kids while making scientists into better communicators.

Earlier this year, *Science Editor* spoke with FYM Chief Editors, Dr Robert Knight, a professor at UC Berkeley in Psychology and Neuroscience, and Dr Idan Segev, a professor at the Hebrew University in brain research, along with Will Savage, Journal Manager, and Laura Henderson, head of Program for Public Outreach, to discuss how FYM involves kids in the peer-review process, why this benefits everyone involved, and the importance of knowing your audience.

Science Editor (SE): How did the idea of *Frontiers for Young Minds* come about?

Robert Knight: I was in a boring meeting at a Society for Neuroscience conference, where they had people from different fields of neuroscience, and they were trying to find out where



the field was going. By about 10 or 11 in the morning, I thought there's got to be a better way to do that. And I said, why don't we get kids involved? The rest developed from there.

Idan Segev: You then came to Israel some 10 years ago and told me about your idea that kids will be the reviewers for the journal, and that these kids should be able to understand what the scientist is saying, and they should be the reviewers. I thought it was an absolutely innovative idea.

Knight: And you've been unbelievable. The origin was basically that: to put kids in charge of the review process with the idea that they could do just as good a job as adults with the right guidance. We would also help them understand what science is; to learn about a hypothesis and a design to test your hypothesis; how to collect data, how to analyze it, and how to write it up. In fact, for the journal, we have kids work with their mentors who are PhD holders or experienced researchers; that's exactly the flow we want the kids to understand. I will say this just to be clear: This is not a dumbed down journal. The final product from the kids is well-written, clear science, readable by other kids between the ages of 8 and 15 and any adult.

Segev: I've learned a lot myself from these kids' articles because there are many fields, such as physics, where I'm not an expert, so the first place I go if I want to learn about something, such as relativity, is the journal.

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SE: Why do you think it's important to engage kids and teens in the peer-review process?

Knight: At least in the United States, kids have STEM (science, technology, engineering, and math) education, but it's formalized and they get one or two hours a week. The things that get them more excited, like projects and science clubs and such, really don't begin until late middle school or even high school. I think it's important when kids are 8 to 12 yr old to expose them to the beauty of science. It gets them started earlier. We would like this journal to be taken as an important part of STEM education in schools.

Segev: In my experience, kids are a little bit afraid of scientists. They think that they sit somewhere in this ivory tower, and they are unique and unapproachable. The fact that the kids can give us feedback through the journal, and that researchers listen to them and change what they wrote is important. In my case, I was rejected twice by an 11 yr old girl. She taught me how to write in many ways, especially for kids.

I think it's extremely important. If I was a kid and a scientist could be a Nobel laureate or very important scientist, who interacts with me, believes in me, and appreciates me, that's an absolutely amazing message. These kids could be inspired to become scientists at some point, and they will not be afraid of these grownups who seem to know everything.

Knight: I completely agree. One of the most rewarding things about the journal is that it's a win for everybody. The kids like to be the reviewers, they like to know their voices are being heard, and that they're learning something. [The mentors] really, really enjoy it. And the authors actually find it's not trivial to make something complex really rigorous, but understandable. So it's a win across the board.

Will Savage: I think one of the real benefits of getting the kids involved is the process of critical thinking and providing feedback, which is not natural to 10 yr old. But you'd be surprised at how little encouragement they need. It really doesn't take a lot, just a little bit, of encouragement, and they open up and provide pretty honest, quite funny, feedback to the authors. If something really is quite dull and boring, the kids will say so. Kids are the ones constantly getting feedback almost until university, and the idea that a kid has an opportunity to do it the other way around is so rare. We are providing that platform, and that's really a key part of it from my perspective.

Knight: They're in charge—and I'm glad you brought that up. I have a collection of some of my favorite reviews from when the journal started. One of them was from an 11 yr old, and to paraphrase it, it says this paper's so boring I couldn't get through the first paragraph. If the authors think

their work is exciting, they ought to write like it is exciting. Something like that you'd never see from an adult reviewer. Once you get them confident that they can speak their mind, as they say, kids say the darndest things. And they're usually spot on in terms of the science.

SE: You've said a common criticism from the kids is that articles are hard to read or boring. What is some other common feedback from the kid reviewers?

Segev: In my experience, I'm doing brain modeling, so I'm using mathematical approaches and equations to model brain processes and trying to develop artificial intelligence inspired by the brain, things like that. I wrote a paper on that topic and the kid, this 11 yr old kid who I don't know in person, I'm not allowed to know. She said, "First of all, why do you need to model something that already exists? You did not explain to me, why do you need to model the brain? Because there is already a biological brain, what is the purpose of the model? This is very fundamental and not an easy issue to discuss, even with grownups. Why do you need to model something that exists? What do you learn from the model? She said, until you explain it to me, I won't accept your paper."

The other thing she said was "What does it mean to model a phenomenon? Can you give me an example of some phenomena that you model and show me, how do you go from the phenomena? Let's say some electrical activity in the brain. How do you model that; how do you know that the model is close to the biology? Give me an example." These were two very deep questions. Scientists take it for granted that you need to model the world to understand it.

She was right. I never explained, why do I need to model something? It's clear to me that I need to model, but this was the first time that she forced me to explain that. I guess this is one of the reasons that the paper is so highly read because it helped people understand why you need to model a phenomenon. If you want to understand it, you cannot just describe it.

Knight: The authors take the kids' input seriously. The other common feedback is the figures are really important. The kids often think the figures are not clear enough and there's often questions about clarity and redoing figures. We also have a glossary of how to pronounce terms at the bottom of the paper.

SE: How do the kids become affiliated with the journal?

Savage: It's an indirect process. We have a huge editorial board of science mentors we recruit who have experience in peer review of some kind, or a fairly extensive publication record, so they're familiar at least with the process of peer review, and we rely on our board of these editorial mentors

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to recruit kids. It can be from a variety of different sources; sometimes it's family members. Often, mentors also pair up with teachers from local schools and in science classes. They'll do a review in the classroom and recruit the kids directly.

SE: What challenges do authors face trying to write articles for kids and then address the reviewer concerns? What feedback do you get from the authors?

Savage: I think Bob mentioned it before: It's usually the figures. Most figures in science are usually quite functional things, generally graphs or tables. Those don't really work for a kid, and if you really want to excite kids about science, graphs and tables just aren't going to cut it. We try to help scientists relate certain aspects and content to real life situations to help kids to be able to visualize it. For example, the "eureka" moment: the water coming up when you take a bath—that kind of style can really help. A Q&A style can help too—getting the kids to formulate and pose peripheral questions in their minds as they're reading is an important way of doing it. If it's not figures, then usually it's choice of language and style, and we have some tips that we send out to authors to help with this.

Knight: Idan and I have been super-fortunate to have this incredible team at *Frontiers* running this journal. Will and Laura have been great at expanding the journal and making sure the product is really clear. And again, the kids and the authors all get feedback. If there's a first read by the editorial office and it was not ready, we send it back and say redo it.

Savage: We do a lot of pre-review work, and we work with the authors quite substantially, even before the review starts. You'd be surprised how often we get manuscripts that come in at 8000–10,000 words, and authors have to get that down to a maximum of 1500 words. That can be a long process, but the authors learn a huge amount, not just in terms of how they communicate their work. You're telling someone who's been buried in their research 24/7 for years, "Now you need to write this for a nine-year-old." It's tough.

SE: How do you think the lessons learned from *Frontiers for Young Minds* about communicating passion

and excitement about science can be applied to scientific journals in general?

Laura Henderson: Excellent question. From my side, I would say that the one thing that *Frontiers for Young Minds* does incredibly well is understanding its audience, and because we directly engage with that audience, we know what their issues are. We know what they want, and we know whether our journal is really speaking to them or not. I would say that too often academic journals simply put content out there and assume that this is what is wanted. I think that the more in touch you can be with your audience the better. That is why the unique involvement in the peer review of *Frontiers for Young Minds* is what sets us apart.

Savage: I worked with *Frontiers in Physiology* before I came into *Frontiers for Young Minds*, so I had direct involvement with a core academic journal. The big lesson for me is it's not just about publishing the paper; the most impactful work that we do is post-publication. I think that's where a lot of journals could do a lot better. There is a very good reason why, for example, our per-article views at *Frontiers for Young Minds* is the highest by a long stretch across *Frontiers*: it's because we put in the effort post-publication.

If journals focus on citation impact, you're only going to get so far with a big Impact Factor because it's only of interest within the academic world. If you really want to get your science out there, you've got to do more. We try not to focus on citations and instead on the audience as a long-term goal. How many editors truly know their audience and what they want and how to reach them? We know exactly who we want to read it, and that's part of the reason why I think that it is successful.

Knight: You could tell your science editors that maybe when they're looking at their papers, if they see things that they are publishing in their fine journals that would be appealing intellectually and exciting to kids that maybe they ought to be encouraging their top authors to submit articles to *Frontiers for Young Minds*.