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Interactive comment on "Ozone measurement practice in the laboratory using Schönbein's method" *by* Ignacio Arturo Ramirez-Gonzalez et al.

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First of all, we would like to thank the reviewer for the constructive feedback on our manuscript. Replies follow:

General comments: I am not commenting on the scientific content of the method presented, as it is not my field. From a scientific communication and science outreach perspective, various aspects remain unclear; a specific reason for choosing to use the 19th-century method is implied but not elaborated on,

The main reason for choosing the 19th-century method is because it is a traditional way to teach about the history of science and at the same time learning by doing about the environment, the atmosphere and air quality. Moreover, this methodology lets to

combine teaching on chemistry and physics together (a chemical reaction is the basis to measure a chemical compound resulting from a photolytic one), meanwhile the main methodologies used nowadays are based only on physics (just by using UV light). Also, it is the most economical. The price of the cheapest ozone measuring device is € 600, which is an unacceptable budget for many high school laboratories around the world. However the practice here presented only costs €00 for 1000 people.

the presentation of the method of delivery is somewhat jumbled and I see no evidence that the approach itself is effective beyond the authors asserting that it was (and which they attribute to the students and teachers involved rather than their own approach) or that it has been properly evaluated in this respect. There is certainly potential here to produce interesting information about the efficacy of the technique in communicating this topic to students, but much more information and a thorough evaluation of this is needed.

We acknowledge that the reviewer is right here. However we would like to point out that measuring the effectiveness of the learning of the students was not the main purpose of this work. Our aim is to develop a teaching approach for something that was not taught before and to perform a scientific outreach activity.

That said, we think that the pieces of evidence that we present, although do not correspond to usual assessments of pedagogical effectiveness, are reasonable and good enough. It is necessary to have into account that it is hard to compare the effectiveness of teaching new content when there was not a previous alternative hands-on approach to do it.

Trying to address the request by the reviewer about extra information, we now include in the new version of the manuscript new statistical information about the perception of the students on the previous teaching of the contents associated with the method here presented. This is now in the Introduction and includes a new figure (see figure 1) about the perception of the students on the previous teaching of these concepts.

Supporting information from the literature around the value of such activities (e.g. raising science capital) could also be included.

As requested by the reviewer in the new version of the manuscript we have included a more complete discussion on this and we cite appropriate literature.

Specific comments: These are given in the attached file.

Page 1, line 12 State the educational level.

Now, as requested, we make clear the educational level. The new sentence reads: 'Usually, the study of the atmosphere at these educational levels (from 13 to 17 years)'

Page 1, line 15 Taught where?

Now, as requested, we make clear that we refer to high schools.

Page 2, kine 26 This implies that it is familiar to children under the age of 11.

We have rewritten the sentence to make clear that we only refer to high school students.

Page 3, line 1 What is the evidence for this?

Now we include evidence of this from the surveys completed by the students (including a new plot in the Introduction) and provide new references existing in the literature that support our statement.

Page 3, line 5 What age range is this assuming?

Please, refer to the reply to the first question in 'Specific comments' of the reviewer.

Page 3, line 10 It's not clear what this means.

We have rewritten the sentence and now it reads: 'Also his practice can be used to make students more familiar with the daily work of scientists as this method is currently used when dealing with the recovery of old meteorological data.'

Page 3, line 17 How many high schools? Were these characteristics true of the survey

respondents, or the populations of the high schools?

We thank to the reviewer for pointing this out, as it has let us spot a mistake in the text. Actually, the age of the students was 12-19 instead of 14-19. We have updated it in the text. Also, the number of high schools is now specified previously in the Introduction.

Page 3, line 18 What did the other 14 questions address?

Now, we include the full survey as supplementary material.

Page 3, line 23 The values are given are different. Were statistical tests performed to ascertain that there was no significant difference?

It was not our intention to get any statistical inference or to make any statement on the statistical significance of the differences. We just want to say that the values obtained are similar. We have clarified it in the new version and now the sentence reads: 'produced a very close value to the one of the previous question'

Page 4, line 10 What is the source for this information?

We now cite the corresponding work.

Page 5, line 3 What are these? If they are to be explained later, it would be helpful to clarify this.

We understand the question by the reviewer, but we do not envisage a way of presenting it better than the current one, because the explanation about the level is under the next subsection that is exactly the next line in the document. However, we are open to suggestions on how to improve it and to incorporate it in future versions of our manuscript.

Page 5, line 5 Who is the simple test for, in this case? There appears to be some contradictory information around this.

This was already explained in the submitted version of the manuscript under the corre-

sponding subsection. We do not appreciate any contradiction, but as for the previous question we are open to modifying it, if the reviewer can point out better where it is and if he/she continues to consider it necessary.

Page 7, line 12 It's not clear what this means.

We have rewritten the sentence to make it clearer. Now it reads: 'This level differs from the more advanced level in the fact the strips are not made by the students. This part is not included at this level, because of the potential difficulty accessing all the materials and the necessary laboratory work behind this.'

Page 8, line 2 How accessible is this, for example for use in schools?

We have clarified this and now the sentence read: '(O3Meter, which can be downloaded from Google Play or from the Github repository and installed on an Android device or on a personal computer)'

Page 8, line 25 This information needs to be given earlier.

We have moved this information to the Introduction.

Page 8, line 25 How was this measured?

It was not our aim to imply an objective measurement of this. However, the answers to the question "Would you like more information about it?" presented in Figure 2, show that after the activity 90.5% of the students wanted it. Also, from a more subjective point of view, we consider that the activity was a success as its development in several high schools made headlines in local newspapers. Now we also cite these news. Therefore, we have rewritten the sentence to make all this clear and now it reads:' As previously discussed, we presented the practice in 10 Galician high schools (to more than 350 students) and it was well-received. Figure 2 shows how after the activity 90.5% of the students wanted more information about it. Also, we consider the activity successful in terms of scientific outreach as its development in several high schools made headlines in local newspapers [Diario de Lemos, 2017; La Voz de Galicia, 2017]'

Page 8, line 30 This fits within the wider context of impacts of outreach activities on school students, e.g. https://www.tandfonline.com/doi/full/10.1080/09500693.2018.1473659

We thank to the reviewer for pointing out this relevant work by Vennix et al. that we did no and now cite in our manuscript.

Page 10, line 3 What was the impact of your method? If you were successful because of the attitude of the students and school staff, what is the evidence that your approach itself was successful in engaging students and raising their subject awareness? Supportive school staff is undoubtedly hugely valuable but effective approaches will also reach disengaged students.

The reviewer is right when points out that the a priori attitude of the students of the students is hard to measure and not enough studied in the results that we present. Therefore, as this is not relevant for the main purpose of the work, that is to present a new laboratory practice combined with an outreach activity, we have removed it from the manuscript.

Page 10, line 7 How large are these groups?

We have clarified it and now it reads: 'The cost per application ranges between 200 and 300 euros per group of 1000 students (1000 strips for one year)'

Page 10, line 12 It's not clear what this means?

After reading this sentence again, we consider that this topic has already been discussed in the manuscript and therefore we have removed it from this part. Moreover, we agree with the reviewer that it was poorly written making the reader feel confused about its meaning.

Page 10, line 15 What is your evidence that this has occurred?

We are not making a hard statement here and it was out of the scope of this activity

the measure how effective was the teaching or learning of the students, as we make clear at the beginning of our manuscript. Indeed, we do not state that the students have actually deepened their knowledge, but that this activity let them to do it. If the reviewer considers our statement as too bold as it is right now, we are open to rewrite it, but we consider that as it is, it reflects this accurately.

Page 11, line 4 Did you undertake any evaluation of this?

No, we did not it. Again, this is out of the scope of this work and we state that this is simply an expectation.

Technical comments: The general English needs some improvement throughout.

Our manuscript has undergone professional language editing, but we have made an extra effort to improve it in this new version.

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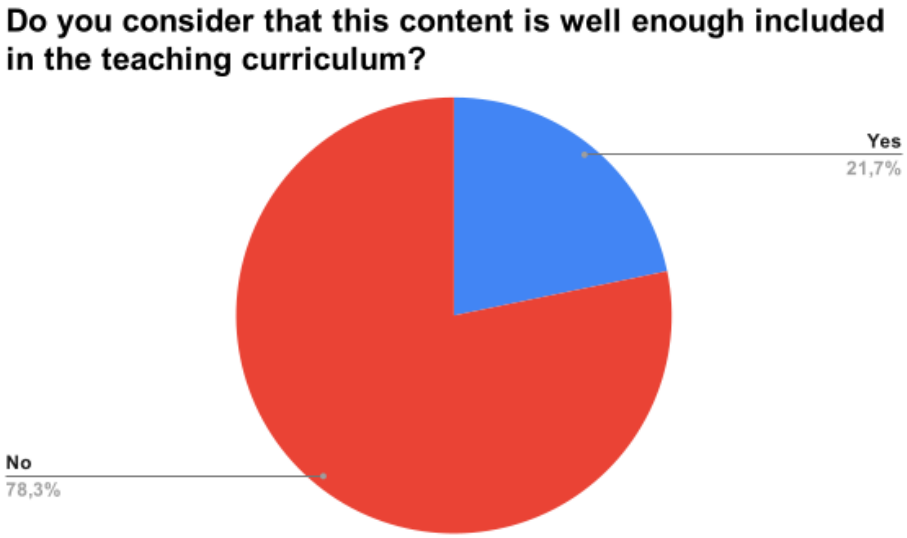

Fig. 1.

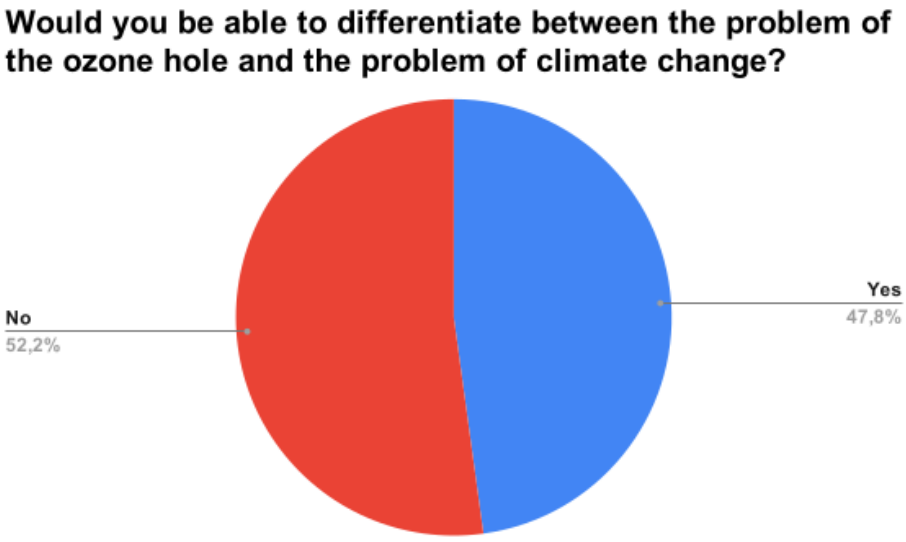
Would you be able to differentiate between the problem of the ozone hole and the problem of climate change?
No
52,2%
Yes
47,8%

Fig. 2.