Active and distance learning in neuroscience education

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Abstract

With social distancing and uncertainty about the complete re-opening of laboratories and campuses, there is a pressing need for a more flexible educational experience. Seizing this opportunity to integrate active learning into adaptive curricula can fast-forward neuroscience education at every level.

Challenging times present not only obstacles, but also opportunities for innovation. The pandemic outbreak of SARS-CoV2 is accelerating ongoing educational transformations, and traditional educational models are being questioned. With social distancing and uncertainty about the timing of the re-opening of the physical campus, there is a pressing need for a more flexible educational experience. This affects neuroscience education at every level, from undergraduate to postgraduate studies and continuing education.

Introduced in high school in the 1990s, active learning is a relatively new trend in higher education. As these educational models have permeated the globe, institutions became less reliant upon traditional models where content is passively delivered to auditoriums of learners attending to the expert on a stage. Instead, other teaching delivery methods were adopted to engage the students through varying degrees of active learning formats, thus partially abandoning the ‘passive’ model (Sandrone et al., 2020a; Stockwell et al., 2015). In parallel, the focus gradually switched from knowledge-retention to knowledge-manipulation. In keeping with this general trend, the concepts of student-centred or self-directed education are slowly emerging in neuroscience, along with terms such as ‘flipped classroom’ or ‘blended’ learning methods (i.e., a mix of in-person and online activities) (Sandrone et al., 2020a; Stockwell et al., 2015). Within the flipped classroom approach, foundational knowledge acquisition is usually the responsibility of the students. In-classroom time, real or virtual, is used to discuss with an expert or finalise the creation of new works.

Active learning increases student performance in science, engineering, and mathematics (Freeman et al., 2014). These methods are usually well-received by the students and demonstrated non-inferiority, if not superiority, when compared to more traditional teaching delivery in neuroscience, neurology, and psychiatry (Sandrone et al., 2020b, 2020a; Stockwell et al., 2015). Online and multimedia platforms favour asynchronous, *ad-hoc* learning, where content can be accessed almost anytime and anywhere. Videos and podcasts add a novel dimension to the learning experience. This has empowered students to work at their own pace, by pausing, rewinding, slowing down and speeding up the content to learn at a rate that matches their needs (Emanuel, 2020). Where no firm academic guidelines about course completion exist, courses such as the massive open online courses (MOOCs) are not even completed, but selectively exploited to revise topics and to achieve more personalised objectives.

Students, therefore, become key players in their educational journey and can embrace a certain degree of curiosity and exploration, which are also typical of scientific inquiry. But caveats exist: the academic requirements to be met represent the frontier to an overly independent, self-directed learning that risks diffuse, incomplete learning. This type of learning cannot be uniformly applied to all content types. Additionally, not all learning experiences are amenable to an online/remote format, such as the practical, hands-on experiences honed in the laboratory.

In the current state of mandatory remote learning, educators are scrambling to adapt to this new educational forum. As many curricula still rely upon more traditional in-person, 'face-to-face' models of education, some institutions may not be equipped to transition entire courses to online formats. Even with a broad array of resources in existence, aggregation of content into a coherent curriculum is often an arduous task, and requires planning and dependence upon external providers.

As a first step towards distance learning, educators may benefit from the broader reach of extramural, professional organisations. For example, the Society for Neuroscience (SfN) hosts a full range of educational *Neuronline* resources (https://neuronline.sfn.org/), and the American Academy of Neurology (AAN) has an online learning centre that touches upon the full range of clinical neurology (https://www.aan.com/education-and-research/online-learning-programs/). Similarly, the Federation of European Neuroscience (FENS) is collating resources and online events from several institutions (https://www.fens.org/News-Activities/News/2020/03/Online-neuroscience-resources/). Yet heavily relying on freely available resources can only be a temporary solution, as it hardly justifies the students' tuition. But it can be an opportunity to generate institutionally crafted flipped pre-curricula, with the best content from disparate repositories collected into a series of masterclasses. In essence, these can form the foundation for educators to supplement the courses with their personal touch.

A flexible curriculum that readily incorporates the latest neuroscientific discoveries by embedding them in educational activities can represent a step forward and increase its formative value (Litt, 2015). A broadly supported and disseminated curriculum offers two major advantages: (1) with fewer resources to update, more contemporary content can be ensured; (2) with more time, lecturers can focus on the accumulation of resources to adapt the course to their audience, while adding personalised insights. Such mixing of core and flexible modules permits the development of more personalised curricula. This paradigm has been envisioned as the future of medical education, which has noted declining attendance of students faced with stagnant courses that often fail to effectively integrate the exponential knowledge growth in the field (Barras, 2019; Emanuel, 2020).

While certain benefits of the in-person experience cannot be replaced, training in essential skills remains a critical aspect of the learning process. Toward this end, new approaches to share real-world, practical experiences with the students are needed. Despite social distancing, neuroscience knowledge and skills can be coupled in several creative ways. For example, reflection on the career skills of a neuroscientist and the characteristic activities therein can guide the redesign of a new remote educational experience. Neuroscience is an interdisciplinary field, but, despite the different research areas, some tasks are common to all of us: penning an abstract, writing a travel grant, assembling a poster, preparing and presenting a slide deck in a time-limited setting, writing a feature editorial or a review under pressure. All these activities can be used as active learning tasks by prioritizing ‘hidden curriculum’ elements as integrated, not ancillary, aspects of formal neuroscience training. Authentic activities for students should mimic the real-life experience as much as possible, even by relying on neuroscientific data freely available online and by setting strict deadlines. In line with this, aside from specific neuroscience contents, other fundamental aspects revolve around meta-scientific elements, which are becoming essential pillars of our community. For example, sharing with the students how to safely handle data, verify data integrity, store data, and promote open access are all essential skills that are rarely taught in traditional curricula (Litt, 2015).

However, recent data showed that students might not have the perception of ‘learning’ when working within active learning environments, despite assessments suggesting superior learning in relation to more traditional teaching formats (Deslauriers et al., 2019). To address this misperception, it is critical to share the rationale with them by presenting the individual activities as part of a broader neuroscientific and career-related context. This increases the authenticity and delineates the value.

One of the most popular active learning tasks, which is already integrated into several curricula globally, is the presentation of a ‘Journal Club’. Other activities to train students include producing a short video or a blog post to engage the public about neuroscience research, or taking part in a book or a movie club discussing aspects related to a neuropsychiatric condition (Sandrone et al., 2020b). Even having the class remotely interact with a guest lecturer or a group of alumni from a previous cohort, while engaging them in a Q&A, represent forms of active and distance learning. These activities can readily be tailored to undergraduate, graduate, or postgraduate students by faculty, and can be flexibly adapted to a wide range of neuroscientific subtopics. To promote even more active engagement, and avoid the risks of anonymity, these activities can be organised in groups through virtual platforms, hence mimicking the synchronous and asynchronous aspects of neuroscientific collaboration and collegial competition. Online software can be used to explore optimal slots for students living in different time zones. Allocating groups randomly, instead of asking the students to select the group themselves, statistically increases the chance of forming different groups for every activity.

Facilitating interaction and collaboration can enhance the educational experience and students’ engagement. To effectively execute these developments, further considerations reside in deciding on the most effective medium for various aspects of the curricula. Delivery of a more robust educational experience relies upon innovation in how technological resources are leveraged. Videoconferencing programs offer opportunities for maintaining 'face-to-face' encounters ranging from small-group discussions to office hours. Even large classroom formats can be enhanced by incentivising attendee participation through various real-time polling platforms, allowing educators to 'take the pulse' of the class's understanding, whilst remaining responsive to questions as they arise. Finally, through integrating organisation tools (such as Slack or Trello) into the educational experience, students will be exposed to resources that not only structure their course and communication, but may also provide practical support for their future career management.

In the context of a more holistic approach, promoting positive change in the lives of students isolated by current social-distancing practices is possible through championing positive mental health-related aspects, good-working practices, and even by sharing stories of the inspirational role models from the history of neuroscience, whose knowledge is often neglected by the students and their mentors (Brenner, 2012). While not a focus of traditional educational models, addressing mental health topics is a critical need for our field, given that more than 50% of the researchers have sought, or wanted to find, professional support for anxiety and depression, as recently highlighted by a Wellcome Trust report (https://wellcome.ac.uk/sites/default/files/what-researchers-think-about-the-culture-they-work-in.pdf). The opportunity to integrate and champion best practices as early as possible in the educational journey must be seized. Also, there is a high percentage of students leaving academia after their postgraduate studies, despite many of them reporting a desire to stay at the time of their training. Such curricular changes can potentially bring positive advantages to academic and non-academic jobs, as this revised educational training will *de facto* provide the students with a novel, authentic skillset that can be used within and outside academia.

Training the next generation of neuroscientists on the aspects mentioned above is entirely feasible in the time of social distancing, without even entering the laboratory. It is critical not just to work reactively to sustain educational offerings, but to seize upon this opportunity to embrace changes that can potentially improve neuroscience education for the coming years (**Figure 1**). In the short term, implementing one or two of the active learning tasks can be a good start in updating curricula to meet the needs of modern learners. In the medium term, staff training and resources to produce new teaching materials, in addition to enhancements of the technological infrastructure supporting the new demands on the students, educators, and institutions must be evaluated and, where possible, realised. In the long term, some of these new, unconventional activities can even be fully integrated into academic curricula, and might replace the existing formative or summative assessment methods.

Nevertheless, several questions remain open, including how to render active and distance learning even more inclusive by reducing the gap between leading institutions and developing and third-world countries. Other elements to potentiate include the translation of cognitive neuroscience findings into the design of new educational programmes, but also the definition of an international benchmark to longitudinally monitor the quality of the performance on assessments (Singer and Braun, 2018). Moreover, educational research data are needed to compare the different implementations of active learning formats and to assess knowledge retention over time (Sandrone et al., 2020a). Future technological developments might create new opportunities to bring the classroom to the students by exploiting augmented reality (AR) and virtual reality (VR) programs (Emanuel, 2020). AR/VR technologies can provide simulated experiences that may, temporarily or permanently, replace certain aspects of hands-on training.

In sum, the aim of active and distance learning is to offer a more flexible, and, hopefully, modern educational experience while mentoring the next generation of neuroscientists. As a result of the andragogical upheaval that the current social changes have caused, sharing positive practices has the potential to re-build the neuroscientific community from its roots, collaboratively. Global circumstances highlight the necessity to bring neuroscience education into the modern era. At a time where social distancing makes us wonder when we will be able to reconnect with our fellow neuroscientists in person, we should continue sharing the wonders of neuroscience, although through a more adaptive educational experience. By rapidly integrating innovative teaching practices, we will continue to reach new heights upon the shoulders of giants, albeit while standing on a digital platform.

Figure 1. Ten steps to develop adaptive curricula for active and distance learning.

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