COMMUNICATION TO THE NON-SCIENTIFIC PUBLIC USING THE WIKIPEDIA FREE ENCYCLOPEDIA JULIEN LEUTHOLD, ADRIAN GILLI ETHZURICH We have designed a reading seminar to practice

julien.leuthold@erdw.ethz.ch

The multilingual, web-based, Wikipedia free Encyclopedia is widely used by people from different audience from everywhere around the world. It is openly editable, allowing very quick updates. We used these properties to design an educational tool used in University classrooms, where students' assignment was to rephrase scientific articles for the public. We share here our teaching experience with an Earth Sciences class, based on class assessments and students evaluations.

During the second half of the 2017 Fall semester at ETH Zürich, a 1 ECTS M.Sc. level reading seminar on the broad topic of Heat and Mass Transfers in Magmatology was taught. Three first semester and six third semester M.Sc. students have attended the course. All students had a B.Sc. degree in Earth Sciences, among which seven had their main specialisation in Mineralogy and Geochemistry and two had their major in Geophysics.

By groups of two, students have read a scientific article, presented it orally to classmates and answered to questions from the peers. During the last two classes, students have edited and created Wikipedia free Encyclopedia pages in relation to their article's topic. Students really enjoyed creating a Wikipedia page, even if they didn't use it before or didn't trust the Wikipedia content. They had little experience with communication to a non-scientific audience and thought this exercise was challenging. Evaluations show that writing about a scientific paper in a Wikipedia page is a less efficient learning technique than reading a scientific article, presenting it orally or discussing it in a group. However, it certainly contributes to better memorise important information and it is an efficient way to practice writing and public and scientific communication skills. As an interesting side effect for the scientific part, it has the potential to reach a wide international community.

With this poster, we wish to encourage colleagues in Earth Sciences and beyond to teach your students how to communicate science, to scientific peers and to the non-scientific public.

1.1. Importance of communication

Communication is very important in academia. Presenting and confronting ideas allows transferring and improving knowledge within the community (between researchers, between teachers and students) Scientific publications and participations to scientific meetings are keys in an academic career. The importance of communication to non-scientific public is frequently underestimated in academia, or delegated to communication specialists (e.g. museum). Brownell et al. (2013) wrote: "Communication of science to the general public i increasingly recognized as a responsibility of scientists. This is a difficult skill that many practicing scientists lack, likely due to the combination of increased specialization over time and the absence of formal training in science communication." Also outside of academia, scientists have to communicate with colleagues in governmental and non-governmental agencies, industry and customers. As teachers, it is our responsability to teach students how to communicate.

1.2. The worldwide impact of the Wikipedia free encyclopedia

The multilingual, web-based, free-content Wikipedia free Encyclopedia is openly editable and widely used by people from everywhere around the world (some 8,000 people view the website every second; Neal, 2016). Wikipedia is steadily ranked among the Internet's Top 10 most popular websites (Konieczny, 2012). Indeed, it is frequently one of the top link on web search engines. Everyone (from an academic to a hobbyist) can make an edit or create a page, drawing a large number of editors from diverse backgrounds. A British survey (Cox, 2014) has shown 64% people trust the Wikipedia Encyclopedia content. This is higher than for well-established paper (e.g. Times or the Guardian) and TV (e.g. BBC News) and nearly as good as for the Britannica Encyclopedia, trusted by 83%. As a matter of fact, the frequency of errors in Wikipedia and the Encyclopedia Britannica are comparable (Giles, 2005). While the daily reach per Internet users of the Britannica Encyclopedia has been constant in the last decades, the use of the Wikipedia Encyclopedia has been exponential (Konieczny, 2007). Being trained to critical thinking, scientists can contribute towards an improvement of public knowledge by editing and creating Wikipedia pages to explain fundamental scientific concepts. Some universities have already started incorporating the edition and creation of Wikipedia pages in their curriculum, using the Wiki Education tools. Here, we investigate a novel teaching technique, consisting in the creation by students of Wikipedia pages based on scientific articles. We thus present, analyse and discuss our assessments during and after a reading seminar class.

1.3. Teaching goals: Written communication skills, share knowledge

Today, in our society, it has become a habit sharing information with close and distant friends and family using the Internet and social media. With this teaching project, we wished to train the students reformulating complex scientific information to the public and publish them on the Wikipedia Encyclopedia worldwide network. We had three goals: 1) Develop writing skills; 2) Develop communication skills for a non-scientific audience; and 3) Improve and extend the Wikipedia Encyclopedia within our field of competence.

Ploetzner et al. (1999) wrote learning by teaching promotes learning, but the amount of learning seems to be more related to the cognitive activities necessary for constructing and presenting explanations than to the teaching itself. We may then make the hypothesis that the student's amount of learning would be bigger while thinking how to rephrase a scientific article into a large public Wikipedia page than by reading that scientific article.

2. Teaching approach: The reader's digest

In Fall semester 2017, the lecturer has taught MSc students a course on 'Heat and Mass Transfers in Magmatology', worth 1 ECTS credit (30 hours of lecture and personal work). This course lasted for 7 weeks, with 2 hours lecture per week. Nine students have taken part. The course was composed of three parts:

1) On week 1, the teacher gave lectures with exercises, serving as general introduction, to create a common basis for the second and third parts. The teacher has given a list of five scientific articles to the students (see Table 1), who were asked to form pairs and select one. The scientific papers covered a wide range of topics, all in relation with the course main topic.

2) The second part, on weeks 2-6, was designed as a reading seminar course. Each week, two volunteering students had read in detail one paper and present it orally for 15 minutes to the class. The other students had to read the paper's abstract, introduction and conclusions, look at the figures and prepare 2 questions they would ask to the presenters.

Week 2: Grove, T.L., Kinzler, R.J., Bryan, W.B. (1992); Fractionation of Mid-Ocean Ridge Basalt (MORB). Mantle flow and melt generation at Mid-Ocean Ridges geophysical monograph 71; American Geophysical Union; 281-310.

Week 3: Nandedkar et al. (2014); Fractional crystallization of primitive, hydrous arc magmas: an experimental study at 0.7 GPa. Contributions to Mineralogy and Petrology; 167:1015.

Week 4: Solano et al. (2012) Journal of Petrology; Melt segregation in deep hot zones: a mechanism for chemical differentiation, crustal assimilation and the formation of evolved magmas. Journal of Petrology; 55(10); 1999-2026.

Week 5: Leuthold et al. (2014) Journal of Petrology; Petrological constraints on the recycling of mafic crystal mushes and intrusion of braided sills in the Torres del Paine mafic complex (Patagonia). Journal of Petrology; 55(5); 917-949.

Week 6: Helz et al. (2014) USGS; Petrological insights into basaltic volcanism at historically active Hawaiian volcanoes. In: Poland, M.P., Takahashi, T.J., Landowski C.M.; Characteristics of Hawaiian Volcanoes; U.S. Geological Survey Professional Paper 1801; chap.6; 237-294.

3) On week 6, the teacher initiated a communication exercise using the Wikipedia media. He explained the students how to edit a Wikipedia page in html (add text, add link, add reference, add image), showing how to proceed on an existing page. He then asked all participants to look at the Wikipedia tutorials¹, create an account and edit existing pages using their knowledge from the course. Additionally he asked pairs of students to create a new page on a selected topic (list of topics in Table below) for the final week 7, as homework, using the scientific paper they had read and presented. The lecturer insisted on the importance to reformulate scientific information for a large public. On the last day (week 7), the students revised, edited and completed pages written by their classmates, using the information they had from their own paper and the knowledge acquired during the class, paying special attention to one related topic (see Table below). This process is a small-scale edit-a-thon event. At the real end of the course, all new pages were submitted for revision by the Wikipedia volunteers.

¹ https://en.wikipedia.org/wiki/Wikipedia:Tutorial https://en.wikipedia.org/wiki/Wikipedia:Training/For_students

Wikipedia page topic ²	Written by	Reviewed by	Decision, grade ³	Date of decision	Nbr visits/month since publication
Lower oceanic crust	Group week 2	Group week 6	Accepted: C	28.01.2018	145
Experimental petrology	Group week 3	Group week 2	Declined: Missing references	30.01.2018	
Deep Crustal Hot Zones	Group week 4	Group week 5	Accepted: Start	20.12.2017	19
Torres del Paine	Group	Group	Accepted: C	10.02.2018	23
Sill complex	week 5	week 4	Later deleted on	08.03.2018	
Kilauea Iki lava lake	Group week 6	Group week 3	Declined: Reads more like an essay	17.02.2018	

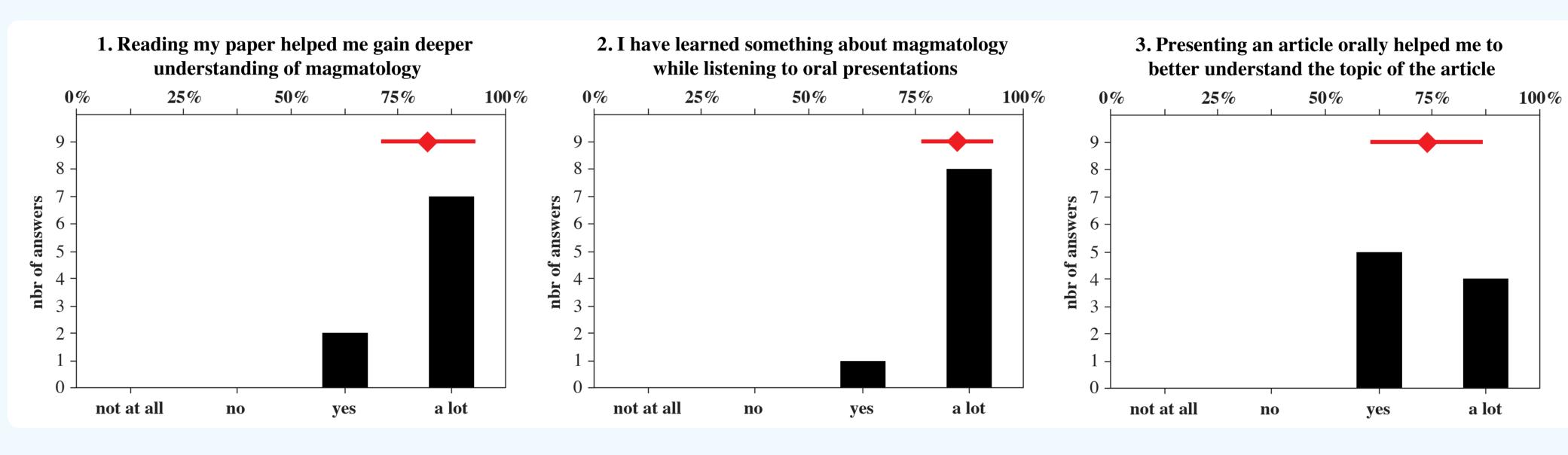
² Pages not yet submitted, under review or rejected can be accessed searching for *draft: name of the topic* on Wikipedia. ³ Wikipedia grades: Stub, Start, C, B, GA, FA

During this course, the students went through successive construction of explanations: 1) They started with self-explanation while reading the scientific article, 2) then formed pairs and discussed and explained the content, 3) then shared to peers in an oral presentation and 4) finally reformulated to the non-scientific public, using the Wikipedia Encyclopedia media.

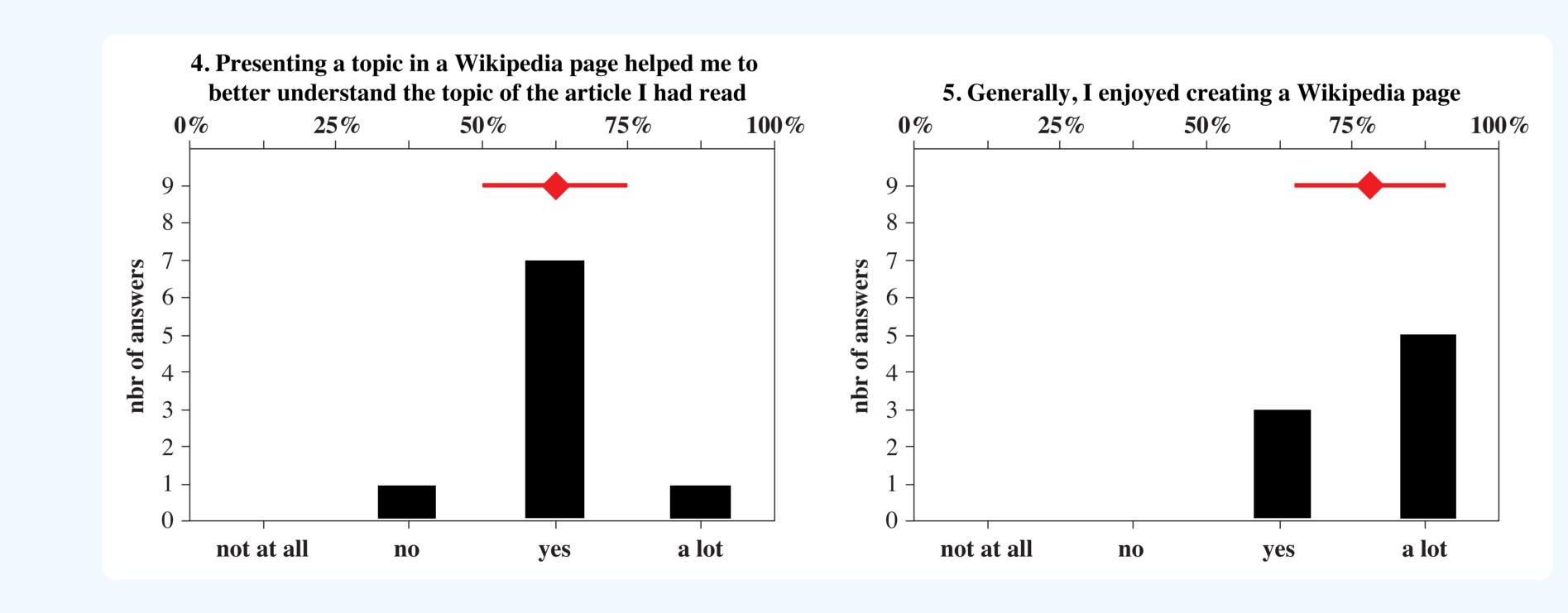
3.1. Assessments on Wikipedia page creation: Fun helps learning

Students were very excited about creating a new Wikipedia page, from the beginning to the end of the exercise, and the lecturer got very enthusiastic and positive feedbacks. He was strongly encouraged to do it again. Discovery, exploration, mental stimulation and excitement help having fun while learning and enjoy learning (Packer, 2010). Some students suggested to focus the course and to create Wikipedia pages on one specific topic. As a quantitative assessment, the teacher has given each student a 15 questions form to evaluate and comment the course with a special focus on the Wikipedia exercise. All 9 students have anonymously returned the printed form filled at the end of the Wikipedia exercise and consented the results to be used in the present study. For statistics, average is shown together with one standard deviation, showing the homogeneity of answers.

Reading a scientific paper (question 1) has equivalent teaching results as listening to oral presentation (question 2) and group discussion about the paper. Presenting the paper orally also helps the student to acquire knowledge about the topic (question 3). Writing a Wikipedia page from a scientific paper does not provide the same amount of learning, but the great majority of students thought it helped to better understand the topic (question 4)



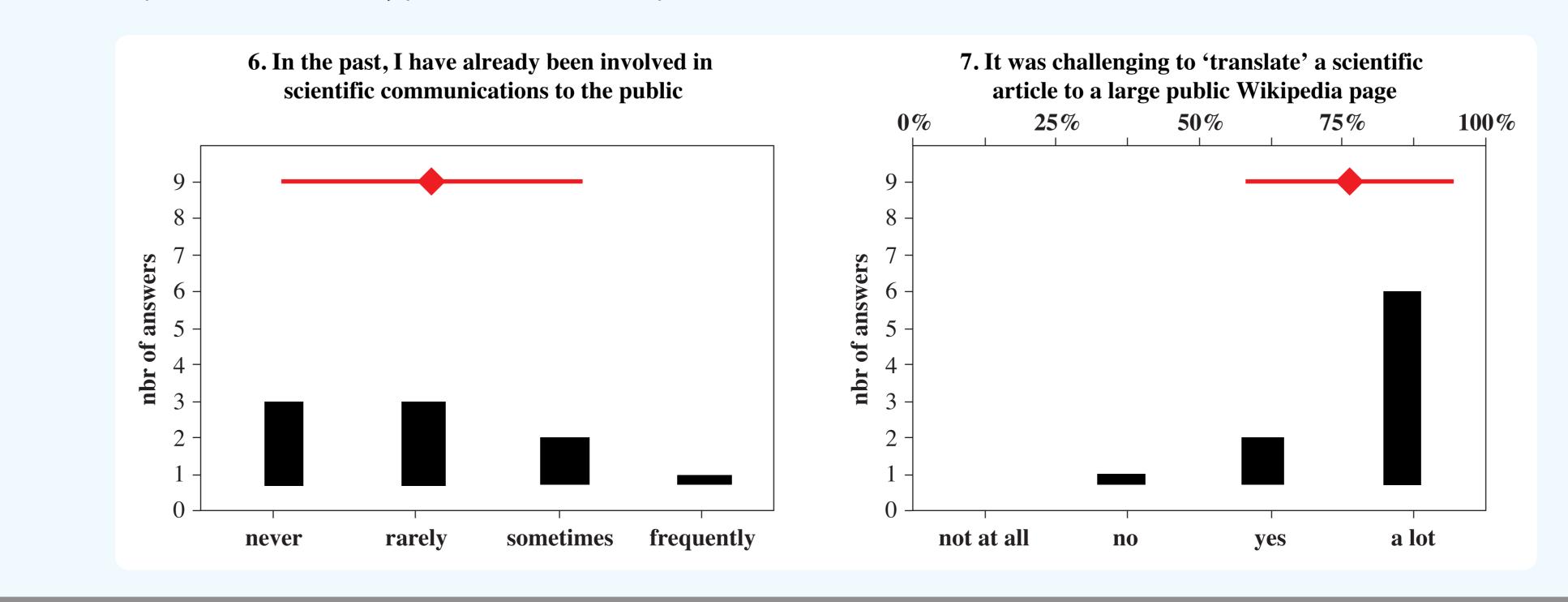
As Wikipedia is accessible and easy to use, some students would use it to find early-stage information and useful references and would pursue their learning using scientific papers. Students who are not using or rarely using Wikipedia don't trust the content. However, those students all enjoyed the exercise (question 5).



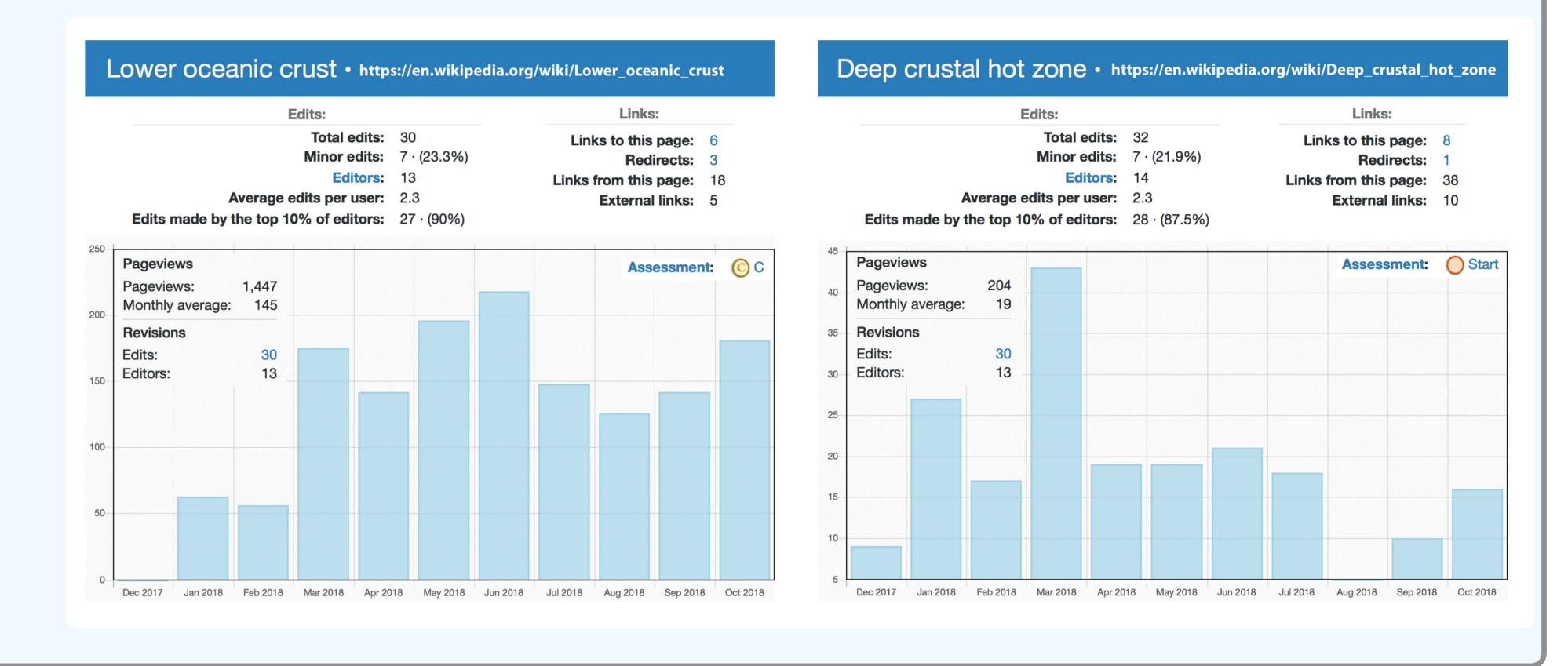
3.2. Assessments on communication to the public: Still needs a lot of work...

Most students had no or only little experience with communication to the non-scientific public (question 6), and very little communication skills, orally and to the non-scientific community. They thus found it was challenging to create a Wikipedia page and popularize scientific information (question 7). However, students who had some experience with non-scientific communication also found it challenging.

In our opinion, despite efforts had been made to popularize the scientific articles, the submitted Wikipedia pages are still difficult to understand for a non-initiated public. The advantage of Wikipedia is its ease to link to other pages, so that technical words may not need explanation within each article. Improvements are clearly possible but would require considerable more time.



the communication of published scientific results 1) orally to scientific peers and 2) to the wider public, using creation of Wikipedia pages.



4. Several good (and few less good) reasons for using Wikipedia in a class

Based on the results of the assessment form, the Wikipedia page creation should not be designed with the primary goal to increase student scientific knowledge, despite it can contribute to it (question 4). This seems to contradict with the idea of Ploetzner et al. (1999) that the amount of learning seems to be more related to the cognitive activities necessary for constructing and presenting explanations than to the teaching itself. But the fact that students could have made additional effort to popularize their Wikipedia page show the cognitive activities may be more exploited. In addition, this exercise offers valuable communication skills, and repetition through paper reading, presenting and rephrasing certainly allows a better memorization. Furthermore, it is a modern tool that corresponds well to today's society needs and habits and a pleasant way to popularize scientific information.

Unfortunately, no student further worked on his published or rejected page after submission or decision, despite the great majority said they would. This is a negative surprise, as assessment and feedbacks were very positive. To get a more resulted product, we recommend the teachers to plan more time for the students to work and develop their Wikipedia pages. However, two pages were graded C ('average'), which we consider already as a good mark, given the available time. In future classes, the teacher will ask other students to work on those pages, to improve them by making them more accessible to the public, extend the content and create links from and to other pages.

With people visiting the new Wikipdia pages every day, the global outreach of this class is much larger than just the 9 ETHZ students. However, in the example described here, there is no interaction between the visitor and the teacher/author, which constitutes a major difference with normal classes. Wikipedia collaborates with teachers and created a special platform dedicated for teaching: Wikiedu. It is possible to create a page for a course, add and remove students, create classroom assignments, assign Wikipedia articles to students and communicate with them. There would even be no need for physical contact between the teacher and the students. The Wikipedia course can then be made accessible to worldwide students, and freely available to the community to encourage free and open access to knowledge.

References:

Acknowledgments: We thank Dr. Pia Scherrer for her supervision during the 2017 ETH Zürich class on the Foundations of Teaching and Learning for lecturers. Dr. Christian Steuer is thanked for his useful comments.

3.3. Assessment on Wikipedia outreach: A much wider impact than during a class

It took ca. 4-6 weeks for Wikipedia staff to review newly submitted pages (see Table). 3 pages have been published (see Table) and 2 pages had been rejected. One page was rejected because references were insufficient and one page was rejected because it looked more like an essay. Despite the teacher encouraged the students to improve and resubmit their page, none did, even if most students said they would go on editing and creating Wikipedia pages. One published page was reported as possibly being copied and pasted from a scientific article, which would be violating the Wikipedia's copyright policy, and later deleted.

In Octobber 2018, 10 months after the end of the course, published pages were visited by 1-4 persons each day and have been further modified by ca. 10 Wikipedia users (considering major edits only) (see figure below). This way, communication via the Internet is a live process and scientific information is being transferred from the scientists to the public. It is important to note the monthly number of visitors is about 6 times bigger than the number of students attending the class. Thus, the Wikipedia publications reach many people from all around the World, among which we may find the next generations of student.

Brownell, S.E., Price, J.V., Steinman, L. (2013). Science Communication to the General Public: Why We Need to Teach Undergraduate and Graduate Students this Skill as Part of Their Formal Scientific Training. The Journal of Undergraduate Neuroscience Education (JUNE), 12(1):E6-E10. Cox, J. (2014). Why People Trust Wikipedia More Than the News. Motherboard journal, 11.08.2014. Giles, J. (2005). Internet encyclopaedias go head to head. Nature 438, 900–901. Konieczny, P. (2007). Wikis and Wikipedia as a teaching tool. International Journal of Instructional Technology and Distance Learning: 4(1). Neal, M. (2016). Science Students Are Writing Wikipedia Articles Instead of Term Papers. Motherboard journal, 11.02.2016. Packer, J. (2010). Learning for Fun: The Unique Contribution of Educational Leisure Experiences. Curator: The museum journal. 49: 329-344. Ploetzner, R., Dillenbourg, P., Preier, M., Traum, D. (1999). Learning by explaining to oneself and to others. In Dillenbourg, P. (Ed) Collaborative-learning: Cognitive and computational approaches. Elsevier. pp. 103-121.