

# Bringing Kids into the Scientific Review Process

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**Frontiers for Young Minds puts kids in charge of scientific publications by having them control the review process. This provides kids the ability to shape the way science is taught and to better understand the scientific method.**

An important role for the scientist of the 21<sup>st</sup> century is to step outside the ivory tower of the laboratory and to take a strong part in educating the public about the methods and the outcomes of the scientific process. *Frontiers for Young Minds* is an initiative that puts this idea into practice to the benefit of the most important people of the 21<sup>st</sup> century: our children who are the next generation of scientists!

*Frontiers for Young Minds* (FYM) is an open access science journal that publishes scientific articles “edited by kids for kids” (see [Figure 1](#)). This project is published by Frontiers Media, the open access publisher based in Lausanne. The open access format guarantees that people from all socioeconomic backgrounds and from all parts of the world have free access to the journal.

STEM education (science, technology, engineering, and math) is more than a buzzword—it is the recognition that our future counts on ensuring a technically literate society. This is why teachers, politicians, and parents are all involved in efforts to improve STEM education in our schools, with adults dominating the design and delivery of STEM training. FYM takes a different approach by having kids shape the way science is taught.

The core idea of the FYM journal is that established scientists write articles based on either their own cutting-edge research or on a central concept of their field, adapted to a level appropriate for kids of elementary and middle school age. The kids then review the work in concert with a science mentor and provide feedback to the authors, who then revise their article accordingly, thus improving the clarity of the paper for kids and parents everywhere. This “peer review” process assures that kids actually understand the

material and also ensures that they understand the scientific process, exposing them to concepts of hypothesis formulation, experimental design for testing the hypothesis, the importance of proper data analysis, and the writing of an effective and cogent narrative adequate for publication.

This process, described in greater detail below, serves three main goals: to educate the kids about a wide range of scientific endeavors, to expose kids to the actual conduct of science, and to introduce them to the peer review process. Our mission statement reflects these goals, “We seek to connect curious minds to the experts and information that will motivate them to ask informed and critical questions about real science throughout their lives. By working directly with scientists, we ensure that our content is of the highest quality. By working directly with kids, we help foster curiosity both in and out of the classroom and engage the next generation of citizens and scientists.”

One important initial decision was to target an age group that often does not have rich exposure to life sciences in the typical school setting: late elementary and middle school kids (8–15 years). The review process starts with each submitted article getting assigned to an associate editor (a scientist from the editorial board of FYM), who will find either a single child, or a small group of children to review the article. An alternative review model is to perform a classroom review, which involves a visit of the science mentor to a school to present some general background related to the topic of the article under review and to discuss the article with the students in the classroom.

The Young Minds Reviewers always have a science mentor assigned, typically a graduate student or postdoctoral researcher associated with the handling editor or in some case a parent versed in the scientific topic of the paper. The mentor is the critical link in the process and helps the FYM reviewers with general questions about the science described in the article and how to best put together a review with questions and suggestions to the authors to improve the paper. After that, the FYM reviewers along with their mentor write up a review commenting on issues such as whether the article was of interest to them and why, the clarity of text and figures, and questions they may have for the scientists engendered by the article. For classroom reviews where there are typically many questions and views, the science mentor synthesizes the classroom discussion into a single review. The authors must address all of the kids’ issues and to date there has not been a single argument from any author questioning the kids’ reviews (and no appeals!). The revised paper goes back to the mentor to approve the revision and move the paper forward to publication. Upon online publication, FYM illustrators add a fun and descriptive cartoon to each article (<http://kids.frontiersin.org>). Here are four lead cartoons from FYM articles covering what is a concussion and how to avoid one ([Ketcham and Hall, 2016](#)), what are neural stem cells and how can they treat disease ([Swayne et al., 2016](#)), how can we remove harmful greenhouse gases ([Sanchez and Kammen, 2015](#)), and whether there is life on other planets ([Zuckerman, 2016](#)). We bet you can link each cartoon easily to the topic of the article (see [Figure 2](#)).



Figure 1. The Logo for Frontiers for Young Minds

The peer review process is a traditional and still important mechanism by which the quality, technical, and ethical standards of the scientific process and its product can be evaluated. Peer review in its present form dates back to a review procedure first used by the Royal Society in Edinburgh in the early 1700s and later adopted by the Philosophical Transactions of the Royal Society London (Spier, 2002). To involve kids in this process offers a unique opportunity for them to learn about science topics that they are interested in and to become involved in the scientific process early on. Our hope is that initiatives like FYM will attract future scientific talent early and help shape Young Minds' thinking about scientific problems and the scientific method. We believe that this exposure will extend to other aspects of kids' lives and shape their critical thinking.

One of us (R.K.) initiated the project by gathering a few interested neuroscientists (who now serve as editor-in-chief or associate editors); the concept is so robust and intuitive that they did not need much convincing. We worked closely with the Frontiers office in Lausanne, whose team developed its format and launched it in 2013, with the first papers appearing in 2014. The journal currently has five sections: Astronomy and Space Science, Health, Earth and its Resources, Neuroscience, and Biodiversity, and we plan to expand into other areas of scientific inquiry. Authors can choose to write articles on new discoveries that they have made or on core concepts in the fields they

study. In the Neuroscience section, our first section to launch, a wide variety of topics have been published including articles dealing with neural stem cells, decoding thoughts in the human brain, the brain and tool making, ventriloquism, deep brain stimulation and Parkinson's, the biology of social and emotional regulation, and many more. In the Health section, articles are focused on topics that promote the health and well-being of young people, and can include topics on a wide range of topics about obesity, smoking, asthma, acne, sex, mental health, or any other issue salient to kids. Papers published to date address topics such as vaccination and tuberculosis, what is a concussion (which includes a great movie on the brain bouncing in the cranial vault during a concussion, <http://ucresearch.tumblr.com/post/131237007666/this-is-your-brain-experiencing-a-concussion-it>), and using nanotechnology to treat cancer. Astronomy and Space Science has tackled issues such as the fascinating question of whether there are other earths in the universe, what are radio waves, and where do stars come from. Earth and its Resources has addressed important topics such as removing harmful gases from the environment, what are marine microbes, how is methane gas produced, how to make fuel from plants, and more. We want to emphasize that all papers, like our kid reviewers, are serious and not dumbed-down versions of the initial publication. The goal of the journal is for the kid to emerge with a clear and

deep understanding of the topic of each paper.

Writing for children 8–15 is a very different task than communicating science for peers—it can be a major challenge for the science authors and the Young Minds reviewers revealed that soon! The reviews are always polite, but the kids can also be unflatteringly honest. One Young Minds Reviewer aged 11 commented, "I think kids between 8 and 15 will have a hard time understanding the words. Because they won't understand the words, they will have a hard time understanding the meaning of the sentences. Not only the words are complex, the sentences are often very long and unclear." Another kid reviewer aged 13 commented, "The science seems good but it is not obvious how this knowledge will help with anything." Imagine that at the end of a paper or grant review! And perhaps the most dreaded review comment came from a 12 year old, "This seems important but the way it is written is so boring I can't even get to the end. Could the authors maybe sound excited about what they are doing?" Ouch!

FYM has become a truly international effort as we approach publication of our first 100 articles written by 160 authors and reviewed by over 400 kid reviewers and mentors from 23 countries including Spain, Ireland, France, Norway, Malaysia, Australia, Denmark, New Zealand, Brazil, India, Japan, South Korea, Saint Kitts and Nevis, the Netherlands, Mexico, Germany, Canada, Switzerland, Israel, United Kingdom, Czech Republic, Sweden, and the USA. Since its inception, FYM has also received considerable media coverage (e.g., CBS News, the Smithsonian, Fast Company, and Discovery Magazine) and has been recognized for its quality content with being selected as one of the American Library Association's "Great websites for kids." We have also initiated a new "live review event" where scientists present the key findings of their paper to a panel of kid reviewers who get to question the authors in front of a live audience. This is an exciting way to let the public see how the peer review process works and how kids can be an integral part of the scientific establishment. We initiated this program at the Chabot Space and Science Center (Oakland, CA) and plan to clone this model at other



**Figure 2. Lead in Cartoons Characterizing the Subsequent Paper for Four Frontiers in Young Minds Articles**

science centers internationally. We have also been fortunate to have the programmatic and intellectual support from major journals who are directing selected authors to FYM. Special thanks to Cell Press, *Journal of Neuroscience*, and the Frontiers family of journals for being early adopters of the FYM model—we very much hope that other journals will follow.

What is next? The key to success for FYM is the continued engagement of scientists from around the world who provide the fuel to engage kids in this novel approach to STEM education. One important goal is to reach kids across the globe and across socio-economic backgrounds. This sort of outreach is important, especially for kids from backgrounds that don't normally benefit from a solid science education, and who would not normally be exposed to science this

close up. An immediate goal is to provide translations of our articles into many languages including Spanish and Chinese, to provide a corpus of interesting articles for classrooms internationally. In a similar vein, we plan to make the review process available in different languages. This will require translation of submitted articles from English into the language of the home country and the participation of scientists and mentors in each country for the kid-based review process. In fact, Idan Segev is running a pilot program in Jerusalem for Hebrew, which, once successful, will provide the model for other languages. These are just some of the many things that we plan to do with this project in the future. If you are as excited as we are about the concept and promise of FYM, please consider becoming part of it as author, associate editor, or science

mentor and join in the quest to involve kids in the scientific process.

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