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RESEARCH ARTICLE



Lockdown lessons: an international conversation on resilient GI science teaching

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ABSTRACT

We report the findings from two global panel “conversations” that, stimulated by the exceptional coronavirus pandemic of 2020/21, explored the concept of resilience in geographic science teaching and learning. Characteristics of resilient teaching, both in general and with reference to GISc, are listed and shown to be essentially what might in the past have been called good teaching. Similarly, barriers to resilient teaching are explored and strategies for overcoming them listed. Perhaps the most important conclusion is a widespread desire not to “bounce back” to pre-COVID ways, but to use the opportunity to “bounce forward” towards better teaching and learning practices.

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Introduction

Many possible events have the capacity to disrupt education. The COVID crisis of 2020/21 has served simply to highlight these risks as educators worldwide have suddenly had to discover how to *pivot* online, universities have faced unprecedented budget disruptions, and students have new priorities for choosing their education pathways. The unique scale of the pandemic compared to other disruptive events, such as earthquakes, has also meant that students and academics internationally were affected by measures which changed teaching delivery in a similar way. Campuses were closed and face to face (f2f) interactions were limited. While the duration and

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impact of the pandemic has affected individuals, institutions and countries differently, we have the unique opportunity to learn from responses globally to a shared experience.

A growing literature already exists on higher education's response to the COVID pandemic (e.g. JISC, 2020a and 2020b; a special issue of *Studies in Higher Education*, edited by Goedegebuure & Meek, 2021; Bryson & Andres, 2020; Day et al., 2021). Early in the emerging crisis generated by the pandemic, three of us (Kemp, Tate and Unwin) decided that there would be value in arranging a world-wide series of panel discussions that focused on *resilience* (q.v.) in Geographic Information Science (GISc) education. The logic here was two-fold. First, this might draw on the lessons learned from the last 30 years of developments in GISc pedagogy and technology, embracing effective course design, innovative learning approaches, open data and software, and substantial developments in on-line delivery, most of that based on the premise of pervasive online connectivity. The now-dated book of essays edited by Unwin et al. (2012) documents some of this early activity, much of which was in the development of internet delivery distance programmes of study that at the time were unusual in geography higher education. From this, it might be expected that the GISc community would be well-placed to transition relatively easily from f2f to internet mediated distance delivery and have experiences of value to those less familiar with the available technology. Second, the international community of GISc educators has members well-accustomed to other, more localised, disruptions to their teaching from which others might well learn. It was thought that, although the luxury of planning in preparation for this crisis did not exist, any opportunity for reflection in mid-pandemic might allow the GISc education community to articulate how we might be better prepared for future disruptions.

The chosen vehicle for sharing answers to at least some of these questions was a series of focussed conversations among panellists and audience members, covering Europe and Africa, the Americas, and Asia and the Pacific, to reach as much of the world as possible within the constraints of crossing time zones. One might wonder why a series of regional conversations could be considered to be a helpful format for prompting reflection and sharing experiences globally. The pedagogical literature identifies *conversation* as an important vector that can assist academics to develop their teaching practice (McCormack & Kennelly, 2011; McCune, 2018; Roxå & Mårtensson, 2009; Thomson & Trigwell, 2018). Thomson and Trigwell (2018) identified a number of roles that these conversations serve, including managing teaching contexts, improving teaching and student learning, being reassured about teaching practices, venting about teaching problems, and transforming teaching practices. These conversations typically occur across what Roxå and Mårtensson (2009, p. 547) described as small *significant networks* that help teachers to make sense of their experiences. However, McCormack and Kennelly's (2011) study of conversation groups demonstrated the value of building conversation networks that cross boundaries (e.g. those presented by different teaching contexts such as institutions, disciplines, and countries) because this boundary crossing produces space for learning from different perspectives and promotes a non-judgmental atmosphere. Hosting a series of regional conversations therefore had the potential to extend participants' significant networks as well as ensuring that the conversation network would cross boundaries, both within and between conversation groups.

Table 1. Questions used to stimulate the conversations in each of the panels.

Panel	Topics for discussion
Panel 1: Pedagogies for Resilient GISc Education	What is resilient GISc education? For whom and against what? Why do we need it? What is a resilient GISc educator? What is a resilient GISc student? What constraints does a disruption like the COVID-19 pandemic place on delivering teaching and learning in GISc? What can we use from our history of developing GISc pedagogies and technologies to make our education more resilient? How can we scaffold learning and teaching GISc in the age of the pandemic? Is this an opportunity to rethink our curricula? If so, how should we do this?
Panel 2: Implementing Resilient GISc Education	How does GISc education interact with Information and Communication Technologies (ICT) and learning technologies? How might a culture of sharing teaching resources help support resiliency in GISc education? How can we ensure quality in resilient GISc education? How can we “future proof” GISc education?

Each panel was assembled by a regional coordinator with the support of a small group, and with central coordination from the US-based *University Consortium for Geographic Information Science* (UCGIS), which kindly sponsored the entire enterprise. The Zoom-facilitated panels all addressed the same, centrally provided, questions but differed in the way they were structured. Each of the three panels was attended by around 40 participants. The Tables in the Supplementary Materials summarise the panel compositions. The panels for Europe/Africa and the Americas, composed mostly of people with an established track record in distance and/or on-line delivery, tended to address the first of these types of experience, with examples of changed teaching practice, technologies for distance delivery, and so on. The panel members for the Asia/Pacific conversation were recruited deliberately to be diverse in the countries in which they worked (China, New Zealand, Australia, Philippines, Indonesia, Japan, Solomon Islands), institution type (major research university, smaller regional university, academic-adjacent non-profit) and institutional roles (teaching staff/faculty, student, and community organiser/educator). In addition, three of the nine Asia/Pacific panellists had worked in the disaster/hazards domain either in research or other practice-based activities and so were able to draw on experiences of local and regional disruptions from a variety of natural hazards (earthquake, tsunami, volcanic eruption, bushfires) to address issues of human impacts, preparedness and risk mitigation (see Dohaney et al., 2020). Table 1 lists the pre-circulated questions used to stimulate the conversations, the recordings of which are available at <https://www.globalgisceeducation.org>.

What is resilience?

There are many kinds of *disturbance* and *disruption* that occur to teaching and learning. These can result from a local issue that impacts either a student or instructor for a short period, such as a cancelled class, through to a global issue that affects all institutions and has permanent impacts, such as the current COVID pandemic. Thus these disruptions in our teaching and learning differ in spatial scale (e.g. local, regional, national, global), temporal scale (e.g. day, week, semester, year, permanent), and focus (e.g. individual, course, entire programme, institution).

From time to time, we have all been forced to disrupt our teaching by cancelling a day's classes because of our own illness or sudden absence: mitigation of this kind of disruption has seldom been a problem. Early in his career, one of us worked in a department housed in a building whose roof collapsed. The remedial work necessitated moving all the teaching for the better part of two years to other locations scattered over the campus. Here, mitigation in the delivery of courses, particularly of laboratory classes in physical geography, was harder to achieve. In another example, the University of Iowa GIS laboratories were ruined when the entire campus was flooded in June 2008. Doubtless, there are other examples. Earthquakes, and other natural disasters, have also necessitated the reassessment of traditional course delivery, where lectures have been given in temporary facilities or indeed, other institutions (De Róiste et al., 2015). More recently, the COVID crisis has had a global impact, affecting all institutions of higher education with impacts on teaching and learning that may well prove to be permanent. Indeed, one of our panellists who had previously experienced disruptions caused by a major tropical storm observed that, in respect of the COVID-19 pandemic:

nothing in the past prepared us for it.

Just as disruption can have many dimensions, so can resilience, but a broad definition offered by the panellists sees it as the *ability to prepare for, plan for, absorb, recover from, or adapt to change and disturbance in the short and long term*. Resilience to disruption can also be envisaged along the individual, institutional, instructional, or academic continuities. Although, as is common business practice, institutions often have risk registers with assessments of the likely consequences of institutional disruptions, the effects of disruption on individual teaching and learning practice have received little attention (Dohaney et al., 2020).

Characteristics of resilience in teaching and learning GISc

Clearly, a resilient system is one that would flourish despite any disruptive circumstances, mitigates against their worst effects, and facilitates a rapid recovery. Our panels were asked to comment on what in our teaching is, and what is not, resilient. Their collective comments suggest the following list of desirable characteristics of a resilient teaching and learning environment. In summary, the conversations suggest that resilient teaching:

- **Focuses on durable core competencies and concepts** to ensure students have the building blocks for an uncertain, yet to be known, working future. Core concepts in GISc that panellists mentioned include scale, spatial autocorrelation, uncertainty, location, distance, heterogeneity, and so on. Core competencies mentioned are collaboration, self-learning, motivation, the ability to think “outside the box”, problem solving, communication skills, and adaptability;
- **Balances these core knowledge and competencies with practice**, so that students develop transferable expertise, leading to more resilience in their future professional lives;
- **Makes learning relevant to student and societal needs**, in that experiencing real world applications of these competencies and concepts, it ensures that students are better equipped to face future, unknown challenges;

- **Is adaptable to changing conditions**, since technical skills and techniques taught without application will not be resilient when things change. This implies that any teaching is as *future proof* as possible, able to accommodate unforeseen developments in knowledge and technology, particularly for students entering an uncertain future. As one panellist noted, we are already

teaching students for jobs that don't yet exist.

- **Empowers and enables students to take responsibility for their learning** with active learning as a key means to achieve this;
- **Supports learning communities**, emphasising the fact that learning is a social activity that needs interaction. While physical GIS labs inherently support learning communities, we need to be able to replicate learning communities in the virtual world so that students can learn from each other, with each other, and help each other. Working in groups adds mutual support and thus resilience for all concerned. The survey evidence collated by JISC (2020b) of student reactions to on-line provision during the COVID crisis very strongly emphasises this need;
- **Is connected**. Resilient students need to stay connected to technology, other students, educators, the institution and the community to give them a feeling of belonging and empowerment when they suddenly become disconnected and disempowered;
- **Is inclusive and empathetic**, taking note of the diversity of students, their levels of attainment, their access to technology and their expectations. Lack of f2f interaction makes empathetic teaching difficult, with implications for a variety of personal, cultural and gender reasons;
- **Is forward looking and opportunistic**: It was noted that one can be resilient and (cost) efficient if, and only if, you plan ahead. As one panellist noted, the need is to *be prepared*, while noting that, as another panellist perceptively observed:

resilience is more expensive – until you need it.

- **Addresses both student and instructor disruptions**: Finally, and perhaps most important, all the panels recognised that it is important to recognise that both student and instructor lives have been disrupted.

Very few, if any, of the characteristics noted above are specific to teaching and learning GISc, and regular readers of this journal will of course note that there is nothing in this list that would not also be described as *good teaching*.

Barriers to resilient GISc teaching

Our second discussion centred around barriers, both general to all and specific to GISc, to resilient teaching and learning. Generally, in a time of stress in higher education globally, panellists noted that, even prior to the pandemic, there was a high risk of faculty

burn out associated with a lack of time to learn new teaching skills and revise teaching materials in institutional settings that, other than through access to teaching facilities and technology, by and large provide very little by way of instructional support.

At first sight, the fact that GISc educators live already in a constantly evolving digital world, with many having more than twenty years experience in distance programmes, may have made it easier to pivot quickly from f2f to digitally enabled distance learning. However, panellists noted that this constant evolution, for example, in web-mapping technologies (Roth et al., 2015), cloud computing, and so on, also makes it difficult to create teaching materials that are *resilient* to change. Open access software, such as the R computing ecosystem used by many spatial analysts or QGIS, are constantly evolving such that web materials require very rapid revision cycles. Barriers to resilient GISc teaching include:

- The **interdisciplinary nature** of GISc often generates high student *diversity* across many dimensions related to technical skills, prior knowledge, domain background, experience, interests, career objectives, and so on;
- A particular issue for GISc teaching and learning is that in higher education, there is often a lack of clarity as to who is responsible for teaching **foundation concepts**. For example, should GISc faculty have to teach students any necessary mathematics or basic statistics, or even basic geography?
- GISc is strongly bound to **computing technologies**, but other than with the use of cloud computing platforms, it is difficult to ensure that with online teaching all students have access to the same technology and assumptions about student computing literacy can be false. Experience suggests that *digital natives* aren't necessarily *digitally literate* and may actually lack basic computing skills and concepts. It was noted that moving to entirely online provision highlights difficulties in a technology driven approach to GISc education, particularly when students have to install systems onto their own machines and/or have limited or costly internet access. There is a very real difference between students who voluntarily enrol onto a programmes of study delivered over the internet who might reasonably be assumed to have reliable internet access and those forced to make use of such access by a disruption. Significant *digital divides*, whether between developing and developed countries or within individual countries, and whether with reference to access to hardware or to internet connections, were observed throughout the discussions;
- By common consent, the room in which the elephant sits is the traditional, and almost always very necessary, **GIS Laboratory**. In f2f teaching and learning, the laboratory and any classes held in it are a critical pedagogic resource: the "lab" is much more than the machinery and the software. In it, instructors can walk around looking over student shoulders to assess who is having trouble, isolate general issues that students find difficult, and so on. Similarly, students working in the same physical space are able to look at each other's screens, explain things to each other, and provide general mutual support. In distance mode, it is harder to look over the shoulder of a student to see where perhaps they might be stuck. Instructors can't walk around and help, and online students often don't have the bandwidth to share screens even when possible and are hesitant to openly share their screen with all the online participants which is often the default option for online tutorials. At

the same time, students in difficulty sometimes won't admit it so that the distant instructor gets no feedback. Online there is no easy way for students to access peer support. Indeed, as several panellists pointed out, the "lab" also encourages and supports the development of social skills. This dependence on the "lab" mirrors the well-known water-cooler/coffee machine experience in commercial and government office settings around the world. Perhaps the key challenge in this section of the discussions was how to persuade students to interact with each other online as they would in the GIS lab. As we continue teaching online, we need to identify and promote the different but valuable social skills necessary for work in a virtual space, the more so as in the world of work the ability to engage in a virtual space is becoming more valued and likely to persist as a necessity;

- In GISc, instruction is sometimes related to preparation for entry into a profession that has **formal accreditation and competence requirements** (for example, accreditation of geomatics students by professional bodies). These competencies are very hard to ensure at a distance. Even where no direct external requirements of this nature exist, there remains a clear need for curricula to ensure that course graduates have the ability to use GIS software in a modern, corporate computing environment;
- Although there is very little in most GISc education that has to be done synchronously (unlike orchestras or language conversation, for example), educationally, there is a need for **synchronous work** (especially collaborative team work) that is difficult to achieve when working across multiple time zones, bandwidths, and even political contexts;
- Finally, in general, there is little tradition of **collaborative course development**, or of sharing course materials between individuals, courses and institutions. While the *NCGIA Core Curriculum in GIS*, which did so much in the early days to further the teaching of GISc world-wide, and the *UCGIS GIS&T Body of Knowledge* remain notable early exceptions (see Kemp, 2012), a resounding call for such collaboration was echoed in all panel discussions.

Strategies for resilient GISc teaching

In discussion, several panellists drew on their own teaching to suggest resilient strategies that address some of these barriers related to course delivery and participation in our community of practice. For course delivery, it was recognised that the organization and management of the learning environment can be designed to be more resilient in a number of ways to facilitate an unexpected, sudden pivot to online delivery. Examples included:

- **Chunking** intended learning into smaller units than in f2f delivery to enable students to learn when they are able to connect and to counter the rapid onset of screen fatigue;
- Using **self-paced local and virtual field work** to teach basic concepts, such as mensuration and representation;
- **"Putting the software to one side"** by using pen and paper exercises and worksheets that are more readily delivered on-line (see, for example, Breetzke et al., 2011; Unwin, 2010);

- When appropriate, **designing assignments** that allow students to bring in their own data to address real problems of interest, which may result in benefits in motivation and in the avoidance of plagiarism;
- **Mixing synchronous and asynchronous online delivery**, making use of principles from flipped classrooms, so that during periods of synchronous contact (whether online or in person) the focus is on group work and student interaction, leaving lectures (if necessary) to be delivered asynchronously;
- **Providing total clarity in setting and addressing intended learning outcomes.** Given that it was necessary at the start of the pandemic on-the-fly to revise learning materials, ensuring that the curriculum maintained a focus on core concepts and skills with accompanying clearly specified learning objectives was an important strategy for a quick reorganization;
- **Scheduling activities that enforce regular contact and learning progress.** Existing technology can help, with, for example, holding weekly synchronous sessions on a clearly defined schedule, setting submission deadlines, short online quizzes, *meet and greet* sessions in which, for example, students present a *story map* of their home town, sharing the development of class team websites and scheduling regular student-led presentations.

Secondly, all conversations concluded that resilience implies *collaboration* between instructors, courses and institutions and building an educational *community*. As noted above, GISc education has numerous examples of successful collaborative work in the domain's early years, such as the *NCGIA Core Curriculum*, the *UCGIS Body of Knowledge* and, in the 1990s, several *GIS in Higher Education* conferences, workshops and symposia. However, much of that early collaborative energy has diffused. For many reasons, collaborating on GISc course materials isn't simple. To be widely usable they need to be *interoperable* between different educational contexts, which was seen to imply a relatively granular approach,; *easy to acquire*, which implies relatively wide distribution via the web; and, ideally, *developed in a well-understood structure* into which they can be inserted. There is obvious potential here for use of the *UCGIS Body of Knowledge*, which is exploited, for example, by the EO4GEO Tools (EO4G, undated) project. In some sense, materials such as these, and the *Living Textbook* (Augustijn et al., 2018), *Geographic Data Science with PySAL and the PyData Stack* (Rey et al., 2020) and *Geocomputation with R* (Lovelace et al., 2019) challenge and possibly replace the traditional printed course text.

Almost a quarter of a century ago in 1998 GISc educators held a meeting (IGE 98) on the theme of *Interoperable GIS Education in the 90s* in which the concept of interoperability in *open educational resources* (OER) was outlined and developed (Heywood et al., 1999; Kemp et al., 1998) and there is an extensive review of GISc OER projects to 2012 in DiBiase (2012). The existence of OER materials might be a necessary condition for their incorporation into course curricula, but experience in their use shows that it is by no means sufficient. There are technical and pedagogic issues in the design of any materials to make them interoperable between individuals, courses, institutions and disciplinary traditions. In today's information rich world they must also be *discoverable*, which implies some resource discovery mechanism based on appropriate metadata, and *modifiable*, so that they can readily be incorporated into one's own teaching.

Almost all the GISc related OER projects to date have relied on some form of time-limited project funding from some central agency or an institution for their creation, such that updating or maintenance eventually becomes problematic. Panellists all noted that rewards for the creation of OER are few. It is a matter of fact that career pathways labelled *research* have greater rewards than those, informally or formally, labelled *teaching*. Although some products of research are patented, even marketed, by the originating institutions, the great mass of research results is made available, free of charge, through its appearance in the refereed literature, and there exists an international infrastructure to oversee and quality control this process. Yet, panels noted that the creation of quality OER is as demanding an intellectual activity as most research, but no such infrastructure exists for them.

It was observed that, in addition to the technical issues that the creation and use of OER imply, there are some substantial economic and social issues related to their use. First, although an example of the development of a shared *Access GIS* used internally by one institution to share teaching resources across all its GISc teaching was mentioned, in general higher education does not have a culture of sharing teaching materials, either internally within an institution or from external sources. There is a student, sometimes an instructor, and often an institutional, expectation that resource materials will be bespoke with an implied notion that teaching is about quality information transmission rather than participatory, mentored and guided exploration (see Sfard, 1998). Students expect to be taught, whereas instructors expect them to learn, leading to a gap in expectations. Yet, as one of the panel observed,

the most resilient education would be monitored and mentored work, undertaken by students working independently without direct instruction.

Institutes, departments, and even individual colleagues, vary in their acceptance of the use of externally sourced materials, students need guidance on how to search for, evaluate and use such materials, and many instructors simply do not have the time to evaluate and modify OER for use in their courses:

I live in a fire hose – course development happens through blood sweat and tears.

This issue is, of course, wider than simply GISc.

Second, whether we like it or not, higher education has and is a marketplace in which OER have a value such that, however created, they are subject to legislation related to copyright and intellectual property rights. There are personal disincentives to creating OER related to the academic reward system. In the absence of any external assessment, their quality becomes open to criticism and to their being used inappropriately, even incorrectly. There are dangers of OER created in one institution being used by free-riding competitors or being monetised in other ways without acknowledgement. And there are issues related to institutional and personal responsibility for content, copyright, and intellectual property rights which introduces the possibility of litigation.

The collaborative development, sharing and use of OER was seen by all as a necessary step towards resilience. A number of panellists spoke in different ways about the importance of what we might describe as networks and communities of practice for resilience, including an incredible mobilization of goodwill in offering and providing support to address our current disturbance. This may be especially important in places

where formal support mechanisms are non-existent and staff/faculty educate without a local critical mass of colleagues in GISc. Some panel members spoke about being able to draw on university resources to adapt to changing circumstances while others had much less access to such assistance. Others pointed to the role of community organizations, such as the (US) *University Consortium for Geographic Information Science* and informal networks in providing support (e.g. calls for help on Twitter, mentoring through organizations like *OpenStreetMap* (OSM) and *Humanitarian OSM*).

From this, a key question might be how we can facilitate building virtual communities of practice (vCOP, Tate & Jarvis, 2017) such that personal relationships and networks grow wider and deeper. This may be especially challenging in times of limited mobility, when we cannot network with colleagues during academic conferences or research meetings. Perhaps in consideration of the wider benefits of strong networks, in the future will we be more able and willing to commit time and resources to that network building and maintenance to ensure resiliency? However, more than one panellist noted that well before any external collaboration, there is much that can be achieved in greater internal development and sharing of teaching resources and that co-teaching, team-teaching, and presenting virtual visiting lectures in regular online classes all seem to happen significantly more now than before. Panellists also questioned whether reliance on personal action to build new educator networks and vCOP is sufficient. Could networks also be built using the strong industry links that are a feature of GISc teaching? And are there ways to strengthen networking within existing national and international academic organizations?

As several contributors pointed out, in many ways, and as the reflections above imply, although resilient teaching is often simply good teaching, it may be that a key problem is that few teachers are engaged with the literature on pedagogy or know how to practice good teaching. Disruptions such as COVID-19 bring such unfamiliarity into sharp relief. The question is moot as to whether all good teaching is equally resilient. It is clear that, as courses are being redesigned for uncertain futures, there are many opportunities for redesign in ways that are in line with best education practices and which maximise resilience.

All of these ideas point to the importance of personal relationships, which, equally, are often important in achieving educational outcomes with students. Finally, the importance of practising an ethics of care was threaded through the discussion. The importance of self-care was noted, and the point was made that you cannot support others if you are yourself falling apart.

Conclusion: bouncing forward

In the popular media much has been, and doubtless will be, said about *bouncing back* to the state of societies before the pandemic, but insofar as it has impacted on teaching and learning in GISc, a key question is whether or not the previous structure and function is worth retaining (Strobl, 2021). Is going back to how things were pre-disruption necessarily a desired outcome? Some panellists argued that, based on historical inertia, existing structures would bounce back strongly, but in all panels the majority argued strongly for a *bounce forward*, learning from the enforced changes and taking the opportunity to re-shape practices. For example, one panellist noted that in the pandemic institutionally

there has been more forward looking (institutional) change in a few months than in previous decades.

and, at a personal level:

My opportunity has been to really think about what students need to learn and how best to deliver it.

Pandemic lockdown and necessity have enabled the acquisition of new teaching and technical skills and provided an opportunity to rethink how and what we are teaching. It was noted that, relative to other communities, bouncing forward may be easier in the GISc community which is familiar with technological fluidity and that ultimately bouncing forward might well prove to be into a more resilient future, and perhaps the key to this lies in the observations of one panellist who noted that they:

really enjoyed being forced to reflect on teaching and evaluate what I do.

Will GISc teaching and learning simply *bounce back* or will it *bounce forward*? It remains to be seen if these reflections, and the changes made to individual teaching and learning, lead to any permanent changes in teaching practice: our next step is to convene a third panel to find out.

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