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Exploring scientific research articles in the classroom

Learn how to use research articles in your science lessons.

By Miriam Ossevoort, Marcel Koeneman and Martin Goedhart

Scientists use research articles to communicate their research findings and scientific claims. These articles are not just factual reports of experimental work; the authors also try to convince the reader that their argument is correct. It is now easier than ever to read the original research behind science stories in the media, as more and more articles are being made freely available through open-access publishing.

Open-access logo, designed by the Public Library of Science. Open-access publishing makes it easier for you and your students to access scientific research articles.

Image courtesy of JakobVoss; image source: Wikimedia Commons

Reading research articles is an opportunity for secondary-school students to learn about:

- The language of scientific communication (structure, vocabulary and conventions such as writing in the third person)
- The way scientists use their evidence to form an argument and justify their claims
- How science works (designing research to test hypotheses; fair testing; presenting results; drawing conclusions; raising new questions; building on existing knowledge)

3 Research articles are generally written in the third person

Reading research articles is not an easy task for students, but they can find it inspiring. Here we describe a classroom activity that we have been using to teach students aged 15-16 years and older about the textual structure (part 1) and the argumentative structure (part 2) of a research article. This classroom activity takes about three hours. It could be less if, after part 1, the students read the article as homework.

Most research articles are written in English, the language of science. If

REVIEW

All science subjects

Ages 15+

Using the suggested activity for discussing or exploring a few well-chosen research papers with students, teachers can not only deepen their students' knowledge of the scientific research in question, but also help them to relate more closely to the professional activities of a scientist.

In addition to the questions posed in the article, the teacher could also ask the students to discuss peer review. For example, what is peer review? Why is it done? By how many reviewers? Why is it important (or desirable) that the review process is blind? What is double-blind peer review? The students could also consider the acknowledgements section and discuss how science is financed.

Some interesting follow-up strategies would be to ask students to design their own research project and to write a small research paper. If this were done in two different classes, the students could then review the research papers of the other class, who have investigated the same or a similar topic.

Which science lessons and which age groups to target with the activity would depend on the research paper chosen by the teacher. However, the strategy would be most useful for upper-secondary-level students (ages 15-18). The fact that most research papers are in English should not be seen as an obstacle, but as an opportunity to implement interdisciplinary projects with language teachers.

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you teach in a school where English is not the language of instruction, you might find it helpful to involve the English teacher in the activity.

Getting started

To begin with, you need to choose a good research article to use. The following criteria are key:

1. Limited length (three pages maximum)
2. Appealing, age-appropriate content
3. Structure including the following sections: abstract, introduction, materials and methods, results, discussion and / or conclusion
4. Easy-to-understand experimental procedure
5. Simple relationship between the data and conclusion
6. Obvious practical or social significance.

When selecting the topic, you might like to focus on something covered in the school curriculum. Once you have chosen a topic, you may want to start by searching for research articles published in open-access journals. For example, the Directory of Open Access Journals[w1] (DOAJ), a directory of scientific and scholarly journals published in many languages, is one potential starting point. We would also recommend Biomed Central[w2], a publisher of 220 open-access, online, peer-reviewed journals in biology and medicine. The Public Library of Science[w3] (PLOS) publishes seven open-access, peer-reviewed journals in biology and medicine. When using these collections, you could search for articles on a specific topic or browse the recent research, featured discussions and / or most viewed sections.

Another source of inspiration could be topics covered in media such as newspapers, popular science magazines like *New Scientist* or *Science News*, or their corresponding websites. These websites generally allow you to enter search terms and filter by topic, date and other criteria; some of the articles include suggestions for further reading, such as the original research articles. You will then need to judge whether the research article itself meets the selection criteria listed above.

Research articles on (animal) behaviour or testing medicines often have easy-to-understand experimental pro-

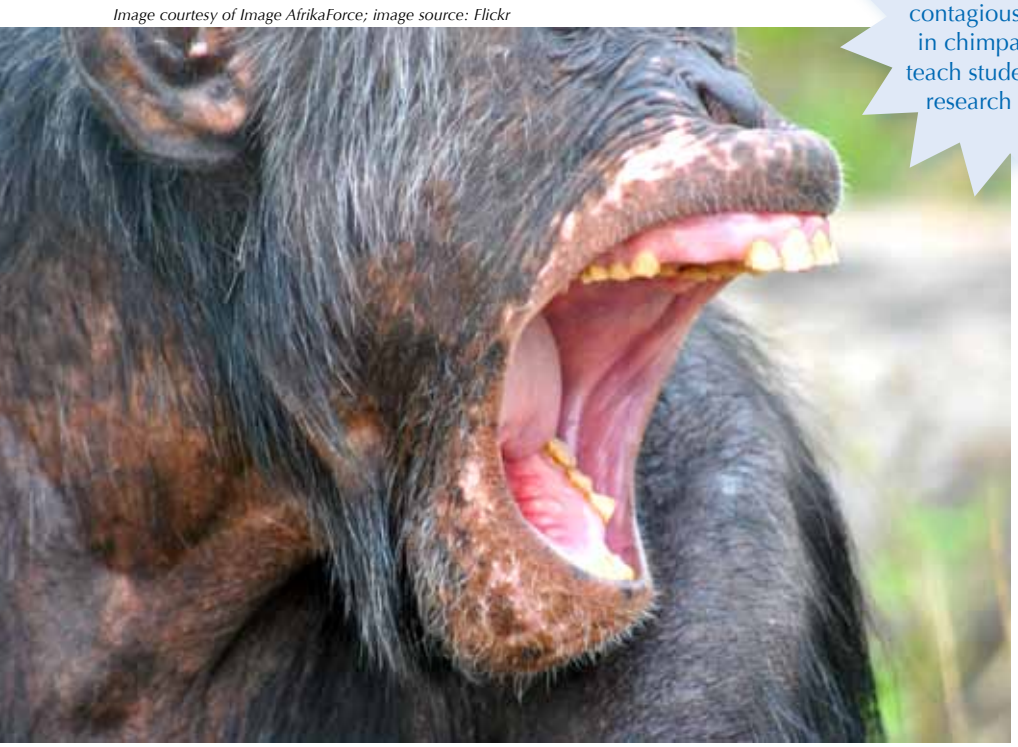
Image courtesy of billaday; image source: Flickr

Topics covered in the media are a good place to search for research papers

Image courtesy of Valerie Everett; image source: Flickr

General science

Image courtesy of Image AfrikaForce; image source: Flickr



We chose an article about contagious yawning in chimpanzees to teach students about research articles.

cedures. One good example is *Computer animations stimulate contagious yawning in chimpanzees* (Campbell et al., 2009), which was covered in several newspapers. We chose this article for its length, its appealing content (looking at pictures of yawning chimpanzees makes you yawn yourself), the straightforward experimental procedure and clear scientific claim. More details of how we used the article can be downloaded from the *Science in School* website[w4].

1) The textual structure of the article

Let's begin by looking at the text and the structure of a research article. It starts with a *title*, which summarises the study and / or its outcome. This is followed by a list of the *authors* and their *affiliations* (i.e. who they work for). Usually, the first author is the main researcher and the last author is the head of the department. Then, the *dates of submission and publication* are given; this shows how long the peer review and revision process has taken. Next, we find the *abstract*, which summarises the content of the article. The main body of the article starts after the abstract.

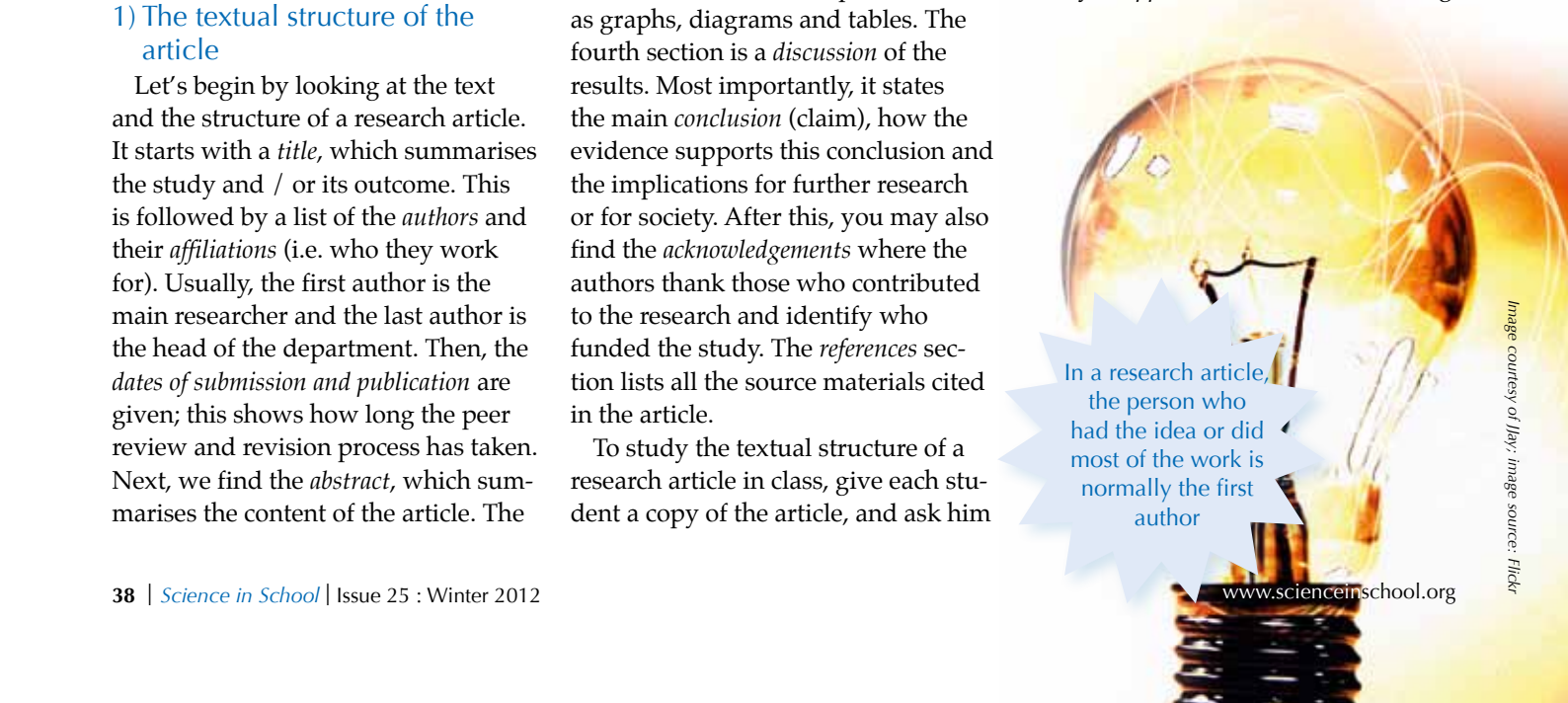
In the main body of the article, the first section is the *introduction*. Here the authors explain the context of the study, i.e. what other researchers have discovered, why this study is important (the gap in knowledge) and what they are going to do. The second section presents the *material and methods* in enough detail for other scientists to repeat the experiments. In the third section, the *results* of the study are summarised in text and presented as graphs, diagrams and tables. The fourth section is a *discussion* of the results. Most importantly, it states the main *conclusion* (claim), how the evidence supports this conclusion and the implications for further research or for society. After this, you may also find the *acknowledgements* where the authors thank those who contributed to the research and identify who funded the study. The *references* section lists all the source materials cited in the article.

To study the textual structure of a research article in class, give each student a copy of the article, and ask him or her to answer some basic questions. By skimming the article to find the answers, your students will quickly become familiar with the structure of the research article and its content. Questions might include:

- Who is the first author of this article? The first author is normally the person who had the idea behind the research or did most of the work.
- Who are the other authors?
- Where was the research done?
- Which sections does the article contain and what is in each section?
- When was this paper published?
- Who funded the research?

2) The argumentative structure of a research article

Remember, scientists write research articles to try and convince their peers to accept their scientific claims. This line of reasoning is called the *argumentative structure* and consists of: the *motive* (why the study was done), the *objective* (what was investigated), the *main conclusion* (the outcome of the study), *supports* (statements, including



In a research article, the person who had the idea or did most of the work is normally the first author

Image courtesy of Jay; image source: Flickr

data from their own research), *references* (to previous research and refuted counter-arguments) and one or more *implications* (which might be a new theory, a new research question, or the impact on society or the research community). Each of these elements is usually found in a specific section of the research article (figure 1).

The next step in the teaching activity is to look at the argumentative structure in more detail. Students could read the whole article in detail, working individually or in small groups to answer guided questions. Next, the answers could be discussed to enhance the students' understanding.

First, let your students read the introduction, then ask them to answer the following questions:

- Why was this study done (*motive*)?
- What was investigated (*objective*)?

Next is the materials and methods section. In our experience, students often find this section hard to understand due to its highly technical vocabulary. Therefore, we suggest that you simply explain how the study was performed.

Then, the students can read the results and discussion sections and answer the questions below either as homework or in class. Ask them to:

- Identify the *main conclusion* (outcome of the study), *supports* for this main conclusion (data from this study or previous research) and the *implication* (e.g. need for further study or impact on society).

If your students find it difficult to identify these elements, let them discuss their answers in groups before sharing them with the class. A good visual way of doing this is to create a poster with a structure similar to figure 1. The students can then review their posters in a classroom discussion.

At the end of this classroom activity, you may want to write out the complete argumentative structure of the research article on the board. Finally, encourage your students to discuss whether they agree with the authors' scientific claim (main conclusion) and to review the article as a whole by playing the role of a reviewer. You could use a role play about peer review[w5], developed by Sense about Science.

There are plenty of media stories about contagious yawning, so this topic would also be ideal for working with news articles. For more details of using news articles in science lessons, see Veneu-Lumb and Costa (2010).

As a follow-up activity, you could ask your students to conduct their own version of the experiment described in the research paper. For example if you used the article we chose, your students could play a yawning video from Youtube (search for 'contagious yawning') to another class of students (who did not know what was being tested) and watch how often they yawn. As a control, they could watch a non-yawning video of similar length.

Image courtesy of Miriam Ossevoort

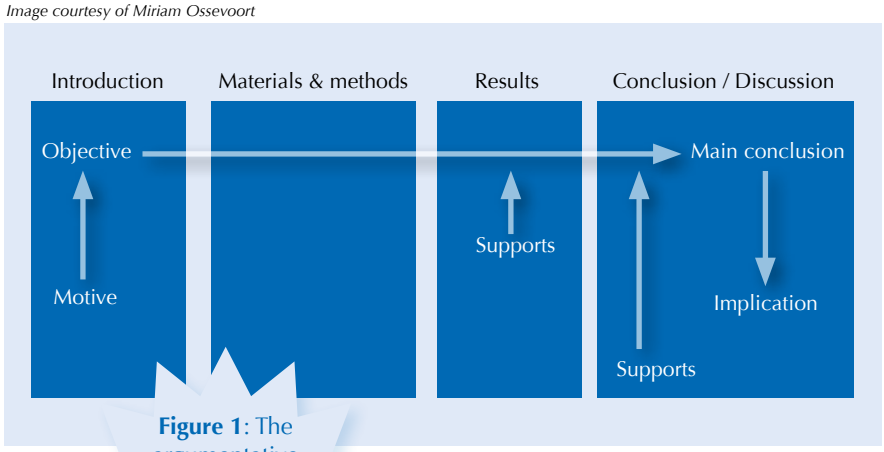


Figure 1: The argumentative structure of a research article and the location of the different elements in the text.

References

Campbell MW et al. (2009) Computer animations stimulate contagious yawning in chimpanzees. *Proceedings of Royal Society B*. **276**: 4255–4259. doi: 10.1098/rspb.2009.1087

The article is freely available via the journal website (http://rspb.royalsocietypublishing.org)

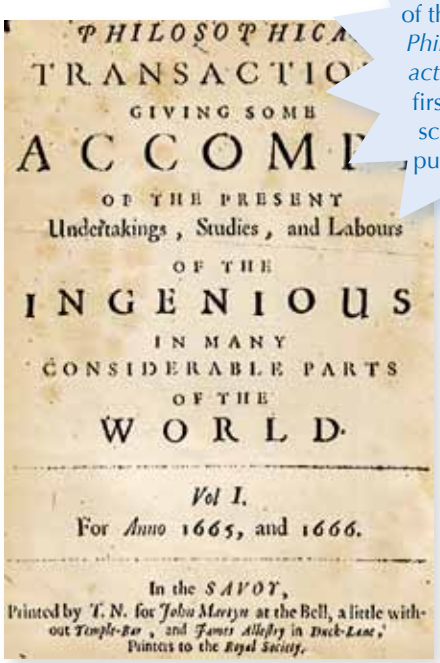
Veneu-Lumb F, Costa M (2010) Using news in the science classroom. *Science in School*. **15**: 30-33. www.scienceinschool.org/2010/issue15/news

Web references

w1 – The Directory of Open Access Journals (DOAJ) is a directory of scientific and scholarly journals published in many languages. See: www.doaj.org

w2 – Biomed Central is the publisher of 220 open-access, online, peer-reviewed journals in biology and medicine. See: www.biomedcentral.com

w3 – The Public Library of Science (PLOS) publishes seven open-access, peer-reviewed journals in biology and medicine. See: www.plos.org


PHILOSOPHICA
TRANSACTIO
GIVING SOME
ACCOMP
OF THE PRESENT
Undertakings, Studies, and Labours
OF THE
INGENIOUS
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CONSIDERABLE PARTS
OF THE
WORLD.
Vol I.
For Anno 1665, and 1666.
In the SAVOY,
Printed by T. N. for John Martyn at the Bell, a little without Temple-Bar, and James Allestry in Duck-Lane,
Printers to the Royal Society.

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The front cover of the first volume of *Philosophical Transactions*, the world's first peer-reviewed scientific journal, published in 1665


No. 4356 April 25, 1953 NATURE 737
MOLECULAR STRUCTURE OF NUCLEIC ACIDS
A Structure for Deoxyribose Nucleic Acid

Image courtesy of Nature

A page from Watson and Crick's famous 1953 *Nature* paper, in which they reveal the structure of DNA

w4 – Download an in-depth analysis of the structure of Campbell et al. (2009) from the *Science in School* website. www.scienceinschool.org/2012/issue25/research#resources

w5 – In a classroom role play, students re-enact the peer-review process, assessing the quality of a mock study on the effect of chocolate on blood pressure. The role-play materials and some supporting information can be downloaded from the Sense about Science website: www.senseaboutscience.net/?page_id=52

Resources

Many *Science in School* articles link to research papers published in the prestigious scientific journal, *Nature*. These papers can be downloaded free of charge from the *Science in School* website. Explore our archive for articles that link to *Nature* papers. www.scienceinschool.org

In 2011, the Royal Society, the oldest scientific academy in continuous existence, made its entire historical journal archive freely available online. See http://royalsociety.org or use the direct link http://tinyurl.com/royalsocarchive

To learn more about authorship of papers, see:

Dance A (2012) Authorship: who's on first. *Nature* **489**: 591-593. doi:10.1038/nj7417-591a

The article is freely available via the *Nature* website (www.nature.com) or via the direct link: http://tinyurl.com/8h4c4lj

Venkatraman V (2010) Conventions of scientific authorship. *Science Career Magazine*: 16 April 2010. doi: 10.1126/science.caredit.a1000039

The article is freely available via the *Science Career Magazine* website (http://sciencecareers.sciencemag.org/career_magazine) or via the direct link: http://tinyurl.com/2uu6hrg

If you found this article useful, you may like to browse the other teaching activities in *Science in School*. See: www.scienceinschool.org/teaching

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To learn how to use this code, see page 65.