

AUTHOR REPLY ON COMMENT REVIEWER #1

Rolf Hut (Referee)

Referee comment on "A snapshot sample on how COVID-19 impacted and holds up a mirror to European water education" by Benjamin M. C. Fischer and Alexandru Tatomir, Geosci. Commun. Discuss., <https://doi.org/10.5194/gc-2022-5-RC1>, 2022

Review by Rolf Hut Tu Delft

The authors report on a survey they conducted among teachers of higher education courses in hydrology to gauge the impact that the COVID-19 pandemic and associated (lock down) measures had on teaching and learning relating to hydrology in higher education.

This is an important topic: education to new generations (of hydrologists) is an important part of geoscientific communication and sharing the insights from fellow educators might help the hydrological community to either be better prepared for future similar situations (I really really hope this will not happen...) or to learn lessons from this situation for education in general.

I do think that there are issues with the setup and the reporting of the study that should be addressed before the current manuscript is fit for publication. Below I will separate those into major comments, that deal with the overall setup and reporting, and minor comments that deal with particular phrases or lines in the document.

Despite that I think that the topic is of interest to the readership of GC, I have pointed out in my opinion some serious flaws in the research and its reporting. I think that with careful rewriting the readership of GC in general and those teaching hydrology in particular can learn something from the results of this survey, so I would recommend major revisions to this document before publishing in GC.

Best regards,

Dr. ir. Rolf Hut

Dear Reviewer #1, Dear Rolf,

Thank you very much for your critical and constructive feedback and food for thoughts to improve the manuscript. Please find below our responses to the individual comments and suggestions (review comment in **blue font**, with our response in **black font**).

Best regards,

Benjamin Fischer and Alexandru Tatomir

Major comments

On sampling and conclusions

The authors rightfully take care to call their survey a 'snapshot'. Only 28 people responded to the survey. The authors claim that this is a '14% response rate', which means they consider the 200 people to whom they sent the initial survey to be their frame (or 'target group'). Given the membership number of, for instance, the EGU hydrology section, the 200 people contacted seem like a sample of the population that is the intended target of this research: people teaching hydrology at higher education institutes. Please provide a definition of who the ideal 'target group' for the survey are: all people involved in teaching hydrology at universities? Given that target group, in the results section please reflect on how representative this sample is for that target group (are all career levels represented? Genders and regions? Etc.). Based on the representativeness of the sample, please make a statement on how much this snapshot can be extrapolated to the wider target community.

Author response: We agree with your comment which aligns with the comment of reviewer #2. We also think the term "response rate" is not a good term to be used in our manuscript.

Our project idea and survey was based on the survey performed by Fischer (2020) focusing on Sweden. Based on this survey we extended and adapted our survey questions to investigate how COVID-19 might impact European water education, focusing on 1) common teaching methods and classroom assessment and examination techniques in pre-COVID-19 times and 2) how did these education methods and techniques change during COVID-19. With this in mind our goal was to reach a large target audience with as many hydrologists involved in university education across Europe ranging from, Ph.D. students to lecturers/teachers, (assistant) professors, course administrators, and researchers. To have a non-biased representative outcome, a random sampling method would be preferable reaching a high number of participants from the total population (Gideon, 2012). However, to follow such a sampling methodology there are general challenges see also Gideon (2012) e.g., (I) unbiased, minimize the sample error, low response, spatial coverage and population representative, and specific to our study (II) what is the total population of individuals identifying them self with hydrology and water-related sciences (members of WMO, IAHS or EGU Hydrological Sciences are likely not representing the full population covering Europe, gender, different roles in education), (III) how many of the former are involved in teaching at university level and (IV) how to reach this population within a certain time frame to represent the Covid-19 Zeitgeist? Due to these challenges we decided to adopt a snowball sampling approach by contacting our network through e-mail with the link to the survey and the request to distribute the survey within the respective department. Drawback of this approach is off course the limited statistical value and potential bias. However, better some data compared to no data. Seen the few respondents we tried to be cautious with statements and not oversell the results of our study. However, we still think that our study is relevant forming first impression on how water education was impacted Covid-19 from the combination of survey results giving a first impression on teaching practices and challenges during Covid-19, reviewing literature of common practices and challenges in water education before and during Covid-19, and the community effort communicated on the internet to help and learn from each

other's experience to continue water education during extreme events like Covid-19 and beyond.

To clarify the sampling methodology, we extend the method section and provide more information on the survey methodology as

Based on this survey Fischer (2020) we extended and adapted our survey questions to investigate how COVID-19 might impact European water education. The survey consisted of three different sections: 1. Information on the respondent, 2. Water education in preCovid-19 and 3. Water education during Covid-19 (Table 1), consisted of in total 30 questions (Table A1) and should have taken approximately 10 minutes to answer. The survey was set up as a web form using Google Forms (a web application to create and share online forms and surveys, Google LLC). To have a non-biased representative outcome, a random sampling method would be preferable reaching a high number of participants from the total population (Gideon, 2012). However, to reach a large target audience, consisting of as many hydrologists involved in university education across Europe from teaching and course administrative staff working in European universities including student assistants, Ph.D. students, lecturers/teachers, (assistant) professors, course administrators, and researchers, within a certain time frame to represent the Covid-19 Zeitgeist we adopted a snowball sampling approach. by contacting our network through e-mail with the link to the survey and the request to distribute the survey within the respective department. The survey was sent by email to more than 200 contacts of the wider network of the authors, all part of different Universities in water education across Europe (Berlin, Göttingen, Stuttgart, Bucharest, Hamburg, University of Zürich and ETH Zürich, University of Freiburg iBr., Tu Delft, VU Amsterdam, Wageningen, Florence and members of the EU-Cost "WATer isotopeS in the critical zONe" consisting of more than 110 colleagues and further to 5 random people). In addition, in the e-mail there was a request to spread the survey within the respective department. The email with a link to the form was sent in November 2020 with a reminder in March 2021. In addition, a post with the link to the survey was posted on the Facebook Hydrology group. The authors of this group did not participate in the survey.

Since the e-mail was potentially also distributed within the university or department the total number of recipients of the survey is unknown. Hence, it is not possible to calculate the percentages. We therefore rephrased the sentence as

Only twenty-eight respondents answered the survey, some European countries are missing and only a few universities per country responded to the survey.

The survey was designed to be conducted anonymously with the option to provide contact information when communicating results. In Figure 1 we highlighted which countries responded and we will add a table which Covid-19 measure were in place at the time of the survey.

Concerning gender, only few respondents provided their e-mail address. Therefore, a more in-depth analysis on the gender was not possible but it would be very interesting considering that the genders likely had different experiences with education during the pandemic. We will rephrase L235-237 as

However, similar to a snapshot sampling campaign, these results are a first indication on how water education was impacted and need further analysis on the long-term impact on teacher and students (considering gender differences) to prepare education for future disruptive natural and biohazardous events.

The response within those 28 does not seem representative of the profession of people teaching hydrology, given for example the skewed distribution of countries. Yet, despite this, the authors make broad claims on the impact of COVID-19 on teaching hydrology, for example in the abstract: "Hence the important knowledge of process understanding in hydrology will be missing for generations of hydrologists". These broad claims do not follow logically nor statistically from the results of the survey.

I recommend that the authors make a thorough assessment of all the claims they make in the manuscript and check if it is supported by the data they present (including a proper statistical analysis in that case) or if it is supported by pre-existing literature, in which case this should be cited.

Author response: We would have been happy to receive more than 28 respondents and tried to be cautious with the statements and not oversell the results of our study which was also noticed by your previous comment "The authors rightfully take care to call their survey a 'snapshot'." Considering the small sample size, we provided only an overview of the data using number of respondents or percentage of respondents or qualitative descriptions such as word clouds to highlight terms and avoiding hard statistics which could lead to wrong interpretations.

Based on previous study and the decrease in practical teaching formats we think, as indicated, that important knowledge of process understanding in hydrology will be missing for cohorts of students. To support our interpretation, we clarify this by providing reference to preCovid-19 literature. In addition, we will verify all our statements and relate to previous studies where needed.

On hydrology in the broader context of higher education during the COVID-19 pandemic

The literature cited contains a long list of papers related to the teaching of hydrology, mainly from the Seibert et al 2013 special issue on the topic. This nicely frames the research in the literature on education in hydrology. However, nearly all literature cited is written by people with a (research) background in hydrology, who also teach. There is a wealth of knowledge from researchers who study (the effectiveness of) educational approaches. Especially since the pandemic, numerous papers have been published detailing the impact of COVID-19 on education of all levels. Given the low number of responses (see above) I think it is even more important to relate the results to what is already known of the impact of COVID-19 on education in general to see if the results for this survey among hydrologists align with the broader view seen across all educational topics and level, or that the results show a remarkably different image for hydrology. I recommend that the authors review this part of the scientific literature and add a reflection on the impact of COVID-19 on education overall in the introduction. In the results and discussion the authors can then reflect on the similarities between their survey results and the

impact of COVID-19 on other fields of education.

Related to this: I believe the study by Wagener 2007 can be used more explicitly in this work as a starting point for hypothesis testing. Basically the overview of Wagener is taken as H0, the situation before COVID-19 and this survey is used to test if the situation has (significantly) changed. The significant part might be an issue with only 28 respondents though...

Author response: We highlight that the studies Wagner et al. (2007) and Seibert et al. (2013) are the starting points for our study and, furthermore, we evaluate the changes in education due to Covid-19. We will include a comparison and discussion between our study (figures 3 and 6) and the findings of Wagener et al. (2007).

We agree it is a good idea to include more literature sources to reflect on the impact of COVID-19 in other fields and relate this to water education e.g. (*Aristovnik et al., 2020; Bormann et al., 2021; Gonzalez et al., 2020; Keržič et al., 2021; Salling Olesen et al., 2021; Stracke et al., 2022; Schleicher, 2020; Ljunghammar and Waxell, 2020; Wanigasooriya et al., 2021; Haley et al., 2021; Marzoli et al., 2021; Fox et al., 2021*).

Minor comments

On my own publication

While I appreciate the citation to Hut 2020, I would like to stress that this publication deals with transferring a hands on physics class from an on-campus, indoor in the lab, situation to an at-home situation. This being a physics and not a hydrology course makes the mention of it feel somewhat strained. I would definitely not call it 'field work' as is done in table 2.

Author response: We never mentioned Hut et al. (2020) in the context of a hydrology course but in our opinion the course described by Hut et al. (2020) could be interesting for hydrology students, e.g., to study the interception of trees (e.g. Van Emmerik et al., 2017). Tough, some adaption and modification of the course might be needed to fit a different pool of students with different background.

In table 2 we noted "field – lab work" to indicate both field and or lab work are possible. To avoid confusion, we will change this as

field- and or lab-work

Other minor comments

- L53-54 Venhuizen 2019 (on which I am co-author) does not make any statements that education on hydrology is ‘flooded by jargon’, merely that the jargon used by hydrologists might be mis-understood by non-hydrologists.

Author response: To avoid misinterpretation, we rephrased the sentence as

Contemporary water education has a high complexity, involves multidisciplinary topics (Wagener et al., 2012) and uses specific terminology and definitions (Venhuizen et al., 2019).

- L132 in the spirit of Open Science, please share the scripts that generate the results

Author response: In case the manuscript will be accepted, the anonymized response data will and Matlab scripts will be made available as supplementary information to the readers.

- L134 please justify the use of a word cloud as a scientific visualization tool, or use a more appropriate algorithm to extract meaning from text based answers to the survey

Author response: Word clouds are common visualization tools to provide a comprehensive representation of text by highlight frequently used words as large fonts (DePaolo and Wilkinson, 2014; McNaught and Lam, 2010; Heimerl et al., 2014).

We believe representing information as a word cloud, such as in Figure 2a 3a, 5 and 8, is an appropriate way to communicate in a condensed way the main message to the reader.

- L170 ‘less known’. This can not be concluded: teacher may very well know of other methods but not employ them for a variety of reasons.

Author response: By using the word “seem” we used weaker statement instead of drawing hard conclusions. It is correct, from our study we cannot conclude that CATs are unknown. A more correct wording is “used”. We rephrase the sentence as

Methods to gauge students’ performance are purely focused on the final exam while other methods seem to commonly used to gauge and improve the students’ performance.

- L171-173 I have problem with the word “conservative” here as it communicates (to me) a value statement that certain, older, types of education are less effective than others. I always argue that there is a type and a place for each type of education, including traditional lectures. I would ask the authors to reflect the distribution of lesson activities and compare it with how things are done in other fields of higher education teaching, if they want to make a statement like this.

Author response: We agree, each teaching method should be carefully dosed and has its place and time. As French and Kennedy (2017) discuss “lectures are important pedagogical, practical and have social benefits for students”. We didn’t intend to use “conservative” as a judgement. To keep the intended message, aligning with the traditional methods in classroom environments used in hydrology (see L70) we will modify “conservative” to “traditional” and include the reference to French and Kennedy (2017).

- L176 I think 'lectures' should be removed: all teaching, including lectures, went online

Author response: We agree, lectures are just one teaching mode. We rephrase the sentence as

COVID-19 acted as a catalyst that forced a move from classroom to online teaching at distance (Figure 4a).

- L181 I don't understand 'critical' in this sentence

Author response: We agree and remove the word "critical".

- L181-197 combine both survey results (figure 5), literature information (wagener 2007) and discussion on methods (timing of the survey). For this paragraph, but more broadly for the entire manuscript, it would help to clearly separate these:

- what is known about teaching hydrology from literature before your survey? What does your survey add to this knowledge?

Author response: The performed literature including papers Seibert etc. which are listed in the introduction provide an overview of the teaching hydrology before Covid-19. We will include and discuss the results of this review in the results and discussion section and highlight the difference with the results from our snapshot survey.

- What are the limitations / caveats of your survey?

Author response: As previously discussed in the reviewers' comment "on sampling and conclusion" and as it was indicated in the manuscript, our study is a first snapshot study. Moreover, we highlight, as discussed in the reviewer comment L235-237, that further analysis is needed. We include this as

However, similar to a snapshot sampling campaign, these results are a first indication on how water education was impacted and need further analysis on the long-term impact on teacher and students (considering gender differences) to prepare education for future disruptive natural and biohazardous events.

- L198-202 a great deal of literature is available on online learning before COVID-19, mainly from the Open Universities of this world (work of Peter Sloep, among others). Please link results to this work where appropriate.

Author response: We thank for the literature suggestion. Peter Sloep's works fits especially in the introduction L81-83

With the development of the internet and digital technology, in recent years education can take a step away from campus teaching by exploring the novel virtual learning (e.g. Garreta-Domingo et al., 2018; Westera and Sloep, 2001).

- 198-208 please mention how often these things were mentioned in the survey

Author response: To clarify we will rephrase sentence L196-197 as

Next to the time aspect, from open feedback and literature we derived additional challenges.

- L209-210 “Despite ... to COVID-19” This is speculative and either needs a reference to back it up or be moved to a separate discussion.

Author response: This sentence is our interpretation from the section but fits better at the end. Therefore, we move this sentence after L217.

- L211 “difficult to tell whether students reached their learning goals” this does not follow from figure 6C, I guess figure 7e is meant? If so than this is a good example of the earlier point on number of responses and significance. If we look at the situation before COVID-19, how many students did reach their learning goal? For how many students was this “difficult to determine” (I guess a rather large percentage given how hard it is to design assessments that actually measure learning). If we draw randomly 28 teachers from the pre-COVID-19 situation, how likely would it be that 39% indicated that students learning goals were hard to assess?

Author response: Thanks for points this error, it is correct and should have been 7e. Figure 7e does not indicate the percentage of students reaching their learning goals but answers from the respondents. Using CATs and different assessment techniques which are aligned to the course goals it should be in theory possible to examine whether students reached their learning goals. In nonCOVID-19 teaching it is difficult, but even more difficult, as highlighted in L216-217 Respondents indicated extra effort to prepare exams, trusting students to not cheat (which is 217 hard to control) up to lowering the level of exams “.

- L218 needs a reference to back this claim up L220-221 needs a reference to back this claim up

Author response: We agree and we will include a reference here.

- L228-231 maybe mention something about the region the respondents were in here, since that greatly influenced which (if any) government restrictions were in place at what time

Author response: We find this is a good idea and we will try to include an additional table with countries and government restrictions in the revised manuscript.

- L234 ‘cover’ should be replaced by ‘come from a selection of hydrologists from’

Author response: We agree.

- L235 ‘needs to be seen’ has multiple interpretations possible. I would suggest replacing by ‘is uncertain’

Author response: We agree.

- L235-237 I would remove this since I do not think this conclusion can be drawn from this snapshot. and L240-272 this whole section is overconfident in the results of the survey and should be re-written with this in mind. For example: “Due to COVID-19 the important knowledge of process understanding in hydrology will be missing for at least several cohorts of hydrologists” can not be concluded from this limited survey and can only be tested a few years after this pandemic has settled and broad research on this is conducted.

Author response: We disagree, with removing the statement in L235-237 but we will rephrase it in combination of both comments as

However, similar to a snapshot sampling campaign, these results are a first indication on how water education was impacted and further analysis is needed on the long-term impact on teacher and students (including e.g., considering differences gender) to prepare education for future disruptive natural and biohazardous events.

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