Teaching Geography

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Writing for *Teaching Geography*

Teaching Geography provides a forum for sharing:

- practical strategies for teaching geography
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If you have a teaching strategy, practical idea, resource to share or particular view on educational practice, we would like to hear from you.

Teaching Geography welcomes articles from PGCE students, NQTs and practicing teachers. If you have an idea but have never submitted an article before and would like some advice, please contact Melanie Norman (*m.j.norman@brighton.ac.uk*), the Editor of *Teaching Geography*, who will be happy to discuss it with you.

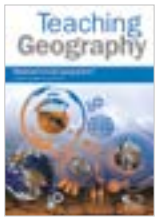
We welcome the submission of these types of article:

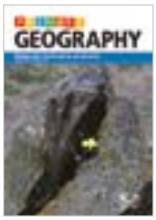
1. **Geographical concepts** articles critically discuss and illustrate approaches to teaching geography or current educational views and how they impact on geography. (1500 words)
2. **The G-Factor** articles (supported by online resources) are based around a practical idea for teaching one or a sequence of lessons. (1500 words)
3. **How to...** articles provide practical advice and strategies for geography departments. (750 words)
4. **Spotlight** articles provide specialist subject information and propose approaches for teaching these topics. (1000-1500 words)

There is detailed information on preparing articles for publication at www.geography.org.uk/getinvolved

Journal Article of the Year Awards

Voting is now open for the Journal Article of the Year Awards. The Awards, for Excellence in Leading Geography, will go to the article in 2017 in each of the GA's journals that voters feel has made the most significant contribution to geographical teaching and learning. This is your chance to show the authors how much their work is appreciated.





Voting is quick and easy. Simply go to the GA website and choose your favourite from the three articles shortlisted online at: www.geography.org.uk/Elections-awards-surveys/GA-journal-awards

Please cast your votes by 1 March 2018. The winners will be announced at the Annual Conference in Sheffield on 5 April.

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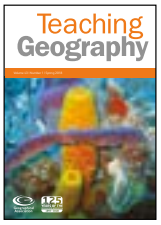

Cover Image: This issue's cover shows sponge biodiversity and morphotypes off the Cayman Islands. Included are the yellow tube sponge, Aplysina fistularis, the purple vase sponge, Niphates digitalis, the red encrusting sponge, Spiratrella coccinea, and the grey rope sponge, Callyspongia sp. Find out more in 'The Cayman Islands coral reefs: global issues, local solutions', page 16. **Photo:** *© NOAA (CC by 2.0)*

Accompanying online materials

For articles with this symbol, go to http://www.geography.org.uk/journals and click on *Teaching Geography*. Select Spring 2018 from the drop down menu and you will find the additional resources for these articles if you scroll to the bottom of the page.

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Using local organisations to support A level place studies
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The Identity Game
(see page 19)

Flash Flood!
(see page 28)

Key to articles
- ■ Geographical concepts
- ■ The G-Factor
- ■ How to...
- ■ Spotlight

Geographical Association

The Geographical Association is the leading subject association for all teachers of geography. Our charitable mission is to further geographical knowledge and understanding through education. Our journals, publications, professional events, website and local and online networks support teachers and share their ideas and practice. The GA represents the views of geography teachers and plays a leading role in public debate relating to geography and education.

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125 YEARS OF THE GEOGRAPHICAL ASSOCIATION 1893–2018

Editorial

Melanie Norman, Editor

The Editor introduces this issue of Teaching Geography.

Welcome to our first issue of 2018. There will be much to celebrate in the GA's 125th year and *Teaching Geography* is introducing a number of innovative changes for the months ahead.

We will no longer have a focus on one specific theme in each new edition. However, there will be connections between articles since this is the very essence of geography. As Steve Rawlinson (2016) said in his Presidential Year *'Ours is a dynamic and highly connected subject'*.

Editorial Board discussions have also resulted in changes to the categories of article published in *Teaching Geography*. The 'purple' category of 'Spotlight' articles will provide specialist subject information and propose approaches for teaching these topics, replacing the former 'Focus' articles. The 'red' category is now 'Geographical concepts' combining 'Planning and pedagogy' and 'Change and challenge'. 'The G-Factor' and 'How to …' categories remain unchanged.

This year will also see members of the Editorial Board editing issues of *Teaching Geography*, starting with Dr Rosie Gillman who will edit the Autumn issue. She is very much looking forward to doing this.

Finally, I'd like to say a sincere 'thank you' to Graham Goldup who has stepped down after many years of contributing to the Editorial Board, and offer a 'welcome' to Lucy Fryer who has taken over from him.

Several articles in this issue connect with each other due to their focus on teachers adapting to and engaging with the new GCSE and AS/A level specifications. Hopefully thoughts shared will help readers to embrace the changes and stimulate ideas for application within individual contexts.

Iain Palôt and colleagues offer an analysis of the examiners' reports on the first AS exam and suggest ways to encourage students to achieve at the highest level. This article connects with several other contributions. For example Hannah Spencer suggests ideas to foster students' deeper thinking through the use of journals and academic literature. Iain et al suggest that *'the lack of wider reading, beyond the text book, will inhibit the outcome of the examination'*.

Kit Rackley's article suggests ways of engaging students with enquiry skills from KS3 ensuring thorough preparation for the demands of fieldwork at GCSE and A level. This approach could go some way to addressing weaknesses in tackling fieldwork questions identified in Iain and colleagues' analysis of Examiners' reports.

Another area of weakness identified in Iain's article relates to GIS *'which for many students appears still to be a closed book'*. Since the ESRI ArcGIS Online platform is now free for all secondary schools there is no excuse for not engaging with GIS as Harry West and Michael Horswell's article clearly outlines.

The articles by Grace Healy and Vicky Ellaway-Barnard address the 'changing places' dimension of the A level specifications. Grace talks about her school's choice of 'a near place' and 'a far place' and how links with local history organisations have enhanced students' understanding of how and why places change, emphasising in particular the human dimension of 'place'. This also comes through in Vicky's article where students use role play to try to understand peoples' notion of attachment, or otherwise, to place and thus how different people respond to different places. I particularly like Vicky's summary where she says, *'I don't think anyone can deny the benefits the students will reap from learning a geography that is relevant, innovative and offers them the prospect of effecting meaningful change'*.

Charles Rawding discusses the importance of history in geography enabling us to understand change over time – *'change can only be understood in the context of historical processes'*. This also applies to Fred Martin's article on the study of countries where he identifies how approaches to country studies have changed over the more than 40 years' existence of *Teaching Geography*, concluding that *'uneasy choices between depth and breadth of study'* have to be made, an issue made even more relevant today with the demands of the new examination specifications.

Once again I draw on observations in Iain's article, *'case studies were often far too broad in scope … resulting in a lack of specific detail and precision'*. Three articles offer excellent case study examples:

- Duncan Hawley provides an in-depth study of seismic activity using the recent Mexican earthquakes as case study examples.
- 'Flash flood!' is an example of flooding in a Yorkshire valley viewed through a virtual environment, but relating to an actual event in this river valley.
- Helena Maxfield provides an example of threats to coral reefs in the Cayman Islands which also gives us the wonderful cover photo for this issue. | **TG**

Editor Dr Mel Norman on the South Downs near Beachy Head. **Photo:** Tony Norman.

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Rawlinson, S. (2016) 'It's all a matter of connections …' *Teaching Geography*, 41, 2, pp. 76-77

Hannah Spencer

Going beyond

Hannah describes how the changes to GCSE and A level geography specifications require students to go beyond the prescribed curriculum content and outlines two strategies which can support them in this process.

Accompanying online materials

Context

The 2016 GCSE and A level geography specifications place strong emphasis on students 'going beyond' their study of the prescribed curriculum content. Ofqual requires GCSE students to 'apply knowledge and understanding to interpret, analyse and evaluate geographical information and issues and to make judgements' (Ofqual, 2015a). The application of knowledge now accounts for 35% of the GCSE final mark (including 10% from a fieldwork component), so our students must draw upon a broad range of material to make reasoned judgements in examination questions. At A level, Ofqual states that 'students should grow as independent thinkers and as informed and engaged citizens, who understand the role and importance of geography as one of the key disciplines relevant to understanding the world's changing peoples, places and environments' (Ofqual, 2015b).

From my experience of teaching the new AQA GCSE and A level specifications, and talking to teachers working with other specifications, I have concluded that in addition to allowing time to teach the large volume of content in adequate depth we need to make opportunities to extend students' thinking. This year I have trialled two strategies to encourage GCSE and A level students to think more deeply and to support them in taking their answers beyond the curriculum content.

Building student confidence

Having taught the Edexcel iGCSE specification for the last two years, I was becoming increasingly concerned about my students' inability to respond appropriately to questions including the command words 'evaluate', 'assess' or 'discuss'. These questions are a chance for students to demonstrate deeper thinking and the application of their learning, yet many of them seemed unable to draw on a range of sources to fully extend their answers, or use informed judgements to reach a deeper conclusion. Knowing that the new GCSE specification places even more emphasis on these types of questions, our department trialled a new planning tool to develop students' ability to handle them confidently – the examination question planning grid in Figure 1. (A blank version of the grid is available to download.)

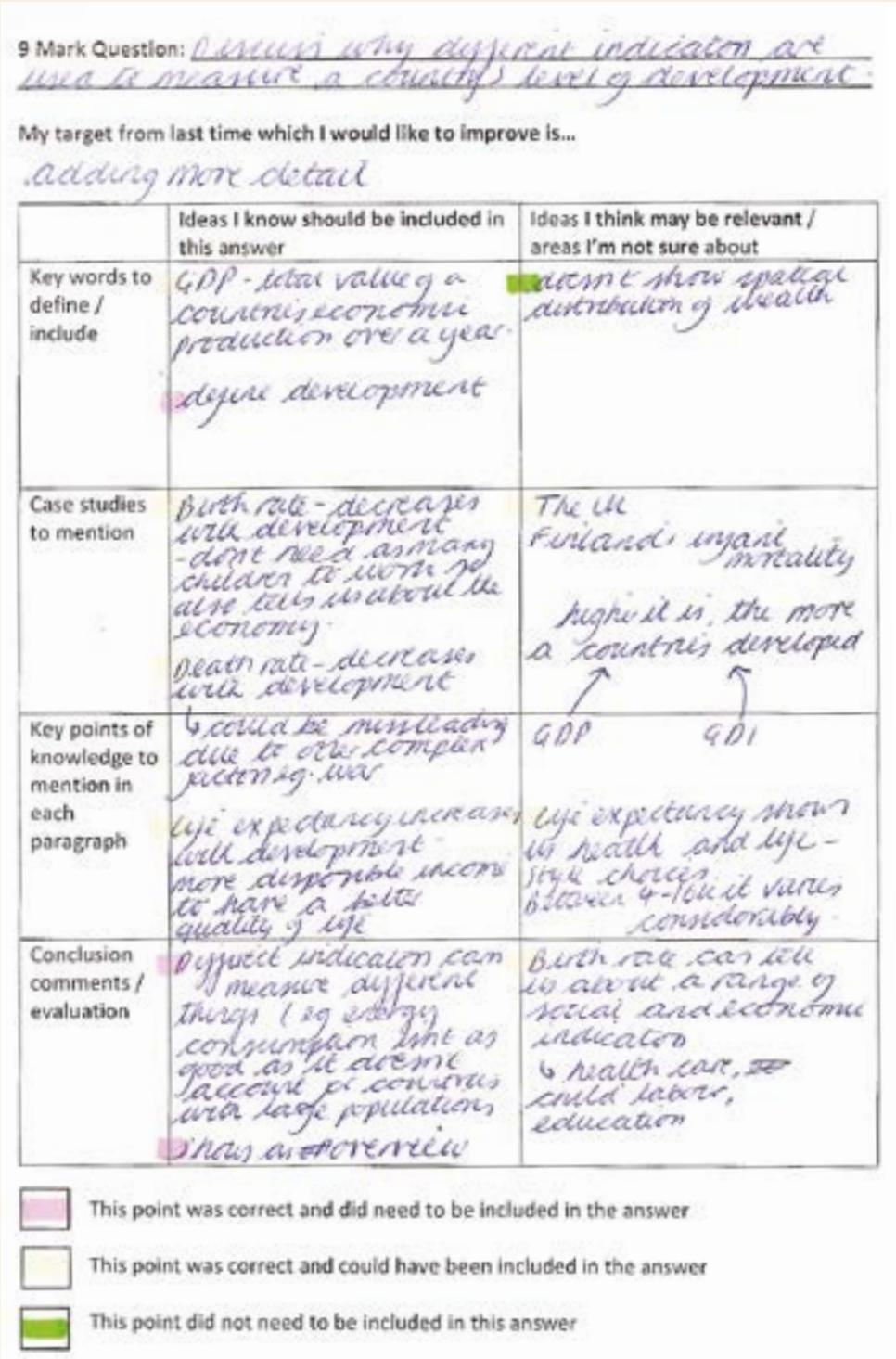
All too often students wanted me to tell them exactly what should be included in each paragraph of their extended answers, so I avoided structuring the grid into distinct paragraphs: I wanted students to develop their own, unique structure. Although initially they did not like this format, they soon adjusted and the most able students enjoyed the freedom to write an answer in their own style – just as they will do at A level.

The first column in the grid was for ideas that students were confident should be included in the answer; the second was for ideas that they thought might be relevant, but were not sure about. Individual or small groups of students completed the grid, then the class fed back ideas; students used the key at the bottom of the grid to identify ideas that were most/least relevant. This was by far the most successful element of the process: students began to include a fantastic array of ideas from other parts of the specification, as well as items they had picked up from the news. To encourage everyone to think more creatively, I would often only award house points to students who contributed ideas for this column (regardless of whether they ended up in the final answer or not).

After some initial reluctance, students soon began to understand the expectations: by the end of year 11 they were including synoptic links to other relevant areas of geography without realising it! Year 9 and 10 students have also been introduced to the grid, with considerable success. When I combined use of the grid with Alison Macdonald's 'Question tracker' mark sheet (Macdonald, 2017), students extended their evaluative comments even more confidently. Once students are confident with the grid, they can easily complete it at home without any need for teacher adaptation. It also makes a good plenary: summarising the content of a lesson and challenging students, particularly the most able, to connect what they have learnt to other areas of the subject.

Keeping an A level geography journal

We already run a school geography society to introduce post-16 geography students to university-style topics and teaching (Spencer, 2013), but I wanted a forum in which to encourage students to critically engage with their wider geographical reading and exposure to relevant media – articles in the news or on social media, lectures they had attended, films and TV programmes they had seen, etc. So I organised half-termly lunchtime meetings with lower sixth geography students, who by this stage had adapted to the demands of A level and were considering studying geography at university. At the first meeting, students were given a 'geography journal', in which they were to evaluate critically their recent geographical media consumption. These 'journal articles' could be useful both in examinations, to support their analysis in extended writing questions, and in their personal statements.



9 Mark Question: Discuss why different indicators are used to measure a country's level of development

My target from last time which I would like to improve is...

adding more detail

	Ideas I know should be included in this answer	Ideas I think may be relevant / areas I'm not sure about
Key words to define / include	GDP - total value of a countries economic production over a year define development	some show spatial distribution of wealth
Case studies to mention	Birth rate - decreases with development - don't need as many children to work so also ties in about the economy Death rate - decreases with development	The UK Finland - infant mortality higher it is, the more a country's developed
Key points of knowledge to mention in each paragraph	could be misleading due to the complex picture	GDP GDI
	life expectancy increases with development more disposable income to have a better quality of life	life expectancy shows us health and life-style choices Between 4-16 it varies considerably
Conclusion comments / evaluation	Different indicators can measure different things (eg energy consumption isn't as good as it doesn't account for countries with large populations Shows an overview	Birth rate can tell us about a range of social and economic indicators ↳ health care, child labor, education

This point was correct and did need to be included in the answer

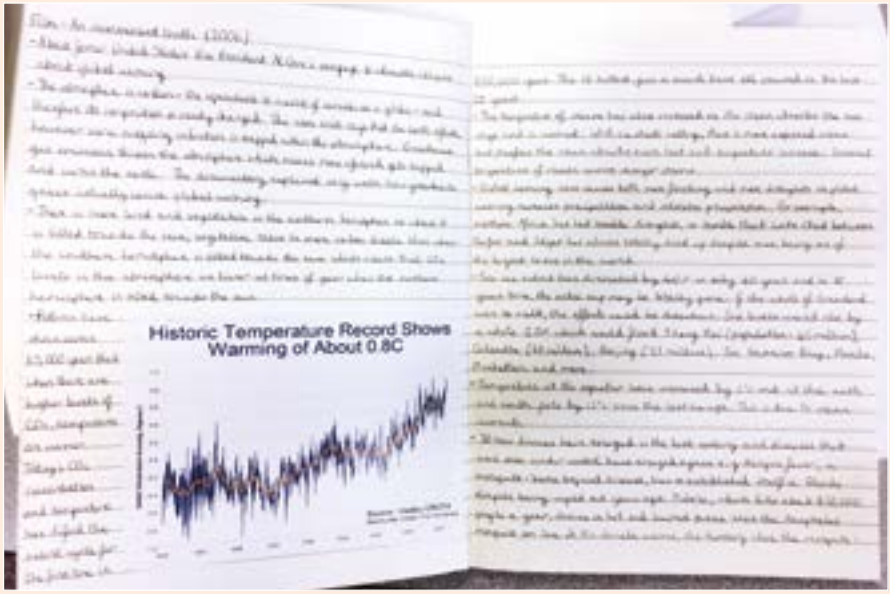
This point was correct and could have been included in the answer

This point did not need to be included in this answer

Figure 1: A completed examination question planning grid.

At each meeting, students would share what they had been reading/viewing/attending, and what their plans were for the next half term. I recommended lectures students could attend and built up a geography library of up-to-date books which students could borrow from the geography office (a list of these is available to download).

Using the journals is an excellent way of fostering students' enthusiasm for particular aspects of the subject. One student, having watched 'An inconvenient truth' (2006), is now passionate about understanding the mechanisms and effects of climate change, taking her beyond the A level content for the AQA specification (see Figure 2a). Beginning the UCAS process, this student commented on how well-prepared she now felt for writing her personal statement. Students' journal entries also demonstrate their ability to be critically engaged: another student, reviewing a *National Geographic* article on German immigration, was particularly interested by the assertion that '… intellectually, the current German population are prepared to accept immigration, but emotionally they are not' (Figure 2b). In future, I will issue geography journals to all lower sixth A level students.



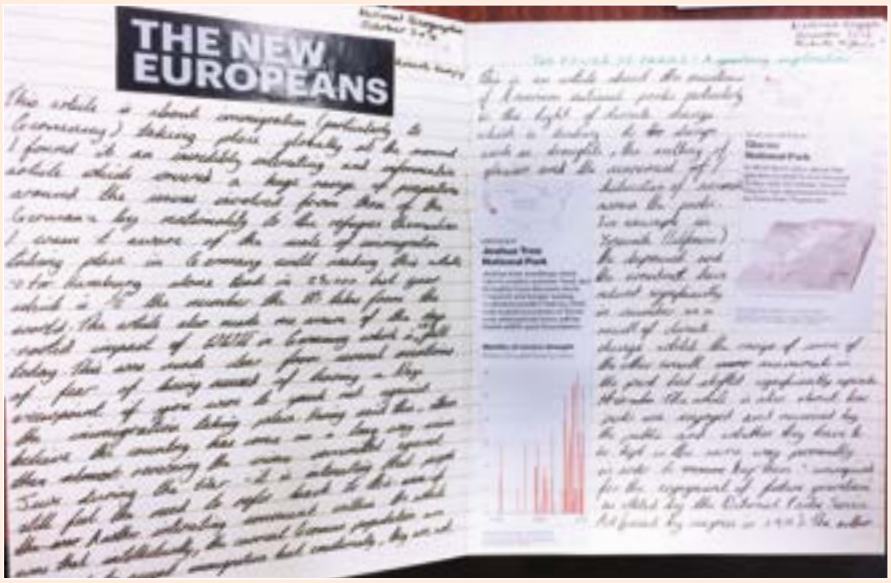


Figure 2a (above) and 2b (below): Examples of completed A level journals.

Although the students in the journals group were very motivated to keep their journals up to date, to embed the process into all students' normal way of working, you could make it a regular homework task from the start of year 12. However, one must be careful not to be too prescriptive, as this can hinder students' development as independent thinkers. I found that one of the best motivators was for students to share their journal entries with others: these informal interactions generated enthusiasm for attending lectures together, for example.

Summary

'Going beyond' the GCSE and A level curriculum is something that many students and teachers find daunting. However, strategies such as those described above can excite and engage students in a way that requires minimal lesson time while creating confident learners who are able to think creatively and take calculated risks in their answers. No matter their academic ability, all students can and should be encouraged to go beyond the geography curriculum as we teach a subject which has so much relevance in today's world. | **TG**

Hannah Spencer is Head of Geography at St Helen and St Katharine School, Abingdon and is a member of the *Teaching Geography* Editorial Board.

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How can the AS examiners' reports help improve your students' performance at A level?

Iain Palôt, Helen Hore, Simon Oakes and Bob Digby

Four members of the GA's Post-16 and HE Phase Committee offer a brief analysis of the 2017 AS examiners' reports (Edexcel, AQA, Eduqas and OCR) and then discuss their implications for geography AS and A level teaching.

As last year's AS examinations recede into the distance and A levels begin to loom on the horizon it is perhaps a good time to look, if you have not already done so, at the examiners' reports from last summer's AS cycle, the first of the new standalone AS, in conjunction with the Assessment Objectives (Figure 2). Students and those preparing them for the examinations need to accept that the bar has been raised for those attempting an A level standard paper after two terms. It is to be supposed that the same will apply for the full two-year linear course and what follows is a limited analysis of the comments made in the reports (Edexcel, AQA, Eduqas/WJEC and OCR) focussing on both the positive aspects of students' answers and on areas that need further attention.

Objective	Requirements	AS	A level
AO1	Demonstrate knowledge and understanding of places, environments, concepts, processes, interactions and change, at a variety of scales	30 to 40 %	30 to 40 %
AO2	Apply knowledge and understanding in different contexts to interpret, analyse, and evaluate geographical information and issues	30 to 40 %	30 to 40 %
AO3	Use a variety of relevant quantitative, qualitative and fieldwork skills to: investigate geographical questions and issues; interpret, analyse and evaluate data and evidence; construct arguments and draw conclusions	20 to 30 %	20 to 30 %

Figure 2: AS/A level assessment objectives for geography. **Source:** Ofqual: Guidance: GCSE, AS and A level Assessment Objectives Updated 31 March 2017

Familiar comments

In this article, it is not our intention to dwell on examiners' perennial criticisms – copying out the question, not answering the question that was set, poor grammar and spelling, incorrect use of technical language, and so on – although of course students must tackle these issues if they are hoping for the higher grades. Students still spend too much time on low-tariff questions and there is an insufficient range of factors being used to deal with the complexity of the higher-tariff questions. Even in mid-range questions of three to five marks, students often only offered one idea thus restricting themselves to a low-level mark.

Figure 1: The bar has been raised for those taking AS level. **Photo:** © Bananastock

By this stage they should know that this will be the outcome of such a limited response.

On the positive side, examiners noted that students seemed well prepared for 'evaluate' questions, recognising that they required a different approach to 'describe' or 'explain' questions. Better answers demonstrated good factual knowledge backed up by the effective use of current data. These answers also benefitted from question deconstruction; a brief plan to structure the answer; the use of examples, whether or not they had been asked for; the occasional annotated diagram and a short conclusion summarising their argument. While conclusions are not always mandatory for evaluative tasks, anecdotal evidence suggests examiners feel more secure awarding high AO2 marks if the answer includes a formal conclusion/judgement.

New assessment challenges

The changing nature of the assessment, however, means that students and teachers need to be aware of the deeper responses now demanded by both AS and A level questions. Possibly the most important development is the Ofqual requirement that at least one question will cross units from the specification and in their answers students will need to apply knowledge from more than one area of the specification content based on their knowledge of specialised geographical concepts. This lack of interlinkage between ideas was highlighted as a weakness in many scripts with synoptic links often being missed in the longer extended answers. As a result, too much reliance on a course textbook which deals only with discrete units from the specification may no longer be enough for students to be confident of achieving higher grades: they must make these connections. (One thinks immediately of the water and carbon cycle connections!).

The lack of wider reading, beyond the textbook, will inhibit the outcomes of the examination. Students should be encouraged to look at recognised journals and specific websites, as well as being introduced to Boolean searching to focus their time surfing. Perhaps use should be made of 'non-geographical' resources, local art galleries, novels, poetry and of course the other subjects being studied in the classroom.

Another area of serious weakness was that some students appeared not to understand what was being tested. They offered application where it was not being tested, or only offered AO1 (demonstrating knowledge and understanding) where it was clearly an AO1/AO2 question (also requiring the application of knowledge and understanding, or the construction of a formal discussion: argument, counter-argument and final judgement).

Case studies were often far too broad in scope (citing London, rather than Stratford, for example), resulting in a lack of specific detail and precision; but where case studies were used effectively they showed that students could recognise patterns at a variety of scales.

Tackling fieldwork questions

It was heartening that the majority of students' answers were based on real fieldwork experiences. However, the fieldwork answers generated the broadest spectrum of comments from examiners. At one extreme, the fieldwork seemed to have no links to the current specification: it appeared to be rooted in legacy specifications, or even GCSE, with students being unable to demonstrate an understanding of the fieldwork process. Many students were unable to evaluate techniques effectively, had access to a limited range of presentational and analytical skills and did not understand where it was appropriate to use them. At the other extreme students showed a clear understanding of the fieldwork process, had used a range of data collection skills and – in the 'Changing Places' fieldwork – had captured a real sense of a place's identity. While many students were generally well prepared for 'Changing Places' questions, they were not all ready for the associated fieldwork questions. However, there was evidence of investigation of a good range of topics and considerable good practice. A range of primary data collection methods had been used but it was clear from the responses that when it comes to conducting questionnaires more successful methods of primary data collection should be considered. This has serious implications for the Independent Investigation for the two-year course and students should have their attention drawn to this comment.

Areas to be addressed

Some students were puzzled by the resources supplied with questions, and need to be reminded that a resource might only be there as a stimulus and not require in-depth description or analysis. There is clearly a need for classroom practice: levels of engagement with, and interpretation of, the resources were inadequate. Other basic geographical skills which needed attention were accurate photographic annotation, accurate grid references and the use of GIS, which for many students appears still to be a closed book. Now that ESRI have made ArcGIS freely accessible to schools, this will hopefully continue to change for the better.

Students must be taught how to deconstruct the question, identify and understand the importance of the command words and what the AO2 links are – especially in the higher-tariff questions.

Major concerns

Two major concerns emerge from these reports. Firstly, too many of the weaker students seem not to have progressed much beyond GCSE. They need more practice in the following areas:

- the specific 'command' words used in the specifications, and their full definitions
- fieldwork management strategies in a variety of locations, not just the one they have learned or which is in the textbook
- planning extended answers, using a sufficient range of ideas and comparing and assessing them to reach a clear judgment.

The second area of major concern is numeracy. Numeracy and its assessment are now part of the examination, and at the outset it was expected that students and their teachers would be prepared for this. AO3 outcomes are less than had been hoped for and this invites careful reflection amongst teachers, assessors and subject design specialists. The June 2017 reports revealed that students could complete a statistical table by filling in the gaps but were then unable to use and evaluate this as a tool for analysis. However, a large majority did make clear sense of other data presented in a variety of forms and could construct factual answers.

Conclusions

These comments are intended to help prepare students for 2018's AS examinations and also to ensure that the first cohort of A level students do not fall victim to these often basic mistakes.

The intellectual demands of the new course may be manageable, but the fact that so much content has to be compressed into a two-term course, plus teaching a full set of geographical skills and the fieldwork requirement, all in time for a May examination, has significantly increased the time pressures on both students and teachers.

The GA's Post-16 and HE Phase Committee will be hosting a session at the Annual Conference to examine the issues surrounding the AS programme of study and its assessment procedures. We should be interested to hear your views, to better inform our discussion with Ofqual and the Awarding Bodies: please contact Iain Palôt, Chair, at lesgrionettes@yahoo.co.uk | TG

Iain Palôt, **Helen Hore**, **Simon Oakes** and **Bob Digby** are all members of the GA's Post-16 and HE Phase Committee.

Email: Iain Palôt at lesgrionettes@yahoo.co.uk

How to … develop (independent investigation) questioning skills at home

Kit Rackley

KIT explores how non-contact time can be used from key stage 3 to help students develop questions and methods for approaching fieldwork investigations at GCSE and A level.

Since all the 2016 geography GCSE 9–1 specifications focus strongly on skills and enquiry, it has become even more important to give students practice and experience of these elements at key stage 3. Take fieldwork for example. Each GCSE requires teachers to take students through the six stages of enquiry, from formulating hypotheses to evaluating the processes and outcomes. Taking a similar approach with younger students to familiarise them with the process before starting GCSE could be the way to go.

Applying the 'Question Formulation Technique'

Students could learn how to develop their questioning skills during independent learning at home by applying the 'Question Formulation Technique' or QFT (Rothstein and Santana, 2011). As you can see from Figure 1, this technique follows a six-step approach, similar to enquiries at GCSE.

In this example, I have used a mixed-ability key stage 3 high-school class in a rural area where a substantial number of housing developments are being built. To establish a focus (Step 1), a statement based on a fact is presented to the students: '872 new homes will be built in our rural settlement of only 2000 dwellings'. Students cannot ignore this radical geographical change to their environment, and they are highly likely to express opinions and possibly concern about it. At the same time, the students are shown an image of one of the housing developments visible from the school (Figure 2).

In Step 2, students engage in a few minutes of discussion, after which they are given a teacher-generated worksheet and asked to put their ideas down in the form of questions.

Figure 2: View from a classroom window of a new housing development right across the road from a school. **Photo:** © Kit Rackley.

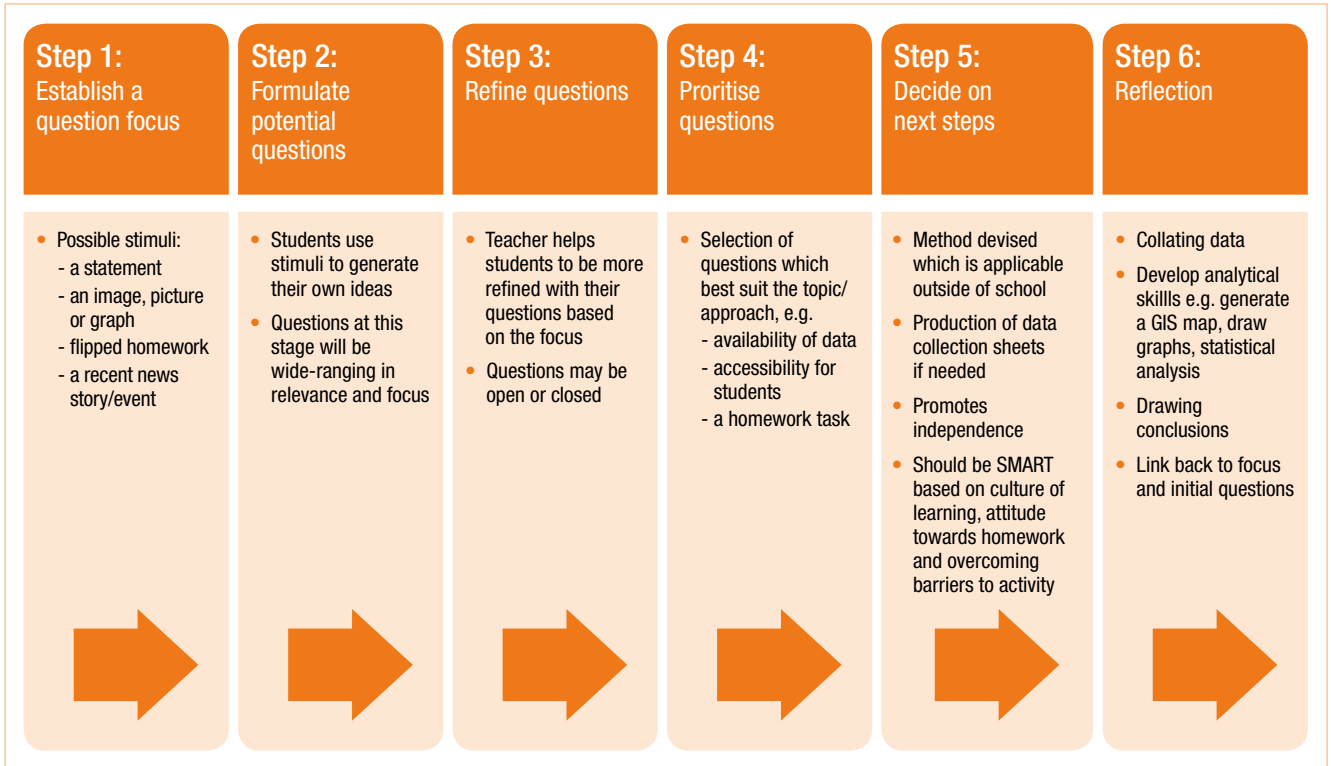

Figure 1: The six steps of the QFT, put in the context of independent investigations. **Source:** Rothstein and Santana (2011).

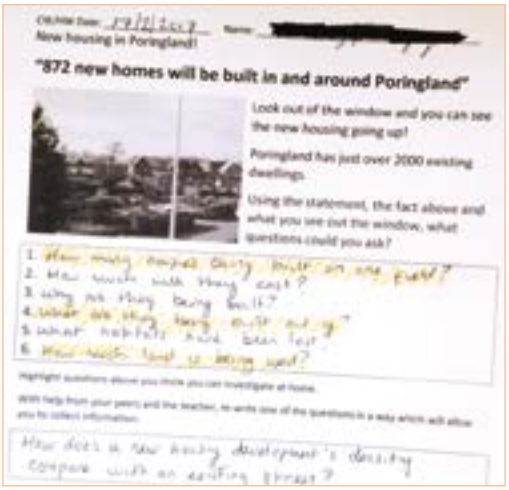

Figure 3: An example of a worksheet to help students generate, refine and prioritise their questions.
Photo: © Kit Rackley.

The teacher's role now is to ensure these questions are both focussed on the topic and realistic: will students be able to investigate them by themselves? Step 3 outlines this process of refining the questions. Figure 3 shows a piece of student work completed at the end of Step 4. The worksheet enables students to prioritise questions that they think could be answered as part of a homework task and, with help, to refine a question so it is appropriate for investigation. In Step 5, students must undertake the biggest and most important element of the independent part of the investigation: devising a simple methodology for answering their questions at home. Students are grouped with peers who have similar questions or who are able to work together out of school. The group, including the student whose worksheet is shown in Figure 3, devised a simple street-walk: counting the number of houses along two streets of similar length, one in a nearby new development and along their own street. With teacher guidance, the student groups generate data collection sheets.

The final step takes place when students return to class after conducting their homework investigation. This is an opportunity to help students develop a range of skills to help them process and analyse the information they have collected.

Drawbacks

This approach is very much dependent on teachers having realistic expectations of what their students can achieve through independent work, otherwise some students could fail to complete the homework. Using the example above, a student may live outside the immediate area and therefore not be within walking distance of a housing development: in these circumstances, the teacher will need to decide whether it would be realistic for the student to arrange to visit a friend's house so they can work on the task together. It may be necessary to provide secondary data resources students could use to generate a range of likely questions. The students' worked examples revealed that one student undertook the task while walking the dog; three while accompanied by one or both parents; a small handful on their way home from school that day. Most said they enjoyed it as it was different to 'normal' homework, and because they wanted to find out more about this significant change to their local landscape.

Conclusion

With peer and teacher support, students of all ability ranges should be able to generate workable questions. However, explaining their questions and the data to be collected in context requires some abstract thinking, and a few students may find this difficult. Further ideas for focus statements and application of the technique can be found in Figure 4. Topics can be generic, but students will find issues tailored to their local surroundings more motivating. | **TG**

Figure 4: Example 'Question Focus' statements for mini-independent investigations to develop questioning skills.

Example 'Question Focus' statements (and topic)	Possible ideas for first steps at school	Possible application out of school
Some rooms in my house need the lights on more than others (energy use, microclimates)	Using maps to find the aspect of a student's house, creating a rough plan of their house, generating a data collection sheet	Data collection tallying total light bulbs, those in use and for how long; tracking how the sun moves over a day by taking pictures; recording what times of day some rooms are naturally lit and for how long
Many planes fly over our area (logistics, transport)	Use a flight tracker GIS to look for patterns; show students how to orient themselves north, how to spot planes etc; generating a data collection sheet	Record frequency and direction of flights overhead at regular intervals by plane-spotting, spotting contrails
The last storm flooded parts of our town	Use of weather and climate data to establish frequency of past storms; use of local news articles from previous floods; use of map skills to spot areas vulnerable to flooding	Taking photos or making annotated sketches of an area that flooded; recording types of buildings/properties at risk
It doesn't always rain when it is cloudy	Make bespoke weather collecting equipment and data sheets (plenty can be searched for online!)	Periodic collection of weather data

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Using local organisations and geographical scholarship to support A level place studies

Grace Healy

Grace describes the importance of tapping into the expertise of local organisations and geographical scholarship in supporting A level students studying 'Changing Places'.

In the summer term of 2016, our geography department spent much time pondering what would make appropriate and interesting place studies for the AQA A level unit 'Changing Places'. For our 'far place', we discussed areas of the country and world which various members of staff knew well; we discussed what local sources of expertise we might draw on for our 'near place' study; and what academic literature might enrich our studies. Now, reflecting on our first year of teaching 'Changing Places', it is clear that all of these factors have had an important role to play in driving our curriculum planning and teaching of this unit: they have shifted our students' place studies beyond the superficial.

Near place study

A local organisation: Mill Road History Society

Starting with our 'near place', we settled on the area and community along and around Mill Road in the city of Cambridge. This area was chosen as it provided scope to investigate the impact of relationships and connections on people and place, and consider economic change and social inequalities. Mill Road was at one point a country lane which has changed significantly in part due to the development of the railway and the University. It is divided in half by the railway bridge, and each side of the bridge has developed in different ways, which we felt offered an interesting geographical complexity to this place study. Gonville and Caius and Corpus Christi colleges developed the area to the west of the railway bridge which is part of the Petersfield ward. To the east is Romsey ward, which developed as a result of the expansion of the railway network (Brigham, 2015). Here we were able to draw on the expertise of the Mill Road History Society, an organisation that researches and celebrates the history and community of the Mill Road area, creating a permanent record of their research and disseminating it as widely as possible (Mill Road History Society, 2016). In autumn 2016, the Society kindly offered to support our sixth-form students by sharing their recent work. They introduced our year 12 students to their research into local buildings and with former residents, and the insights this had led to. This helped set the context for our study, and outlined the key changes that had faced residents, which gave us a framework for considering peoples' lived experience. We have continued to build on this connection: Mill Road History Society supported a larger group of geography students by contributing a lecture to the Sixth Form Lecture series of the Cambridge and District GA in October 2017.

Students were able to draw on Mill Road History Society's resources, including the use of Building Reports and interviews conducted with former residents from the Capturing Cambridge (2016) website, to build up a detailed picture of the area. Once students' studies were under way, we undertook a day's fieldwork along Mill Road. Here the Society treated us to a historical introduction to the main phases of change along Mill Road and their impact on the built environment. Learning about the historical uses of different buildings and landmarks along Mill Road was particularly helpful for students, as after the introductory talk they were able to explore Mill Road and identify these landmarks for themselves. We started out at the Bath House (Figure 1), which formerly served as a public baths for the local population and since 1976 has been a community centre. At the Bath House we also saw photos of Ditchburn Place (Figure 2), the oldest surviving building on Mill Road. It opened in 1838 as the Cambridge Union Workhouse and has transitioned through various uses (e.g. County Infirmary and Cambridge Maternity Hospital) culminating in its current use as sheltered accommodation for the elderly. As well as experiencing human geography fieldwork and gaining confidence in applying research methods (questionnaires, interviews, land use surveys), the students' appreciation of the historical uses of existing buildings meant that they were able to visualise what they would have been like in the past.

Hopefully our Mill Road place study has the potential for a mutually beneficial relationship to develop between our geography department and Mill Road History Society: there is a great opportunity for our students' NEA independent investigations to offer worthwhile contributions to the Mill Road research.

Figure 1: Mill Road Bath House. **Photo:** © Peter Bridge.

Figure 2: Ditchburn Place, Mill Road. **Photo:** © Mill Road History Society.

Far place study

Geographical scholarship

For our 'far place' we wanted somewhere that would contrast with Mill Road, but also offer similar threads of geographical change over time for our students to draw out. Digbeth, an area of central Birmingham, has complemented our 'near place' by providing us with an area that has a considerably different socio-economic profile (e.g. higher levels of deprivation, higher proportion of ethnic diversity). In terms of economic change, as Birmingham's former industrial quarter, it offers an insight into a shift from economic activities focused upon industry to an area that has now diversified and continues to undergo large redevelopment as part of Birmingham's Big City Plan. Our students did not get the opportunity to visit Digbeth so it was important that the lesson sequence exposed them to a range of sources that could develop a rich 'sense of place' and understanding of peoples' lived experience across time. Luckily, I found a project called Digbeth Speaks (2013), which aimed to preserve the diverse heritage of Digbeth by creating an audiovisual 'time capsule' of its communities during 2013. The oral history interviews gave our students an understanding of past and present-day views about the area. Some extracts from the interviews are shown in Figure 3.

When planning our Digbeth place study, I was very pleased by the quantity of academic literature available to support students' geographical learning. The output of the Eastside 'Rescue Geography' Project (2008) was particularly helpful in aiding students' understanding of the developing character of Digbeth and how peoples' lives are affected by continuity and change. Jones and Evans (2011) introduced students to the idea of urban regeneration being mediated by local place. This also helped to embed the new terminology and theory that students had acquired earlier in the Changing Places topic (e.g. locale, sense of place) and it was helpful for them to see how other academics interpreted Harvey's (2006)

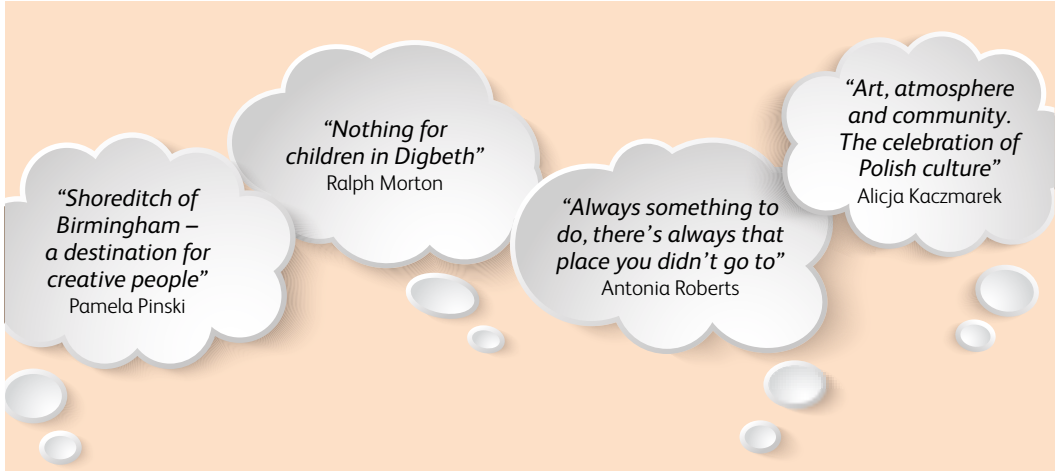

Figure 3: Snippets of Digbeth Speaks' Oral History Interviews articulating first impressions of the area, and present day experiences.

and Massey's (1994; 2005) ideas of space and place. In Jones and Evans (*op cit.*) I also came across a selection of helpful geo-located quotes, and Dr Phil Jones at the University of Birmingham kindly gave me access to the full complement of quotes from the interviews with photos of the locations discussed. Our sixth-formers were able to use this wealth of geo-located data to better understand their 'far place', as well as to develop their use of GIS. Jones *et al.* (2008), on exploring space and place with walking interviews as a research practice, helped students to understand how geographical research is carried out. This really emphasises the importance of choosing appropriate articles that are accessible to students and can develop their geographical knowledge and understanding. When exploring the available academic literature, I used abstracts to help gather relevant articles. Some literature, due to its focus or complexity, was not appropriate for using with students, but it did inform my geographical knowledge of our far place study and therefore shaped my curriculum planning.

Historical scholarship

Carl Chinn, Professor of Birmingham Community History at the University of Birmingham, has published widely about peoples' lived experience both across Birmingham and within Digbeth. His work gave us a broader appreciation of housing conditions in the past and developed students' understanding of the multi-dimensional nature of people's lived experience. For example, the terraced housing in Digbeth was 'blackened by smoke', 'cramped', 'lacked privacy'; but the area was also characterised by 'strong neighbourhoods bonded by powerful ties of kinship and neighbourliness' (Chinn, 1991). When we came to look at the mid-twentieth century slum clearances, students had a glimpse of 'outsider' opinions about the poorer residents: the use of the term 'slum', for example, 'emphasised the lack of empathy shown by the officials and outsiders with the poor' (Chinn, 2015). The slum clearances also revealed social inequality. In Birmingham, only residents who had lived there for five years qualified for resettlement: immigrants from Ireland and the Caribbean who were joined by their families were obliged to take accommodation in decaying and unhealthy multi-occupancy dwellings (Chinn, 1991).

Conclusion

As geography departments continue to refine and develop their teaching of 'Changing Places', I would highly recommend drawing on local organisations and the academic research base that exists around place studies as a way of developing both your own knowledge and your students' understanding.

I am continuing to reflect on how geography teachers can draw effectively and helpfully on academic literature, both to inform my curriculum planning and to develop more of our students' understanding. I have been inspired to do so by the way that some history teachers draw upon historical scholarship directly with students (e.g. Foster, 2010; 2011); how historical scholarship has been used to make teachers' curriculum planning rigorous and historically sensitive (e.g. Foster and Goudie, 2016); and the value of a departmental culture of sharing and reading historical scholarship (e.g. Murray, Burney and Stacey-Chapman, 2013). | **TG**

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Helena Maxfield

The Cayman Islands coral reefs: global issues, local solutions

Helena describes a case study conducted by her students into threats to the coral reefs of the Cayman Islands, and attempts to mitigate them.

Accompanying online materials

Coral reef ecosystems are an important example of the direct impact of human activity on our environment and of consequent longer-term environmental change, both areas that are included in the 2016 GCSE and A level specifications. The Cayman Islands, a British Overseas Territory in the western Caribbean Sea, are used here to show how mitigation strategies can reduce the impact of changes in the ocean which threaten coral reefs. Mitigation strategies can prove quite challenging both in implementation and managing the results, and ultimately, as with any global issue, a more holistic international approach is the key to protecting the reefs for the future.

As geographers, we teach students to use a conceptual framework to conduct case studies. In a coral reef case study, the parameters of the investigation are the factors which threaten their degradation, and preventative or mitigative responses to these threats. The following case study, into the efforts of the Cayman Islands authorities to protect their coral reefs, was researched and conducted by GCSE students.

The Caymans are made up of three islands in the Western Caribbean Sea, northwest of Jamaica and southwest of Cuba (Figure 1). These islands were uninhabited until the 1800s owing to the lack of fresh water and the presence of mosquitoes. The Caymans exhibit some of the world's best fringing reefs, which have developed along the Cayman trench where the sea bed plunges from a narrow shelf to depths of over 4000m. Fringing reefs grow near the coastline around islands and continents. They are separated from the shore by narrow, shallow lagoons.

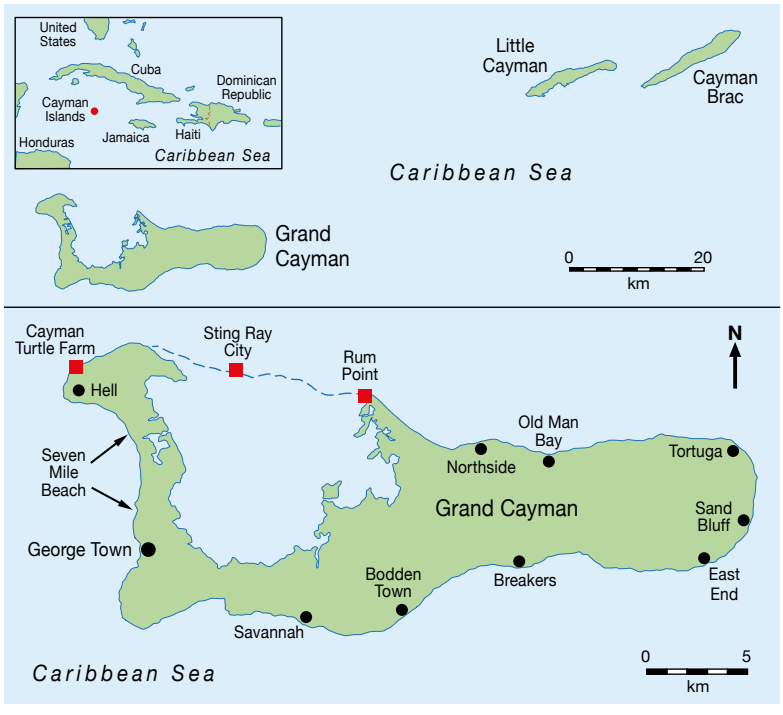

Figure 1: Map of the Cayman Islands.

Why are coral reefs important?

To introduce students to the case study, they were given the following information on the global importance of coral reefs.

1. Coral reefs are among the most fragile and sensitive ecosystems in the world. They are also the second most bio-diverse habitat after equatorial biomes, containing a high percentage of the world's marine species, and they maintain complex ocean food webs and food chains. Globally, they are currently undergoing a period of decline. It has been estimated that 30 % of coral reefs are critically damaged and that by 2030 approximately 60 % of reefs may be lost (Hughes *et al*., 2003).
2. Coral reefs can protect equatorial islands from tropical storms, which – partly as a result of climate change – are increasingly frequent and of greater magnitude.
3. The shellfish, fish and other seafood that live on the reefs are in great demand as a source of food.
4. Coral reefs are an important tourist attraction. As a country's tourist industry develops, its GDP increases, generating funding for higher wages, improved infrastructure, and investment in healthcare and education. This allows countries to move their economic base from secondary- to tertiary-based industries (Rostow's sector model).

The case study

At the start of the lesson, each student was given one of the following three questions and asked to individually write their answer on a post-it note:

- What are coral reefs?
- What threats do they currently face?
- What could be done to mitigate these threats?

Students then read each other's answers, and in a teacher-led discussion they used these to gain a background understanding of the seven main threats to the Cayman Island coral reefs (Figure 3).

Students were then given descriptions of the six strategies developed in the Cayman Islands (Figure 4). When they had studied them, they were asked to:

- rank each in order of importance (they could use a 'diamond 9' approach)
- decide what the success criteria might be for each strategy.

Figure 2: Sponge diversity on a healthy coral reef in the Cayman Islands. **Photo:** © NOAA (CC by 2.0)

1. Coral bleaching

Corals are sensitive animals that require optimum marine conditions in order to thrive. If their balanced environment is altered, the coral starts to bleach (turn white) and die.

2. Thermal expansion of the oceans

In addition to the stress inflicted by higher sea temperatures, rising land and sea temperatures have caused the oceans to expand, resulting in the corals being 'drowned' at greater depths.

3. Increasingly active hurricane season

The frequency and magnitude of tropical storms has increased in the last few decades. The physical strength of these storms can destroy or cause severe damage to the reefs around the Cayman Islands.

4. Vulnerability to UV rays

High UV penetration into the waters surrounding the Caymans' continental shelf, owing to the south-facing orientation of the coral reefs, can lead to further thermal stress on coral reefs.

5. Invasion by macro-algae

Macro-algae compete with, overgrow and replace seagrass and coral habitats. This in turn reduces the light reaching sea-bottom (benthic) communities, causing low oxygen conditions (hypoxia) and eventual die-off of sensitive species such as hard and soft corals and sponges.

6. Invasive species, e.g. lionfish

The lionfish has no known predator and can decimate fish numbers, to the point at which coral reefs collapse.

7. The direct and indirect effects of tourism

Tourism has a known long-standing impact on the Cayman Islands, affecting the environment in a variety of ways:

- damage caused by large numbers of dive boats
- divers can directly stress the coral
- tourism has created a market for souvenirs and drive the islands' growing demand for seafood
- sunscreen leaves a film on the water which can negatively affect coral reefs.

Figure 3: Threats to Cayman's coral reefs (more detail about each of the threats is given in the accompanying download).

The impacts of tourism – diving off Grand Cayman. **Photo:** © Shutterstock/ Warren Metcalf

Figure 4: Prevention and mitigation strategies (see Download C: Prevention and mitigation strategies, for full details).

1. Marine parks

A practice hailed by the DoE as its most successful to date is the designation of a marine protected area system, which includes marine reserves, line-fishing zones, no-diving zones and SPAG (Spawning Aggregation) zones.

2. The REEF programme

This is a collaborative project between REEF, an American NGO dedicated to ocean conservation, Oregon State University, the University College of San Diego Scripps Institution of Oceanography, and the Cayman Islands DoE, which set up the Grouper Moon Project. The project aims to protect the Nassau Grouper and to educate and raise awareness of sustainable fishing practices.

3. Marine turtle programme

Turtle numbers have declined, owing to the Caymanian dependence on their meat and injuries inflicted by boat propellers. This programme aimed to monitor and protect turtle nests, and was launched by the Cayman Islands DoE in 1998. Originally the programme covered 30 nests, and there are now more than 35.

4. Cayman Island Tourism Association: 360 dive sites

This CITA project involved the creation of 360 dive mooring sites, to increase diving tourism, and alleviate pressure on popular, crowded dive sites by making others more accessible. However, many of these mooring sites have yet to be used, especially those which are more remote.

5. National Trust for the Cayman Islands: Sea Sense

The Cayman Sea Sense project is a sustainable seafood education programme dedicated to helping restaurants and their customers make informed and environmentally positive seafood choices.

6. Department of Education: Lionfish culling

Licensed lionfish culling by dive operators, tourists and local diver monitoring have reduced the numbers of lionfish in specific culling zones.

This led to a discussion about the need to manage the local marine environment but also to understand the complexities of a changing marine system.

Finally, students were asked to discuss the prevention and mitigation strategies and decide how successful they were. This was an opportunity to explore how some strategies could be successful on a local scale, whereas others would require international collaboration.

Reflection

> *'When students have background knowledge they are able to engage, think and therefore remember'* (Willingham, 2009).

In this case study lesson, background information enabled students to decide what else they wished to know about these strategies, and how to evaluate their success. They had access to additional resources and the internet, allowing more directed and independent learning to take place. Students were supported by the class teacher during this part of the lesson.

The activities allowed students to develop a range of skills: recalling knowledge; comprehension; thinking skills; and critical thinking. Individual students required scaffolding support during the research task. Students showed a strong understanding of the issues involved in the case study, and their complexities.

Conclusion

Throughout this coral reef case study a recurring theme was evident: namely that the impact of anthropogenic climate change serves as both a catalyst and causal factor.

The Cayman Islands benefits from its status as a British Overseas Territory, with a proactive Department of the Environment which has been successful in managing many of the more tangible threats to the Caymans. Of the three islands which make up the Caymans, the healthiest and most resilient coral reefs are found on Little Cayman, which is subject to less stress: it is likely that these will survive the delayed impacts of threat posed by the largest El Niño event recorded to date from 2015–16. | TG

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Useful websites

Coral Reef Alliance: http://coral.org/coral-reefs-101/coral-reef-ecology/types-of-coral-reef-formations/ (last accessed 5/12/17).

NOAA National Ocean Service, Coral Bleaching: https://oceanservice.noaa.gov/facts/coral_bleach.html (last accessed 5/12/17).

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The Identity Game

Vicky Ellaway-Barnard

Vicky describes how she introduced the concept of 'place' to her A level students via 'The Identity Game', its successes and pitfalls, and what she will change for next year.

Accompanying online materials

Figure 1: Students playing the Identity Game. **Photo:** © Vicky Ellaway-Barnard

While the new A level specifications were being implemented, and geography teachers up and down the country were planning new teaching resources on the concept of 'place', I was busy researching and writing up my MA dissertation. I had spoken to academics, teachers and the geography team at OCR about how they interpreted 'place' in the new specifications and their ideas on the best way to use university-level research to teach geography's 'big concepts'. My research led me to conclude that ideas of 'identity' are intrinsically interwoven with the concept of place: they involve an understanding of 'belonging'; of who is 'in' and 'out' of place, and how these boundaries can be broken down. In completing my MA research I had done far more than normal 'background' reading, *and* I had consulted the experts. In essence, I thought I had this new core content nailed. The plan was to get our lower sixth students to hit the ground running: by exploring concepts of identity in week one they would be grappling with current geographical thought at a much higher level than they had experienced before, and this would set them up for success in later topics by being able to apply geography's underpinning concepts to new ideas. Well, that's what I thought would happen. As it turns out, students don't always respond to your brilliant lesson plans in the way that you imagined they would …

A bit of background

'The Identity Game' is a lesson designed to get students thinking about geography's 'big concepts' by encouraging them to experience 'place' through someone else's eyes. We follow the OCR specification, but the idea of identity in understanding 'place' is integral to all the new A level specifications. After extensive discussions with the department, and guided by my MA research, we thought it best to begin by teaching the more complex ideas, as these would underpin later topics. While an understanding of geography's key concepts is not new to school-level geography, the inclusion of 'place' in the core content does mark a significant step forward in terms of the sophistication of students' geographic thinking at this stage of their academic careers. The new A level requires students to have a more nuanced understanding of concepts (OCR, 2015) that encourages them to grapple with the complexities of a conceptual geographical understanding, from theoretical stances to 'real world' experiences and representations.

I am a big fan of the latest curricular changes. Although they have meant a huge amount of work for us as classroom teachers, I don't think anyone can deny the benefits the students will reap from learning a geography that is relevant, innovative and offers them the prospect of

effecting meaningful change. Curricular reform that considers what makes a good geographical education is important because, as the GA (2012) notes, the way we make sense of the world is changing: students need to be geographically literate in order to participate as global citizens.

The lower sixth starting the new geography A level course were a mixed ability class of 10 students, out of a cohort of roughly 30. Most of them knew each other well, having been at the school together since key stage 3 and, although we do have a handful of students arriving new into the sixth form, there was only one boy who was new into this particular class. I introduced 'The Identity Game' to this class very early on – in their second week of the new A level course.

How to play

Only two resources are needed to play 'The Identity Game': a set of identity cards and a sheet of scenarios (both available as downloads). However, a fair amount of space is needed to play effectively, so the game could be set up outside or by pushing the desks to the sides of the classroom. Give each student a card (Figure 2), which becomes their new 'identity', and ask them to stand in a line along the back of the classroom. The cards give details of age, gender, sexuality, religion and role: aspects of identity that directly relate to the OCR specification, but they could be easily adapted. Once the students are in place, read out the list of scenarios, and ask them to take a step forward each time they think they

Age: 17 Gender: Female Sexuality: Heterosexual (straight) Religion: Christian Role: GCSE student, oldest child of five	Age: 17 Gender: Female Sexuality: Homosexual (gay) Religion: Christian Role: GCSE student, youngest of two daughters
Age: 22 Gender: Male Sexuality: Heterosexual (straight) Religion: Muslim Role: university student, volunteer for refugee charity	Age: 18 Gender: Female Sexuality: Bisexual Religion: Buddhist Role: A level student, young carer for disabled mother
Age: 18 Gender: Female Sexuality: Heterosexual (straight) Religion: Jewish Role: Oxford University student, part-time babysitter	Age: 20 Gender: Male Sexuality: Homosexual (gay) Religion: Sikh Role: apprentice at a car garage, youngest son of four
Age: 32 Gender: Female Sexuality: Bisexual Religion: Muslim Role: part-time teacher, volunteer at the local mosque	Age: 47 Gender: Male Sexuality: Heterosexual (straight) Religion: Jewish Role: insurance banker, married, father of three
Age: 41 Gender: Male Sexuality: Homosexual (gay) Religion: Atheist Role: single parent of two girls, mechanical engineer	Age: 54 Gender: Female Sexuality: Heterosexual (straight) Religion: Muslim Role: widow with no children, unemployed

Figure 2: An extract from the set of Identity cards.

would feel comfortable in that 'place', based on their new identity. Read out a few scenarios so that the students become familiar with the game, and then ask them to pause where they are standing to see how far they have, or have not, moved relative to their peers. Direct questions to those students who have moved forward the most and the least to encourage them to assess the reasons behind their decisions, as well as to consider which aspects of their new identities they felt were the most influential in deciding whether they felt included or excluded from certain places.

Student responses

Student responses to this task were strong at the time, with – considering this was so early in the A level course – some fairly perceptive comments from individuals. However, when written down, the ideas discussed during the game didn't seem to translate into strong examination-style responses: when not verbally challenged, some students' answers became stereotypical and unsubstantiated. For example, some students would write, of religion affecting a sense of place,

> *'Muslims will feel less confident on the Tube'*

or, of how gender affects sense of place,

> *'Women will feel more intimidated at football matches'.*

To remedy this, encourage them to explore any unsupported ideas, and lend weight to their arguments, students were set follow-up work on 'place' as discussed by relevant contemporary theorists (see downloads). Although not directly cited in the OCR specification, we chose to look at Cresswell's (2004) idea of people being either 'in' or 'out' of place, and Massey's (2005) work on relational thinking. After analysing these particular theoretical standpoints, students were able to explain their ideas more coherently. For example, in an examination question on how religion affects a sense of place, one student responded:

> *'… negative representations of Muslims in the media mean that a person of that faith may feel victimised or that they stand out in certain associated places, such as the Tube'*

drawing on Cresswell's (2004) idea of people feeling 'out' of place. And in answer to an examination question on how gender affects sense of place, another student drew on Massey's (2005) ideas of relational thinking, explaining that

> *'… women may be perceived to be more intimidated in typically male-dominated places, such as at football matches, but this ignores other competing factors that may actually make them more empowered in this situation, such as their role in the family or their age.'*

Reflection

As that initial lower sixth cohort began their second year of A level, I had cause to reflect on their transition up from GCSE. I didn't see the follow-through of those 'big' geographical ideas into the later topics as I had anticipated – instead, the concept of 'place' is one that we have had to continually revisit and discuss in relation to other geographical debates. This year, we have decided to teach our optional topics first, starting with Human Rights, and come to the core content of the 'Changing Spaces; Making Places' topic after Christmas. I was hesitant about changing my original A level structure: I had been so certain that the 'hit them hard with university-level geography' approach would be a success. However, it will be interesting to see whether allowing students the time to get to grips with the necessary examination technique, as well as working for a term at A level standard, before exploring major new concepts with them, will make a difference to the sophistication of their geographical thinking at the end of year one.

I still feel that it is important to teach these 'big ideas' effectively, as an understanding of place encourages students to become 'global citizens' (Bonnett, 2012; Schmidt, 2011), who have the necessary skills to play an active role in adapting, and determining appropriate responses, to change and uncertainty (Hill and Jones, 2010). I want to finish by linking what has been discussed here back to my MA dissertation research. It is significant that all of the people I interviewed, including academics, teachers and representatives of OCR, mentioned that they would begin teaching about 'place' by starting with an individual's identity. In engaging with the constructions of place that students necessarily bring to their learning, they gain a more critical awareness of how knowledge is co-produced. And that, in my estimation, is what the Identity Game is really all about. | **TG**

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Harry West and Michael Horswell

GIS has changed! Exploring the potential of ArcGIS Online

Harry and Michael describe Esri's ArcGIS online platform and demonstrate how it can be used to give students a sound introduction to GIS, enhancing their ICT skills and developing curriculum knowledge.

The curriculum has changed

Geographical Information Systems (GIS) have received a mixed reception amongst UK secondary teachers. For many teachers GIS conjures up memories of lost data, slow computers, complex language, and highly specialist software. Consequently, when GIS first appeared in the geography curriculum in 1991 many were sceptical, and some geography teachers still feel uncomfortable using GIS software. Instead, they use platforms like Google Earth and online maps as a 'quick fix' substitute. The result is that students get minimal exposure to GIS prior to university.

However, the latest curriculum refresh places greater emphasis on GIS. The 2014 national curriculum geography programme of study for key stage 3 requires students to be able to use GIS to interpret and analyse places and a range of geographical data (Department for Education, 2013). This is also the case at GCSE and A level. As the technology develops and students become more familiar with it, GIS is likely to become more firmly established, both in the curriculum and in student expectations.

Figure 1: Example basemaps from ArcGIS Online (above = OS Open raster base map; below = Imagery base map).

It is no longer enough, therefore, to rely on the 'quick fix' Google Earth GIS experience to give students the skills and experience they need. This article outlines the changes that have taken place in the Esri ArcGIS Online platform, and describes how teachers can easily incorporate this new technology into their geography lessons, enhancing students' learning experience and skills development.

Technology has changed

As with most computing applications and platforms, GIS is slowly shifting away from traditional offline desktop software to cloud-based online environments. A range of open-source web mapping applications is available, including OpenWebGIS, MangoMap, and MapBox. However, some online platforms are hampered by complex interfaces, and some require a knowledge of coding to take advantage of their potential, so test the range of options available before making a choice.

ArcGIS Online offers a simple and easy-to-use interface, making it ideal for secondary classrooms. Web maps form the basis of the platform, and the web mapping application allows users to visualise, explore, and analyse geo-spatial datasets. A range of easily visualised base maps, including imagery, and OS OpenStreetMap (Figure 1) are included as standard.

Accessing data for GIS has never been easier. Under new, open-access licenses users can now source a huge array of datasets, including census data, elevation and slope, satellite imagery, geology and flood risk areas. Most spatial data formats can be downloaded and then uploaded to your account for use in the web mapping application. You can also access Esri's 'Living Atlas', a collection of datasets and maps that can be easily added into web maps, all within the platform. Figure 2 maps the AQA GCSE units against some of the 'Living Atlas' data that could be used in teaching activities.

Students can interrogate and explore any data in a web map. Most datasets are interactive, in that as you click and zoom in/out, different information and interaction options are presented. As well as giving students the opportunity to explore and interpret data they also offer a range of analytical tools and functions. These allow students to examine and summarise key trends in data, or create new datasets to help interpret spatial patterns. Some common analytical tools are described below.

- **Create buffers:** Create a buffer of a specified distance around a feature. For example, you could identify areas within 500m of a river channel that might be at risk of flooding.

AQA GCSE unit		Example 'Living Atlas' data
Unit 1: Physical Geography	The Restless Earth	World seafloor geomorphology; recent earthquakes; earthquake faults
	Rocks, Resources and Scenery	UK bedrock and superficial geology; world elevation GMTED
	Challenge of Weather and Climate	Active hurricanes; recent weather radar imagery; current wind conditions
	Living World	Local nature reserves; forest landscapes; world tree cover
	Water on the Land	OS open rivers; Environment Agency flood alert areas; live stream gauges
	Ice on the Land	Glaciers of the world; changes in snowmelt timing (1975–2040)
	The Coastal Zone	Seafloor bathymetry; protected marine areas; coastal population density
Unit 2: Human Geography	Population Change	World population estimates; population growth rates; UK census demographic information
	Changing Urban Environments	World cities; London urban heat island; urban water stress
	Changing Rural Environments	Agricultural land classifications; countryside stewardship
	The Development Gap	UK economic activity; undernourished population; index of multiple deprivation 2015
	Globalisation	Internet users per 100 population; world exclusive economic zones; UK balance of trade 2015
	Tourism	Spain: leisure and entertainment; world transportation

Figure 2: Units in the AQA GSCE specification mapped against 'Living Atlas' data.

- **Create a watershed:** uses elevation data to create a watershed around a river network.
- **Find hotspots:** uses for mapping clusters, for example to show crime hotspots.
- **Interpolate points:** uses to create a continuous surface from point data. For example, if you had rainfall measured at a series of points, this tool would create a continuous rainfall surface.

ArcGIS also allows you to create 'Story Maps', which are interactive web-based presentations based around your web maps. 'Story Maps' allow you to combine your thematic maps with a narrative, providing a media-rich, interactive, and fun presentation format. Previous *Teaching Geography* articles have discussed the role of 'Story Maps' in geography, the different templates and functions, and how students have engaged with them so far. The Esri Online Gallery is a collection of ready-made, high-quality 'Story Maps' that can be used as examples for students or as classroom resources.

Fieldwork is still seen as geography's signature pedagogy, and it is very easy to think of GIS as an 'indoor activity'. ArcGIS Online connects to other Esri applications that students can utilise for fieldwork. 'ArcCollector' and 'Survey123' enable students to collect data, whether physical measurements or survey responses, in the field. You sign in to the apps with the same details as your online account. This means that any data you collect in the field can be visualised and analysed instantly online, without the need to upload or manage it yourself. Alternatively, the Esri 'Explorer' app allows you to download any web maps and analytical results you have created for use in the field.

Support has changed

Previously, access to Esri's applications was through a paid subscription, which limited its use in the secondary classroom. However, in April 2017 Esri announced that it would be providing the ArcGIS Online platform (and apps such as 'ArcCollector') to UK secondary schools for free. For the first time, this gives teachers and students free access to a powerful, easy-to-use, GIS environment.

With your free subscription, you also have access to the Esri support team and online help. The online help pages are rich with information and examples to guide new users through the platform. Also in 2017 Esri, in collaboration with the Royal Geographical Society, launched the GeoMentor programme. GeoMentors are trained GIS users and professionals who offer support for local secondary teachers in bringing GIS into their classroom. The level of support offered by GeoMentors varies on an individual basis, but may include face-to-face meetings, email support, school/field visits, and classroom support with students. Links to register your school, and to sign yourself up to the GeoMentor programme for support, are given at the end of this article.

Your classroom could change

As well as enabling you to develop activities linked to your own local area and syllabus, Esri has developed a range of ready-made learning activities. These are selectable by unit and learning level, and span the full range of GCSE and A level topics. Figure 3 shows an example activity: an interactive map of the Dawlish Warren shoreline management plan. A link to all the Esri learning activities is included in the resources section at the end of this article.

Figure 3: The Dawlish Warren shoreline management plan learning resource. **Source:** Esri UK, 2017.

Conclusion and further resources

The ArcGIS Online platform has the potential to transform the teaching of GIS in UK secondary schools, providing a data-rich, interactive, and fun learning experience for students. Online GIS is moving the field into a new era, far removed from the clunky specialist software you may have experienced in your own training. There is a growing support network made up of Esri and GIS professionals, and we strongly encourage teachers and geography departments to take full advantage of this, now free, resource. | **TG**

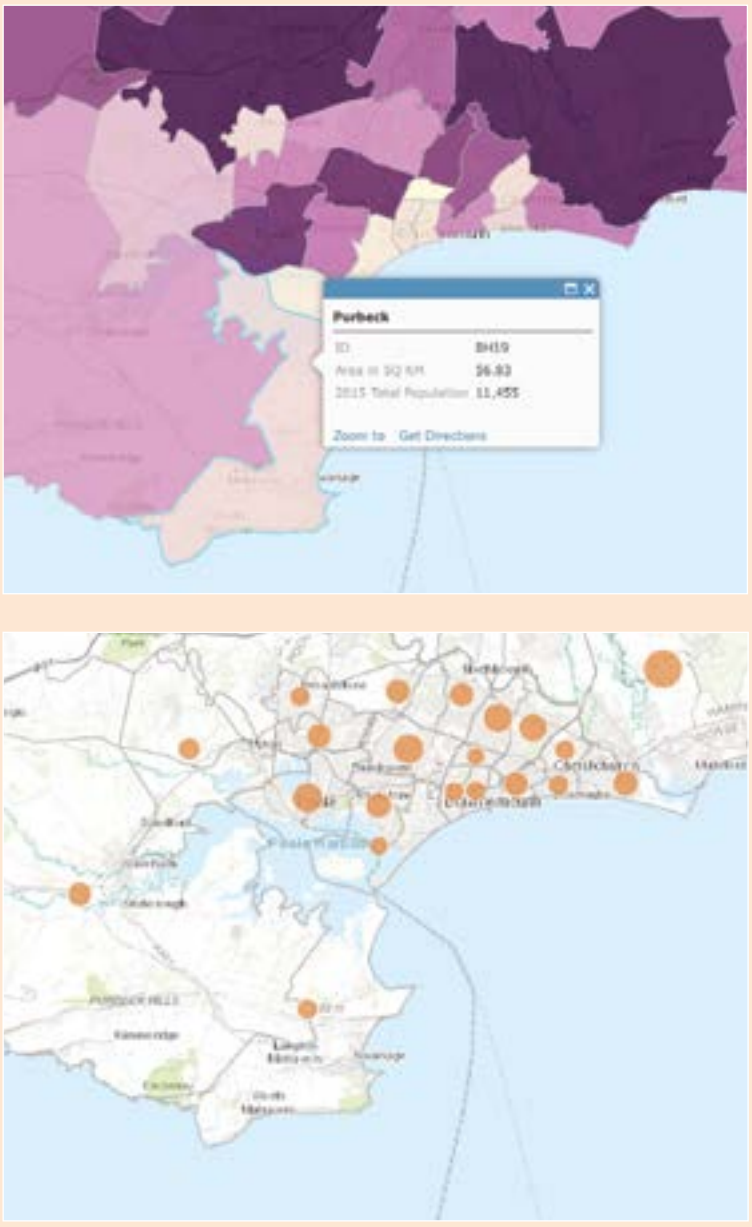

Figure 4: Different symbolisation options for population data.

Example activity: Calculating population living in flood alert areas along the South Coast.

This worked example will calculate the number of people living in Environment Agency flood alert areas along the South Coast (Swanage/ Poole). We will only be using data that is freely available through the 'Living Atlas'. This method can be adapted and used in any flood alert area.

1. Firstly, open the web mapping application and navigate to your area of interest. It is possible to add data in and search the 'Living Atlas'. You only need two datasets for this activity – the 'Environment Agency: Flood alert areas', and 'United Kingdom Postcode District Boundaries 2015' (which contains the total population of that district in 2015). The 'Living Atlas' also includes other census aggregation areas, such as output areas and regional areas, which also contain population statistics.

2. You can symbolise data to show spatial patterns in different ways. For example, the population data can be shaded by postcode area, or represented by symbols scaled to represent the total population (Figure 4).

3. Use the 'Summarize Within' tool to calculate the total population living in flood alert areas. First, select the flood alert areas, then select the census postcode dataset to be the layer to summarize. In the field box, select '2015 Total Population'. You can calculate different statistics, such as the maximum, average, and standard deviation. In this case, select 'Sum'.

4. Run the tool. The output will be a new dataset shaded by the total number of people living in that flood alert area.

5. Open the attribute table for that dataset from the contents pane. You will see that there are multiple entries (broken down by the different alert areas). You can summarize this for the entire study area by selecting the column of data and clicking on 'Statistics'.

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Useful links (all last accessed 5/1217)

ArcGIS Online: https://www.arcgis.com/home/index.html
Department for Education (2013) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/239087/SECONDARY_national_curriculum_-_Geography.pdf
GeoMentor programme: https://schools.esriuk.com/geomentor/
Living Atlas: https://livingatlas.arcgis.com/en/#s=0
Ready-made GIS activities for the classroom: https://schools.esriuk.com/teaching-resources/#-
Register your school: https://schools.esriuk.com/
Story Map Gallery: https://storymaps.arcgis.com/en/

History in geography: the importance of change over time in geography

Charles Rawding

Charles uses examples from environmental geography to argue that a lack of historical thinking can result in static, inaccurate and potentially misleading geographies.

Accompanying online materials

The National Curriculum (2014 on) requires that students are able to 'explain how the Earth's features at different scales are shaped, interconnected and change over time'. They are also required to investigate 'geological timescales' in relation to physical geography. However, there is no explicit requirement to conceptualise geographical change within the context of historical understanding. This article will argue that historical change must be seen as an ongoing process.

Figure 1 shows a standard map, regularly found in atlases and used in the classroom, of world biomes. Such maps are extremely useful and communicate clear and effective geographies. However, they are also static representations of a very dynamic world. As Ken Thompson says, in his thought-provoking book *Where do Camels Belong?*, 'The Earth is home to just short of two million species of living organisms. At least, those are the ones we have recognised, described and named. There are certainly many more, maybe up to 10 million, possibly even more. Each of those species has a characteristic distribution on the Earth's land surface, or in its oceans, lakes and rivers … Run the clock back only 10,000 years, less than a blink of an eye in geological terms, and nearly all those distributions would be different, in many cases, very different.'(Thompson, 2015, p. 3)

Changes in species distribution

On this sort of timescale, plant associations are ephemeral. The changing nature of plant distributions can be linked to climate change, both historic and contemporary. Thompson again (2015, p. 16): 'The British Isles are particularly interesting, because sea levels fall dramatically (by about 120m) during a glaciation, creating a land connection between Ireland, Britain and mainland Europe. As the ice melts, Ireland and Britain once again become islands, Ireland significantly earlier owing to the greater depth of the Irish Sea. So there are always species that manage to reach Britain as the climate warms, but fail to reach Ireland, which is why (with apologies to St Patrick) Ireland has no snakes in the present interglacial.'

During the last glaciation, species we now consider native were to be found in warmer climes elsewhere in Europe. 'The oaks, shrews, water voles and (now extinct) bears that live in Britain in the present interglacial spent the glaciation in Spain, while the tawny owls, grasshoppers, newts and alder and beech trees reinvaded from the Balkans.' (Thompson, 2015, pp. 16-17)

Equally, elements of our countryside that we consider British may be quite recent arrivals. The Romans introduced pears, garlic, onions, cabbage, turnip, radish, 'real' apples (as opposed to the

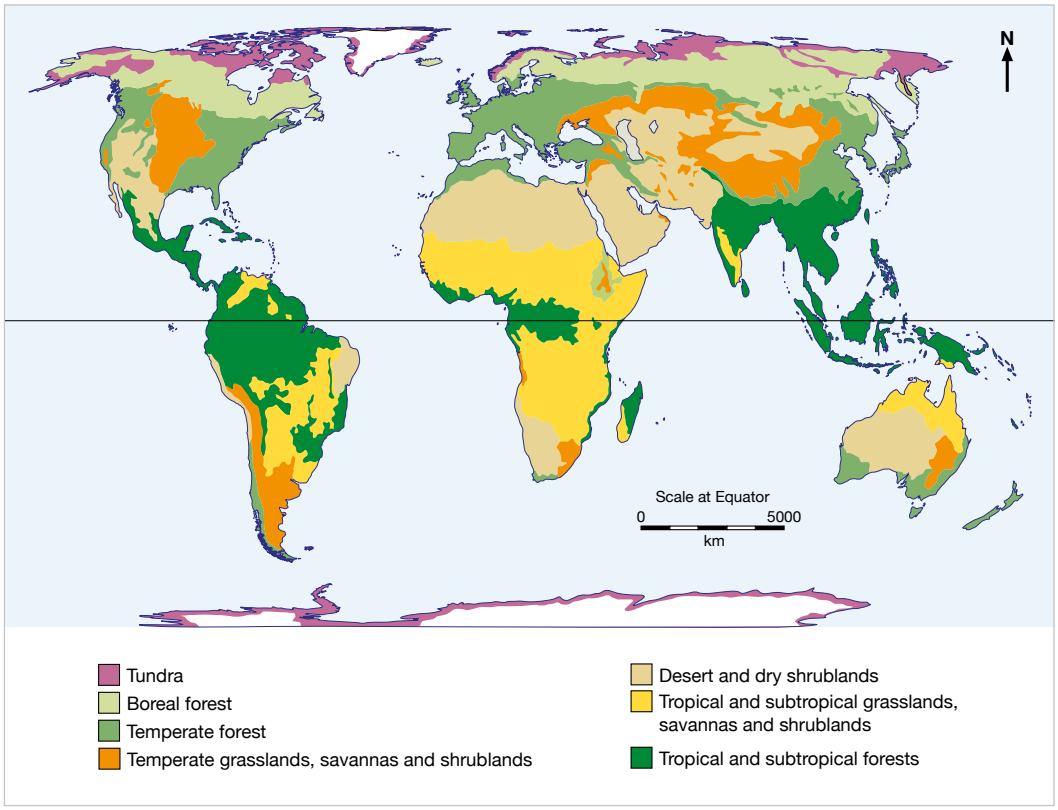

Figure 1: World biomes.
Source: www.carbon-biodiversity.net/content/text/carbon-stored-by-biome.jpg

native crab apple), chickens and rabbits, while medieval introductions include the wallflower, horseradish, chicory and sweet chestnut. Rather curiously, the sweet chestnut is now considered to be an 'honorary native' by the Woodland Trust.

If we then consider some iconic representations of elements of Britishness, the waters become even muddier. For instance, the red rose of Lancashire (*rosa gallica*) came from Central Europe, while the leek, the national symbol of Wales, was brought in by the Romans. If we add in St George being a Turk, it becomes clear that providing an effective historical perspective can deepen geographical understanding significantly.

Invasion biology

A further historical perspective, on ecosystems, provides an effective counter-balance to some contemporary writing in the popular press about harmful 'alien' species invading the habitats of 'native' species. This 'invasion biology' uses militaristic language drawn from the work of Charles Elton (1958), who during the Second World War worked for the Ministry of Agriculture on pest control in the drive to maximise food production. In reality, the threat of invading alien species is overblown. As human populations have grown and trade and travel increased, ever greater numbers of species have been moved between countries and continents. 10 % of all plants imported into Britain go on to escape, to some extent. Of these, 90 % remain 'casuals', surviving only as long as they continue to escape from cultivation; the other 10 % establish self-sustaining populations, and about 10 % of these become pests. In other words, 12,500 have been introduced, 200 have become fully established and between 11 and 39 have become pests (Thompson, 2015).

Few people who visit Britain's countryside when *Rhododendron ponticum* is in flower can comprehend the damage that has been caused to our **native** flora and fauna by this exotic Victorian introduction.

The plant is responsible for the destruction of many **native** habitats and the abandonment of land throughout the British Isles. The reason for this is simple. Where conditions are suitable, Rhododendron will out-compete most **native** plants. It will grow to many times the height of a person, allowing very little light to penetrate through its thick leaf canopy. This effectively eliminates other competing **native** plant species which are unable to grow due to insufficient light. This in turn leads to the consequent loss of the associated **native** animals.

Figure 2: Rhododendron: a killer of the countryside. **Source:** www.countrysideinfo.co.uk/rhododen.htm (The author has added the emphasis.)

One of the most frequently cited successful invaders is *rhododendron ponticum*, which was introduced into Britain in the late eighteenth century. It was planted extensively by nineteenth century gardeners and used as ground cover for the Victorian passion of shooting. Yet it is now reviled in some quarters (Figure 2) while being fêted in others (Figure 3). These changing and varying contexts provide an opportunity to develop a rich understanding of how landscapes develop and the multitude of social and economic influences that create them.

Figure 3: Figure 3: Sheffield Park, Sussex. **Photo:** © Chris Fisher.

Equally, if we take a longer perspective on 'invasive' species, we can question the tone of some of this reporting. Thompson (2015, p. 157) discusses ecological succession in second-growth forests in Ohio, which '… all developed on abandoned agricultural land … it's clear that in the early stages species from Europe and Asia, including Japanese honeysuckle, bindweed, wild carrot and multiflora rose, are both frequent and abundant. But as succession proceeds, all these species become less common. Few remain after 60 years, and after 140 to 160 years not only have almost all disappeared, the few survivors are distinctly uncommon and it's not certain if any of them have a long-term place in mature forest. In other words, the best way to get rid of these species, at least if native forest is your aim, is to ignore them.' Most aliens do no harm at all, and may do some good (in another context, however, the brown tree snake has eaten all the birds on Guam!).

The role of humans

In providing such an historical context, it is also vital that we acknowledge the increasing role of humans in environmental geographies (Rawding, 2018). By some accounts, humans now move more rock and soil than all of nature's forces (water, ice, wind and landslides) combined (Ruddiman, 2007). At the same time, the wholesale transformation of the landscape by humans makes it far less favourable for some species and much more favourable for others. If the former happen to be native and the latter 'alien' how much 'human agency' is involved in the replacement of the one by the other?' (Thompson, 2015, p. 36)

Thompson concludes that this process results in both winners and losers. 'Winners were big, fast-growing, fecund, early maturing plants, well able to cope with the modern fertile, disturbed agricultural and urban landscape. Losers were the exact opposite: often small, slow-growing, long-lived, poorly dispersed and essentially confined to declining fragments of an older, less intensive agricultural landscape.' (Thompson, 2015, p. 118)

The discussion of such issues ensures that the world map of ecosystems shown in Figure 1 should be regarded not as a fixed entity but as a snapshot of the current situation.

Conclusions

If we now consider landscape change over time, it becomes clear that an historical perspective is not only essential but also extremely useful in developing a more holistic approach to understanding geography as an academic discipline (Rawding, 2013; 2014). For example, the Capability Brown-designed landscapes that adorn the parklands of aristocratic estates were a statement of high fashion and the politics of the late eighteenth century, yet they have come to represent a particular view of the English landscape which has been packaged by tourist authorities and bodies such as the National Trust as quintessential England for consumption by domestic and foreign tourists alike. An ahistorical approach fails to appreciate the context within which such landscapes developed.

Adopting an historical approach also offers opportunities to make effective cross-curricular links, not only to history, but also to English literature and art. We cannot treat landscape in a vacuum: it must be considered in the context of relationships between people and the world they inhabit (Cosgrove,1998).

A deep understanding of geography cannot be achieved without understanding change. In turn, change can only be understood in the context of historical processes. As such it is essential that geographers fully accommodate historical approaches when teaching their subject. | **TG**

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Chris Skinner

Riding the (flood) wave: the Flash Flood! desktop application

Chris's Flash Flood! application uses real-world data to simulate the events and impact of a flash flood in a virtual river valley.

Computer simulations are a great way to visualise things which are too rare and/or too inaccessible and dangerous to witness, and a gaming framework provides a relevant and interesting way for students at all phases to engage with them. A flash flood is a particularly rare and potentially destructive event which you would not wish to witness in real life but which can be shown safely via computer simulations. The Flash Flood! application does this and is available in several formats, with free software downloadable for Desktop and Virtual Reality (VR) versions, and also as 360 YouTube videos. It is built using real-world data, based on a real flooding from intense rainfall (FFIR) event, and demonstrates the destructive capabilities of these events. (Figure 1) Flash Flood! was conceived for the Natural Environment Research Council (NERC) FFIR research programme.

The Flash Flood! application

The simulation in Flash Flood! takes place in a small section of a virtual river valley. In the downloadable software, a participant can freely explore this section, walking up the steep valley sides or along the stream. In the YouTube version, the movement is fixed. A three-minute simulation of the event shows a storm building and the water level rising, before a dramatic 'wall of water' sweeps down the valley. The river bed is torn apart, vegetation stripped away, and the devastation is revealed once the flood waters recede. A bird's-eye view of the valley section can be seen using 'drone mode', which is only accessible using the downloadable software and requires an XBox controller.

This is all based on an actual event in Thinhope Burn, a small upland river valley in the South Tyne system (Figure 2). This valley witnessed an FFIR event on 17 July 2007 which dramatically altered the landscape. Thinhope Burn was of interest to geomorphologists because its well-developed series of terraces showed the system's adjustment to past climatic changes. In 2004 Dr David Milan, a geomorphologist from the University of Hull, conducted a survey of the valley using a differential Global Positioning System (dGPS) in a backpack. Without knowledge of the flood, he returned in 2007 to see the valley had changed, and has since been conducting repeat surveys to monitor the catchment's recovery. In 2014, as part of the FFIR project, Dr Milan, Dr Chris Skinner (Hull) and Dr Matthew Perks (Newcastle) conducted a more accurate and precise Terrestrial Laser Scanner (TLS) survey of the valley. Dr Milan's research into this event can be found in Milan (2012).

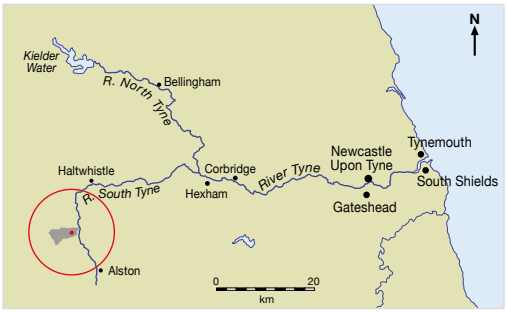

Figure 2: The area of the Tyne river system. The Thinhope Burn catchment area is shaded grey (bottom-left along the River South Tyne), and the area depicted in Flash Flood! is shown by the small red dot.

Figure 1: Screen shot of the Flash Flood! 'wall of water' taken from the 360 video on YouTube.

Figure 3: Contrasting views of the Flash Flood! – before the flood (top) and after the flood (below).

This is of particular significance to geomorphologists because it is very rare to have such data collected so close to a flood, both before and after. This means we can see just how much damage such flooding can cause, and use that knowledge to test and improve the computer models we build to predict these changes. Understanding how catchments recover from these rare and destructive events, and how long it takes, is also important, especially in the light of climate change predictions that intense rainfall events will become more common and more intense.

The initial, pre-flood, scene in Flash Flood! is built using the 2004 dGPS. We worked with indie-games developers BetaJester Ltd who built the data into an immersive gaming environment using the UNITY-3D gaming engine. The post-flood scene was built in a similar fashion using a TLS survey of the valley section. The flood timeline and animation is based on the 2007 event, with water levels based on computer modelling of the flooding. Figure 3 shows the scenes as illustrated in the YouTube version.

The Living Manual

The Flash Flood! desktop is supported by the Living Manual. This includes instructions and comprehensive background information for the software, as well as more detailed scientific explanations (in plain English). It is called 'the Living Manual' as it is intended to be updated regularly rather than by periodic, or iterative, updates. The Living Manual will be populated by FFIR project members, sharing their research in an understandable way.

The software was developed with 'science-interested adults' in mind, to communicate our research in a science festival-like setting. However, the basic function of the software makes it very flexible, and it has found uses outside its original purpose.

Figure 4: How Flash Flood! desktop might be used in the classroom (with thanks to Richard Bustin for his help).

Teaching ideas	
Map visualising	Before students use Flash Flood!, get them to explore the Thinhope Burn valley on an OS map. What would the valley be like to stand in? What is the map evidence for this?
Asking geographical questions	Get students to explore the pre-flood environment. Interrogate the landscape: What is it like? Why? How might it change in the future? What might happen in a flash flood? In advanced classes you could discuss geomorphological ideas of river sensitivity (Milan, 2012).
Landscape descriptions	Students can use descriptive language to explore and describe what they see. What does the area look like, what words can they use to capture the scene? Have them note down details from before the flood (narrow, shallow channel, lots of vegetation to the water's edge, trees near the river, large boulders). Have them compare their notes to the scene afterwards. Was there anything they should have made a note of but didn't?
Assess flood risk	What makes this valley susceptible to flooding? Get students to explore the area then list the reasons for high risk (steep narrow valley, bedrock channel).
Flood experience!	Let the valley flood and get the students to watch the events. They need to write down descriptive words that express how being there must feel. They could think about all senses – what would it sound like, feel like, smell like? Why?
Action plan to escape the flood!	Get the students to imagine they were in the flash flood. How much warning would they have had? What would they do? Where could they go for safety? Some of this can be enacted by moving around the valley. Who could they call for help?
Comparing landscapes	Get students to explore the post-flood landscape and describe the scene. Comparisons can be made to the pre- and post-flood worlds, using comparative language. What destruction has taken place? You can also view Thinhope Burn on Google Earth and use the timeline tool to see actual images of the flood damage.
Down-valley flood	Get students to use OS maps to see where the river flows to. What happens to the wall of water and all of the material it carries? What might the downstream impacts of the flash flood be? Can you see these using the timeline on Google Earth?
Managing the valley: a decision-making exercise	Should we try to manage the valley to prevent flooding (discussion)? If so, what could we do? Should we spend money in this valley, or elsewhere?
Future flash flood discussion	Get students to think how we could reduce the impacts of a flash flood. What could we do? Consider a number of options (plant more trees, widen and/ or deepen the river, build a large dam to hold the water back).

The Living Manual is open to anyone who wishes to contribute – it prompts a few ideas, but we hope that contributors will discover their own ways of using the software and share their ideas, lesson plans, etc. with the community via the Living Manual.

Suggested classroom ideas

The Flash Flood! desktop software is flexible and simple to use, and works best when supporting material provided by the teacher. It can run on most modern PCs and can be controlled using a mouse and keyboard controls, although an XBox controller does open up extra non-vital functionality. The YouTube version just requires an internet connection. Figure 4 provides a few prompts on how Flash Flood! can be used in the classroom.

Getting hold of Flash Flood!

The software is available to download for free from the SeriousGeoGames SourceForge page (https://sourceforge.net/projects/flash-flood/), and it is recommended that you download the Desktop No Radials version. The Living Manual, which contains full instructions, can also be downloaded here; alternatively you can download the Quick Start and Controls files to get going straight away. If you have a PC with the required minimum specification and an Oculus Rift Consumer Model, you can also download the software for the VR version. Not all networks will allow the installation of third-party software.

An alternative to downloading the software is to use the 360 YouTube videos available on the SeriousGeoGames YouTube channel. These can be viewed using any PC with an internet connection. They are best viewed using a smartphone or tablet device, via the YouTube App, where the view can be changed using the device's motion tracking. The video will not work in 360 through a web browser on a mobile device: you need the YouTube app. Narrated and un-narrated versions are available. The video can also be made to work in split screen by pressing the goggles icon in the bottom-right of the video, allowing it to be used with Google cardboard-type headsets.

We would appreciate any feedback on the software, and any comments or pictures we can share via the SeriousGeoGames Twitter and Facebook account would be very gratefully received. You can use the hashtag #ISurvivedtheFlashFlood to share feedback.

Figure 5: Chris Skinner demonstrating the Oculus Rift Virtual Reality headset (Development Kit 2 model shown) with SeriousGeoGames software at the Hull Freedom Festival in 2015. **Photo:** © University of Hull Faculty of Science.

The Flooding from Intense Rainfall project

The Flash Flood! software was funded by a Knowledge Transfer grant from the NERC FFIR project. FFIR draws together several universities, the Met Office and several other organisations in the public and private sectors, and represented in the Flash Flood! project itself are the Universities of Hull, Reading and Newcastle. Experts in meteorology, hydrology, geomorphology and social science are all working together to understand the issues of FFIR.

FFIR events occur primarily in the summer as a result of convective thunderstorms. Convective storms require a lot of heat and moisture to form, and our current models are good at predicting these conditions. However, these storms can last for as little as a few minutes, and fall over a very small area – pinpointing exactly when and where they form is not currently possible. This is why a weather forecast will tell you that an area is likely to experience thunderstorms, but not when and where exactly. The FFIR meteorologists are working to discover indicators which might help us predict these storms more accurately.

Even if we can predict these storms, we still need to know when they might trigger flash flooding. Flash flooding is loosely defined as any flooding which occurs rapidly, so it can refer to both pluvial (surface) flooding, as seen in urban areas when drainage systems are overwhelmed, and also rapid onset flooding from rivers. The rapid onset of flooding in rivers can be very destructive: the flood wave can carry large amounts of sediment, making it much heavier than water alone, and can devastate whole sections of river valleys. This is the focus of the Flash Flood! application.

Weblinks

SourceForge download page: https://sourceforge.net/projects/flash-flood/files/?source=navbar
Flash Flood! YouTube (narrated): https://www.youtube.com/watch?v=23JPhz631Mc
Flash Flood! YouTube classroom version: https://www.youtube.com/watch?v=0WQaq85oQr4
(all last accessed 30/12/17)

Reference

Milan, D. J. (2012) 'Geomorphic impact and system recovery following an extreme flood in an upland stream: Thinhope Burn, northern England, UK', *Geomorphology*, 138, pp. 319–328.

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Duncan Hawley

On shaky ground: the physical facts of recent earthquake events in Mexico

This article explains the physical processes involved in the 2017 Mexican earthquakes and how a greater understanding of earthquake events can help mitigate their effects.

Accompanying online materials

Teaching about earthquakes often focuses on impacts and mitigation, and the physical event itself gets only cursory treatment – a mention of 'magnitude'; the location of the epicentre; a very generalised context within plate tectonics. Earthquakes are often attributed simply to 'plates moving towards or grinding past each other'. However, a deeper consideration of the physical geography 'facts' can help students understand both the impacts of earthquakes and the difficulty of predicting them. In a broader context, studying the physical processes can provide powerful knowledge for evaluating measures of preparedness and influencing the political will required for hazard reduction.

It is worthwhile, therefore, to consider seismic activity more closely and interpret the patterns produced by earthquakes at a regional scale. The two significant Mexican earthquakes of September 2017 (Figures 1 and 2) provide an interesting contemporary case study to illustrate this approach.

Interplate and interslab seismotectonics

Central America is seismically active. The Middle America Trench off Mexico's southern (Pacific) coast (Figure 3) marks the beginning of subduction of the dense oceanic Cocos plate beneath the more buoyant continental North American plate. The plates converge at rates of between 5 and 7cm per year in a north-easterly direction.

As an oceanic plate descends, friction with the overriding plate eventually stops its motion.

The interface between plates is said to be 'coupled and locked', so the oceanic plate cannot continue descending – it gets 'stuck'. However, gravity still pulls on the slab of the oceanic plate. This has two effects:

(i) Along the interface of the plates *compressional stresses* build up in the descending plate. At a critical point the gravitational pull overcomes the friction and the oceanic plate slips, releasing the built-up stress as energy in seismic waves – physical vibrations in the ground. This is termed an *interplate event* and the earthquake rupture is usually characterised by a *thrust fault* where one block of plate is pushed up over the other.

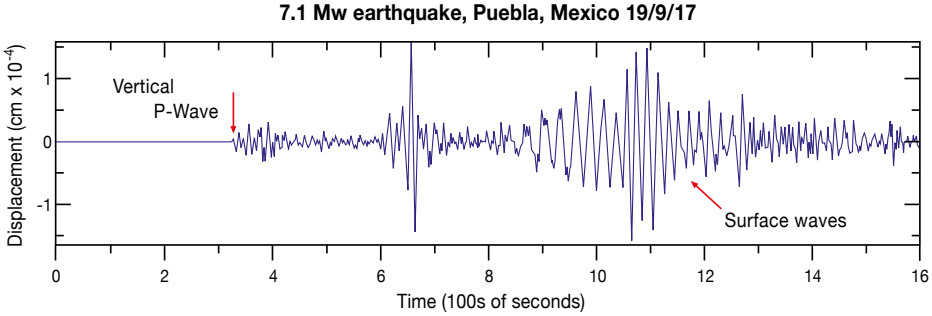
(ii) Gravitational pull also stretches the descending plate slab, building up *tensional stresses* until these exceed its breaking point and it 'snaps', releasing the energy as seismic waves. This is termed an *intraslab event* and the earthquake rupture is characterised by a *normal fault*, where one block of slab drops relative to the other to accommodate the extension of the plate slab.

Seismic waves ripple out from an earthquake *hypocentre* (the point of the initial rupture) in two forms: *compressional (primary or P-) waves* and *transverse (secondary or S-) waves*, producing distinctive shaking movements. Both types are easily demonstrated using a slinky spring. When the energy reaches the surface of the Earth, P-waves cause compressive bumps from below and S-waves a side-to-side motion, but the seismic energy also generates distinctive *surface waves*. These arrive after the main P- and S-waves and only travel at or near the surface of the Earth (Figure 2).

Figure 1: Data for the Tehuantepec and Puebla earthquakes. M_w denotes moment magnitude scale and is now used instead of the Richter scale to describe magnitude.

Event	Date	Time (local)	Location (Lat./Long.)	Magnitude	Depth (km)	People affected	Fatalities
Gulf of Tehuantepec	7/09/2017	23.49	15.068 -93.715	M_w 8.1	69.7	844,000	98
Puebla	19/09/2017	13.14	18.550 -98.489	M_w 7.1	51.0	35,000	369

Figure 2: Seismic trace of the Puebla earthquake, 19 September 2017. **Source:** University of Wisconsin, Milwaukee.



They are slower than the other waves and can be the most destructive, because the amplitude (height) of surface waves is relatively large and their motion makes the ground appear to roll along, lifting and dropping as they pass. Moreover, surface waves change in amplitude and velocity depending on the density of the bedrock they travel through. In weaker (less rigid) rock they slow down and increase in height. These different shaking intensities create different impacts.

Mapping earthquake patterns on and in the ground

Mapping the distribution of earthquakes helps to identify seismically active zones and also informs our understanding of the plate processes within a region. 'Model' subduction zones are recognised by a linear belt of significant earthquakes running approximately parallel to the (offshore) trench, with the hypocentres of the earthquakes becoming progressively deeper further away from the trench. The shallowest earthquakes, dominated by interplate events, occur down to the base of the overriding plate (between 50km and 70km). Deeper earthquakes are intraslab events, occurring as the descending plate slab slips into the mantle below the continental plate up to a depth of around 400km (and sometimes deeper). On the surface this is reflected in an earthquake belt that is generally around 800km wide (depending on the angle of subduction).

Magnitude measures the energy released by the earthquake, calculated using the size of the seismic waves, the amount of ground deformation and the area of the rupture, factoring in the resistance of the affected rocks. The result allows the 'size' of the earthquake to be described as a number between 1 and 10 on the *moment magnitude scale* (Mw). Shallow (interplate) earthquakes tend to be of a magnitude between 4.0 and 5.5 whilst the magnitude of the deeper (intraslab) earthquakes tends to be higher, between 6.0 and 8.5 or greater.

It is easy to understand that higher magnitude earthquakes have greater energy release and can potentially affect a much larger area. However seismic energy is lost (by absorption and scattering) as it travels through plates, so that physical effects decay with distance from a hypocentre; consequently shallow, lower magnitude earthquakes can be more damaging than deeper, higher magnitude events.

In Mexico, mapping earthquake distribution reveals a pattern that does not neatly fit a classic 'model' subduction zone (Figure 4.)

The coastal events are mainly compressional, low-thrust earthquakes rupturing at depths of between 20km and 60km, characteristic of interplate events. They are interpreted as being caused by the release of stress that has built up by coupling and locking along the plate slab interface/boundary as the Cocos plate subducts at a shallow angle.

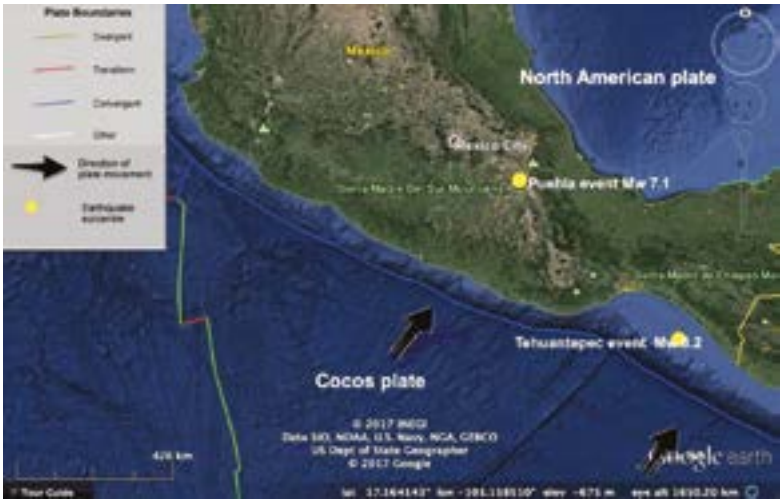


Figure 3: Image of southern Mexico showing plates and epicentres of the September 2017 Mexican earthquake events. The Middle America Trench is easily identified off the southern coast. **Source:** Google Earth.

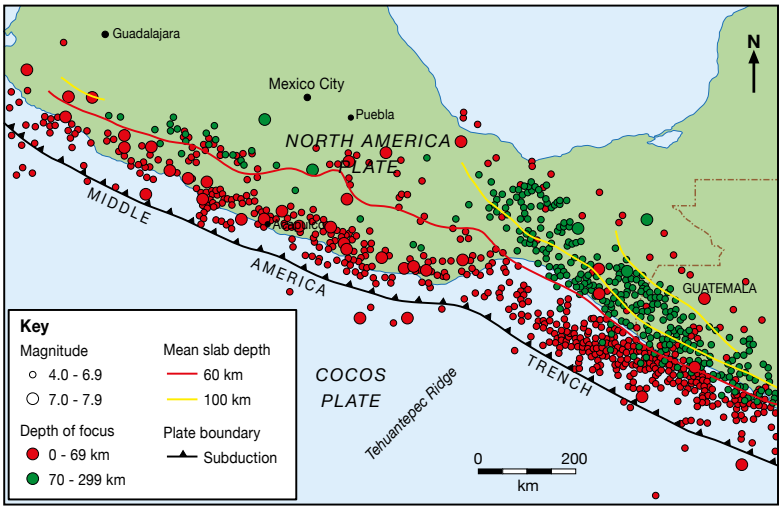
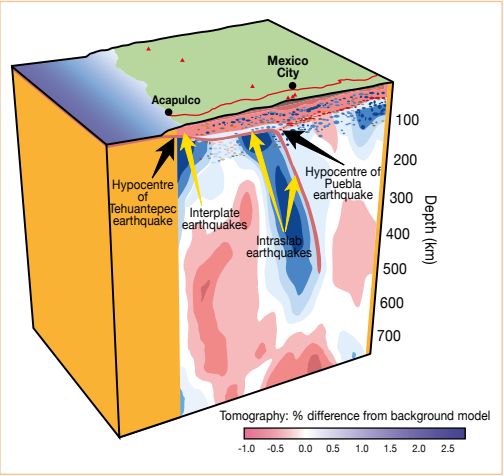


Figure 4: Plots of earthquake epicentres, depths and magnitudes, Mexico 1900–2010. **Adapted from:** *US Geological Survey Open-File Report 2010–1083-F* (http://pubs.usgs.gov/of/2010/1083/f/).

Further inland the pattern shows a belt of slightly deeper, slightly higher magnitude earthquakes rupturing at depths of between 60km and 100km, producing normal (tensional) faults and located up to 350km from the trench. However, very few earthquakes occur beyond this 'limit'. This pattern is interpreted as caused by the Cocos plate slab 'flattening out' under the North American plate as far as the centre of Mexico, before plunging deep into the mantle. As it does so it stretches the flatter portion of the slab which ruptures along internal weaknesses, leading to intraslab earthquakes and normal faulting.

The Tehuantepac event of September 2017 bears the hallmarks of an intraslab earthquake. At 70km down the rupture ripped up through the Cocos plate before stopping at about 40km depth, likely at the plate interface. At a depth of 51km the Puebla event was just below the plate slab boundary, which suggests an interplate event, yet the hypocentre was 300km from the subduction trench and the rupture developed as a normal fault: both characteristics of an intraslab event. This puzzle is explained with the help of seismic tomography (Figures 5a and 5b), which reveals the earthquake hypocentre as located where the Cocos plate plunges more steeply beneath the North American plate, causing tensional stress to build up at the bend in the slab: ripe for rupturing.

Figure 5a: Tomographic block diagram showing the subduction of the Cocos plate beneath the North American plate. The brown line shows the slab of the Cocos plate; blue areas are denser, cold material and pink indicates less dense (warmer) areas.



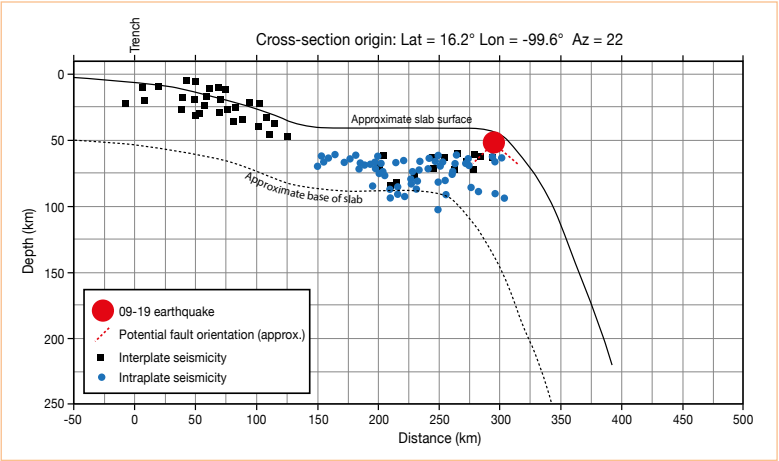


Figure 5b: Cross-sectional diagram showing the subduction of the Cocos plate beneath the North American plate, indicating the location of the September 2017 intraplate ruptures.

Seismic gaps

Mapping segments of a plate boundary that has ruptured in the past indicates where no recent seismic activity has taken place. These segments are more likely to have built up a high level of stress, ripe for release as an earthquake, and it is thought that these 'seismic gaps' indicate the location of future earthquakes and are therefore potential hazard zones. Two seismic gaps can be identified in the coastal earthquake belt of Mexico: the Tehuantepac gap and the Guerrero gap (Figure 6).

The Tehuantepac event struck just outside the Tehuantepec gap but more than 1000 aftershocks have been recorded in the gap itself. These may have been strong enough to release stored energy, which would make future earthquakes less likely in this area. At over 900km, the distance to the Guerrero gap is too great for stress transfer to 'jump'. Similarly, the Tehuantepac rupture on 7 2017 September did not trigger the Puebla event on the 19 September 2017 as the stress transfer zone would have been a maximum of 400km and the epicentres were over 650km apart. Mexico's particular tectonic setting indicates a serious threat of the next earthquake being an interplate rupture occurring in the Guerrero sesimic gap: this is therefore closely monitored, not least because of its proximity to Mexico City.

Tsunami hazard

Offshore earthquakes can result in tsunamis. The offshore Tehuantepac event triggered a tsunami warning; however, in the event the waves were smaller than anticipated, measured at only 1.75m above high-tide level because significantly the earthquake rupture did not break through to the seabed. As an intraslab event the rupture did not cross the plate interface and continue up to the seabed and this would undoubtedly have limited the height of the tsunami.

Shaking intensity

Reports of shaking compiled into isoseismic maps show the distribution of shaking intensity: where there are differences from the expected concentric distance-decay pattern these can help identify areas more vulnerable to impacts due to the ground conditions.

Ground conditions played a significant part in the shaking experienced in Mexico City. The capital is built on unconsolidated sediments (sand and clay) of an old lake bed, so even though it is some distance from the epicentre the capital (and some other areas) experienced slower and higher seismic surface waves than in the surrounding regions of more solid rock. Figure 7 shows high shaking intensity in these 'outliers'.

In the Puebla earthquake at least 45 buildings in Mexico City collapsed, trapping people in the ruins and resulting in 228 fatalities. In the towns of the surrounding provinces old churches collapsed, killing 26. Even so, the damage was not

Figure 6: Rupture zones and seismic gaps along the southern Mexican coast. **Adapted from:** www.sciencemag.org/news/2017/09/unusual-mexico-earthquake-may-have-relieved-stress-seismic-gap

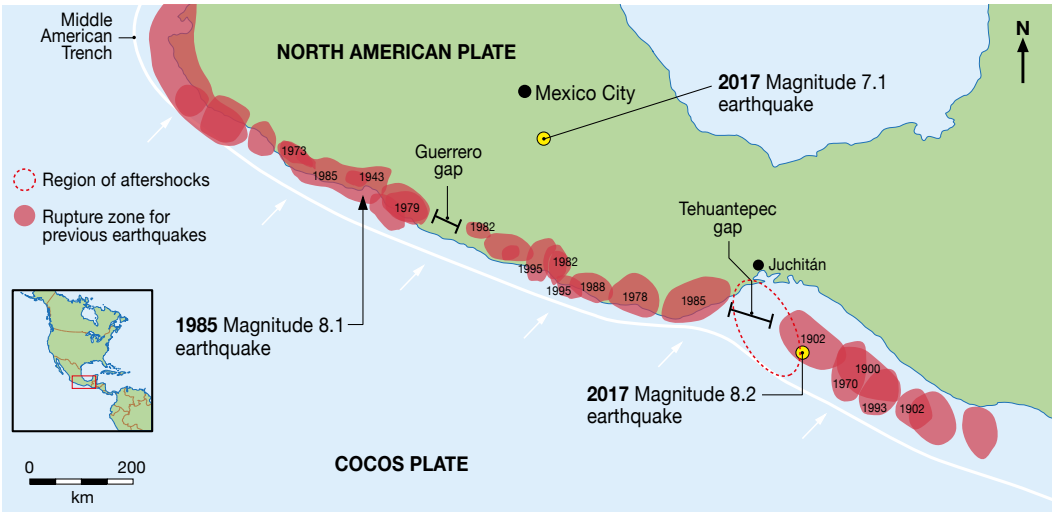


Figure 7: Shaking intensity map of the Puebla Mw 7.1 earthquake showing a 'distorted' pattern with outliers of high shaking intensity. **Source:** https://earthquake.usgs.gov/earthquakes/eventpage/us2000ar20#map

on the same scale as the 1985 Mw 8.0 Michoacán earthquake that struck the capital on the same date 32 years previously: this killed c.10, 000 people. Subsequently, new regulations and investment in earthquake-proofing included engineering buildings to withstand back-and-forth accelerations of surface wave motions and strengthening older buildings to resist shearing and collapse (policy and regulations updated in 2003). To help first responders locate victims, satellite images are now used to map areas of likely damage. Mexico's Seismic Alert System (SASMEX), designed to shut down rail and traffic movements and the operation of machinery, uses over 100 seismic stations to detect earthquakes and trigger warnings via mobile phones. There was only 20 seconds' warning of the Puebla event, but this was sufficient for people to put earthquake drills into practice. City-wide earthquake drill is practised each year on the anniversary of the 1985 event, so people had been through the drill earlier in the day, and this probably reduced the fatality and casualty rates.

Summary

The complex and variable nature of the effects of differing events can be attributed to a number of contributing factors:

- the seismotectonic setting
- the highly variable nature of the hazard distribution, chiefly ground conditions and shaking intensity
- the population exposure
- the vulnerability of the built environment
- the resilience of the communities affected.

The 2017 earthquake events in Mexico are useful case studies to illustrate this complexity and variability and also to suggest how an understanding of the regional tectonic setting and physical factors underpinning earthquakes can help reduce their impact. | **TG**

Further reading

Video explanation of P-wave, S-wave and surface wave motion: www.iris.edu/hq/inclass/video/seismic_waves_p_s_and_surface

Video animation and explanation of P-, S- and surface wave motions through different surface materials: https://www.iris.edu/hq/inclass/animation/buildings__bedrock_effects_of_amplification__liquefaction

https://earthquake.usgs.gov/learn/topics/measure.php

Seismic events in Mexico can also be accessed via a Google Earth interactive map at: http://d32ogoqmya1dw8.cloudfront.net/files/sp/library/google_earth/examples/usgs_5.v2.kmz

www.jpl.nasa.gov/spaceimages/details.php?id=pia21963

www.iitk.ac.in/nicee/wcee/article/13_9002.pdf

Video on the Michoacán earthquake and subsequent earthquake mitigation actions: www.iris.edu/hq/inclass/animation/mexico_earthquakes__tectonics

www.bbc.co.uk/news/av/world-latin-america-11379041/millions-practise-mexico-city-quake-drill

(all last accessed 31/12/17)

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Fred Martin

From the archive: does anyone really study countries?

Fred reflects on the changing challenges of teaching about countries and the difficulties of striking a balance between breadth and depth.

Accompanying online materials

Introduction

My aim is to identify and reflect on how articles in past editions of *Teaching Geography* have dealt with studying countries. The question raised in the title alludes to whether such articles deal with a study of the country as a whole, or whether the country forms a case study backdrop for geography's topics, themes and issues. I also consider how countries are selected for study, and the tension between achieving depth of understanding, and achieving breadth of knowledge.

A country in parts

In 1981 the title of an article about Northern Ireland (Wills, 1981) included the phrase 'A divided country'. This was odd, because Northern Ireland is not a country by any international legal definition, i.e. it is not a separate member of the United Nations or a separate member of the EU. Confusion as to how to refer to the different parts of the UK is still evident: words such as 'country' and 'nation' are often used interchangeably to describe Scotland, Wales and England.

Figure 1: Unite for Europe march, London, 2017.
Photo: Ed Everett (CC)

Rationale and resources

Also in 1981 an article about Japan (Blease, 1981) provided a rationale for choosing a particular country to study. The rationale here was Japan's economic importance and its suitability as a context in which to study a range of topics. The focus, however, was on resources rather than on ideas for teaching about Japan as a whole. Studying Japan for the A level 16–19 syllabus was also the focus of a 1990 article, where again, it was seen as a useful platform from which to study topics such as natural hazards, pollution, urbanization (Bunce *et al*., 1990).

The political dimension

Serf and Hoyte (1988) explored the part that a political understanding can play when studying a country. The article took human rights in South Africa as its focus, building on comments by Sir Keith Joseph that geography could be a political and value-laden subject. This approach contrasted with the formulaic way in which countries had been taught some twenty years previously, i.e. via a set list of topics: the country's physical geography, its population and its economy. An emphasis on human rights encouraged students to think about the underlying political processes that affected the country's geography, and especially aspects of its population distribution.

Prescription and selection

The first national curriculum introduced by the 1988 Education Reform Act brought an abrupt halt to teachers' freedom to teach the countries they felt were appropriate and could resource. The study of selected regions within countries was also made compulsory.

Regions are mostly fluid geographic constructs rather than political entities with set borders, and this can make them hard to identify and define. Despite this, the national curriculum prescribed the study of large-scale but manageable areas that it referred to as regions. Comparisons were to be made between countries and between regions in a country; an unwitting effect being that the selection of countries to study was channelled into extremes in which stereotypes were created.

To help teachers update their knowledge, *Teaching Geography* commissioned articles that were mostly written by university-based academics with particular expertise in the prescribed countries. In one 1992 article by Russell King, Italy was said to be a good country to study because its regional contrasts were the greatest. However, he also noted the danger of making sweeping generalizations about a country and its regional differences. Similar articles were

written on Germany (Wild, 1992), Spain (Naylon, 1992), France (Scargil, 1992), Nigeria (Binns, 1993) and Brazil (Momsen, 1994). Implementing this element of the national curriculum in the classroom would present a challenge.

Planning to teach

In 1992, a description of a unit of work on France and two of its regions set out what could be achieved within a 10-hour time allocation (Smith, 1992). The general geography of France was to be taught in two hours. The work also involved studying two topics that seemed to be well illustrated in France, i.e. industrial change and the Channel Tunnel. All lessons were tightly linked to specific Statements of Attainment, creating, one might argue, a new type of formulaic approach, though its content was selected to represent key topics and themes as relevant for the country.

Smith's article should serve as a reality check to Ofsted and others, who have often insisted on both breadth and depth of study in a subject in a very limited time. The number of countries in the world, without even considering the regions within them, creates a conflict between breadth and depth that is hard, if not impossible, to resolve.

The country toolbox

An article in 1993 comparing the 'superpowers' (listed as the USA, CIS and Japan), provided a variety of teaching strategies for key stage 3 geography (Maynard *et al*., 1993). It also suggested how students could make links between data so that relationships and explanations within the countries could be explored. This ensured a degree of academic rigour that moved the students beyond simply identifying and describing the similarities and differences between them.

In 1995, Graham Ranger warned about the danger of superficiality when studying a country. His key recommendation was to adopt an enquiry approach, i.e. by asking key questions about topics and themes as relevant to each country. There was also guidance on how to go about selecting countries to study, taking the long view in order to achieve some kind of rational coverage throughout a student's education.

A further article on how to teach about a country appeared in 2001 (Dinkele, 2001). Although the article focused on Namibia, its ideas had wider applications. It suggested that the study of Namibia – or any country – should not be introduced until year 9. Only by that age could students be starting to understand the totality of themes and topics involved, even in a country with as few perceived complexities as Namibia. This article was also rich in providing teaching methods that would be appropriate for students of this age.

In 2011, the year of revolution that led to 'the Arab spring', Egypt provided the context for an article on 'changing representations' (Kennedy, 2011). Students used resources to challenge stereotypical views and to reach a more rounded understanding of Egypt's people and their standard of living, emphasizing the 'excitement and uniqueness of distant places'. This article represents a rare example in *Teaching Geography* of studying a country currently appearing in international news.

Stay current

In 'Sampling the world' (Hopkin, 2011) John Hopkin reflected on issues relating to choosing countries to study. He warned of the danger that places, including countries, could become 'largely a backdrop' to geography's themes, topics and issues. He also warned of the problems of negative stereotyping that can arise when a country is only used to illustrate a particular issue. A broader problem is that sampling of countries can militate against achieving a 'coherent framework' in a student's place knowledge. He further warned that geography's old models in relation to economic development and the classification of countries need to be constantly updated to reflect changing data, especially in relation to indices of development. He notes the expectation that students know 'where places are and what they are like' that has gained traction in recent years.

Since 2011, there have been few articles with one or more countries as their focus. Amis (2015) studied aspects of population in Russia, mainly because of its inclusion in the most recent national curriculum document. Lowe (2016) gave short descriptions of each of the BRICS countries. Kyndt (2015) considered the part played by borders between countries, making for an interesting, if limited, theme.

Country reflections

Studying countries should afford opportunities to study distributions and interactions between topics and themes over large areas; however, whether this has often taken place is arguable. Perhaps this is a step too far for the majority of key stage 3 students.

Choosing countries to study also remains problematic. Studying countries at the centre of news events would help keep the subject relevant, but evidence from the published articles suggests that this is generally not a priority. Perhaps teachers of geography are more constrained by narrow learning objectives and the time needed to create new resources; or perhaps the issues are too complex to be handled within one traditional subject.

As they struggle to meet the demand for both an encyclopaedic knowledge of countries and capitals, and the academic rigour needed to understand the concepts and processes at work in a fast-changing geopolitical environment, teachers will still have to make uneasy choices between depth and breadth of study. | TG

Online resources
The online resources contain a full list of the *Teaching Geography* in this article

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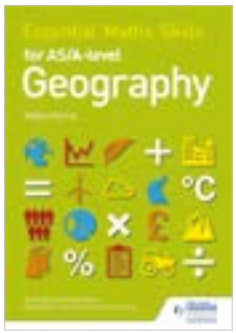
Reviews

Reviews of new geography resources.



BOOKS

Essential Maths Skills for AS/A-level Geography

Helen Harris
ISBN: 9781471863554
£10.99, Hodder Education

This useful and timely book is part of a series of essential maths skills books in all major subjects, reflecting the increased emphasis on quantitative skills in the 2016 A level specifications. The book has a matrix matching contents with all the awarding bodies, and the contexts in the book link to both core and option topics. There is also support for fieldwork skills and the NEA (independent investigation), both of which have a statistical element to them.

The book includes a series of exercises, which guide students through an understanding of data, before exploring measures of central tendency, dispersion, concentration and correlation. Much here will be familiar to those of us who have been teaching for a long time, but the key audience here will perhaps be students and teachers who are new to data handling skills, or those who want reassurance that they are approaching these skills in the right way. Statistical testing is covered, and there are some exam-style practice questions.

Worked examples for each skill are followed by guided questions or practice questions. The geographical applications of each statistical technique are outlined at the end of each topic. Teachers might use the exercises as class activities or homework tasks. A copy of the book and a visualiser would make a useful pairing to take students through the stages of completing particular exercises, before providing them with an activity to complete independently. A web link is printed on every page giving access to a PDF of answers to all the exercises, which might be accessed by unscrupulous students, and could perhaps have been included more discreetly.

One of the book's appendices has a useful flowchart matching contents to statistical methods that are relevant to geographical fieldwork.

This is a very useful and focused book. It achieves its goals well by providing a stand-alone set of exercises, which could also be slotted into the teaching of relevant specification topics if that approach is preferred.

Alan Parkinson is Head of Geography at King's Ely Junior. He edits 'Webwatch' for the GA Magazine, is a Primary Geography Champion for the East of England and is a member of the GA's Secondary Phase Committee.

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Coasts
Debbie Milton and Gerd Masselink

Coasts are a very popular option within the 'Landform systems' compulsory core of all four A level specifications. Given that only a few of the world's countries do not have a coast, they are areas of global importance – economically, socially and environmentally. This book will help move your thinking to a higher level by placing coasts within a scientific systems-based approach. It considers coastal systems and processes, rocky and depositional coasts, sea-level change and coastal response, and coastal management.

Glaciated Landscapes
Richard Waller and Peter Knight

This book identifies the key geographical issues that can be explored through a case study of glaciation. It describes the different types of glaciers, explores the mechanisms of glacier motion, considers specific landforms, landscapes and landsystems associated with different glacial environments, and describes how processes and materials in glacial landsystems can create both opportunities and hazards for humans.

Emerging superpowers: India and China (second edition)
Gill Miller

This new edition has been fully updated to meet the requirements of the 2016 A levels in England and Wales. It considers issues such as the rapid economic growth of both countries, the implications for people and the environment, the shift from rural to urban populations, and each country's role in global geopolitics. The book will also provide background reading for those undertaking individual investigations on international geopolitical change.

ALSO IN THIS SERIES

Changing Places
Emma Rawlings Smith, Simon Oakes and Alastair Owens

This book covers core content for all four A level specifications. It considers how meanings and representations attached to places help shape human actions and behaviours that affect places, and discusses how relationships that exist between people, economy, society and environment can explain why places are constantly changing.

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