COMMENT — During writing, keep this paragraph as it creates the drop required for the opening page and enables you to the write to fit. Leave space for a display item if applicable. Note that the heading Introduction is not in the layout and the affiliations, email and DOI are outside the text area, so these lines can be ignored when judging the length.

Rebuilding research

Stefan Howorka

The COVID-19 pandemic has had a dramatic impact on the way we do research. Here, I share an approach to rebuild research capacity in a new collaborative fashion termed 'teamlets'. Teamlets enable a team-based approach to boost morale, increase data integrity, faciliate interdisciplinarity, and ensure continuity of expertise.

The COVID-19 pandemic has had a devastating impact on scientific research and researchers, wherein many Master and PhD students, postdoctoral scientists, and principal investigators have been blocked from entering the laboratory, their office and writing-up areas. Experiments have not been conducted and personal meetings with colleagues have not taken place. In addition to a drastically lower research output, self-isolation has resulted in personal stress, loneliness, and a lack of perspective — all of which has lowered research productivity even further[1,2]. These additional challenges have also added to the already existing mental health crisis in graduate education[3].

What is the way back to a successful and vibrant research group? What can be done to re-motivate group members, enhance social interaction and human wellbeing, and achieve high research productivity?

[H1] Teamlet structure

In this Comment article, I would like to share with you a strategy that helps to achieve these aims; it may also be useful and relevant to research groups post-pandemic to maintain a supportive and positive research environment. This strategy deviates from the traditional concept of students working alone on a chemical research project. Instead, this strategy features students working in small "teamlets" of between two and five members. The teamlets pursue a common research objective, usually to acquire data and write a scientific manuscript, but also to identify and solve a scientific problem. Within this structure, students can work in a single or multiple teamlets, depending on how their skillset matches the goal of the project. It is common that each PhD student and researcher works on more than one project to increase scientific throughput and output by minimizing experimental downtime.

Sub-groups are common in industry and have been the norm in larger academic research groups for some time[4]. However, in many academic cases, the sub-group structure is rather hierarchical, with a senior postdoc managing subordinate researchers. While this has a proven track record, there are downsides[5]. The principal investigator often ends up removed from the more junior group members, and an undesirable system of patronage can develop that is characterized by a pressure to deliver upwards. In the worst cases, more junior or less popular group members are given night and weekend shifts to work alone — a practice with inherent safety concerns — while senior graduate students and postdocs get more desirable weekday access to equipment. In other cases, students are being made to compete for the same objective in a grim parody of evolution where only the fittest survive. This management style can be psychologically damaging for students. In the worst cases, it encourages poor scientific practice through short cuts and data manipulation, leading to erosion of academic integrity.

By contrast, the teamlets redesign the research group into a much more horizontal structure. The day-to-day management of teamlets is delegated to one or more of the members, depending on their preference and personalities. Scheduled, periodic meetings with the principal investigator ensure that the teamlet stays on track; additional meeting are available whenever the project needs additional input and support.

[H1] Compatibility with doctoral studies

How does the delegated management of the teamlet relate to the individual nature of a PhD? To maintain the required training for a PhD, each student has to lead at least one teamlet focusing on the student's core PhD topic. The PhD student also carries out the key body of research for this project. Thereby, the teamlet strategy does not negate the nature of a PhD to produce a piece of independent scientific research. Rather, it helps enable and enrich the PhD by cross feeding ideas and results. The PhD student will still be required to explain the method and outcome of all research described in their thesis — even if the student did not carry out particular experiments themselves. This may add pressure on the PhD student but will lead to a much broader understanding of the science.

[H1] Advantages of teamlets

Having students and other researchers work together in teamlets has several other desired advantages. After the enforced isolation during COVID-19 lockdowns, most students and researchers enjoy working with others, with an accompanying boost to motivation. Further-

more, regular discussions within teamlets help to increase intellectual ownership and critical thinking, as well as both collaborative and communication skills. By contributing to multiple projects, the likelihood of success can be improved and compensate for the unpredictable nature of research. Thereby, collaboration can increase the opportunity for co-author papers and reduce the pressure on an individual project. Greater ownership and the delegated management structure moreover improve the resilience of the teamlet to foreseeable disturbances without any need for the principal investigator's (PI) involvement. For example, a teamlet can quickly reshuffle the workload when a member has to quarantine after a contact with a COVID-19 infected person, or when there are other difficult-to-reschedule private commitments.

Discussing data and project results among peers within a teamlet can enable more junior members to become more confident to ask questions in front of the principal investigator. The more relaxed setting also enables a more inclusive environment that supports students from under-represented groups[6]. In addition, as there are more eyes on the project, there is more opportunity for greater data scrutiny and, hopefully, better-quality research output[7]. Working in teamlets also helps bring together different expertise required for interdisciplinary projects. Teamlets thereby extend and accompany other peer-to-peer learning strategies to improve interdisciplinarity among students[8]. Creating teamlets across two different research groups with a similar mindset can provide a mechanism for collaboration[9], which is ideal when working on a project which cuts across multiple methods or scientific disciplines. Sharing the goals and the expertise within teamlets also prepares the researchers and students for the team-based approach often adopted in industry[10]. A final advantage of running self-managing teamlets is that the PI's time and energy can be freed up and invested in student support: to enhance collaborations, to develop new scientific ideas, and to write publications and grant applications.

[H1] Limitations of teamlets

Teamlets can have shortcomings. For example, disagreements of opinions within a teamlet can become more frequent as the number of members increases. Another source of friction could be the tendancy for the most senior researcher to lead the project rather than the designated team member. Several of these social frictions can be managed by the PI's careful selection of teamlet members, as discussed below. Clearly laying out the ground rules at the start of the project can also help. Teamlets may not appear to be ideal for all group members, such as researchers who have mastered all the techniques required for a project. In this case, they may not see any benefit of working with others because multipoint communication and collaboration usually slow down progress. However, these individuals would be a valuable asset to a teamlet to transfer their skill-set and offer broad scientific training.

[H1] Realizing the success of teamlets

Realizing the benefits of teamlets strongly depends on the careful selection of teamlet members based on their scientific and personal compatibility to form the functional units. Team selection — based on the science — aims to synergistically pool separate academic strengths of teamlet members to create the spectrum of skills required. By comparison, choosing personalities can capitalize on existing positive relations among several group members. Careful selection also avoids placing a more dominant character next to other members who are developing their academic self-confidence.

Key to realizing the success of teamlets is to link the increased freedom of teamlet members with their greater responsibility and accountability to achieve the agreed aims. Working together can, perhaps counter-intuitively, improve the independence of each individual researcher, while the close collaboration can also strengthen their emotional resilience[2].

[H1] Teamlets post-pandemic

In summary, I propose to redesign research groups in a horizontal structure based on mutual collaboration, learning and support, with an accountable focus on achieving the agreed output. This redesign could help foster independent yet team-active scientists for pandemic-free times and addresses demand from future employers in industry, start-ups, consultancy, technology transfer and government, as working in teams is widely used in these workplaces. Finally, collaboration of independent researchers is also more representative of modern science and key for tackling the major global challenges we face.

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