HOW CAN STEM BE ENHANCED BY GEOGRAPHY?
Invitation for Papers and Notes for Contributors

An Invitation to Share

- *Geographical Education* is a refereed journal. Articles submitted to *Geographical Education* for consideration in the Refereed Articles section are reviewed anonymously by a minimum of two referees. Articles are selected by the Editor based on the outcome of the anonymous reviews and ratified by the Editor. Authors of accepted articles are sent guidelines for their final submission. Contributions to other sections such as Book Reviews and Reports are not refereed. The ISSN for *Geographical Education* is ISSN 2204-0242.

- We invite your participation in producing this journal. *Geographical Education* encourages school and university teachers and all others interested in geography to share their ideas and experiences in order to promote sound practice, innovative strategies, modern developments and reflection in geographical education.

- Contributions of varying length are invited, with a maximum of 5000 words for major articles and research reports. Shorter articles of 2000 words, featuring classroom strategies, reflections on particular issues and practices in geography teaching, inservice education workshops and comments on previous articles are especially welcome.

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Welcome to the 2021 edition of *Geographical Education*. This edition is one outcome of the Australian Geography Teachers Association’s (AGTA) work around actioning a recommendation from *Shaping Australia’s Future: A strategic plan for the discipline of geography*. This recommendation centred on recognising geography as a partial STEM subject, and hence the title for this year’s journal is *How can STEM be enhanced by geography?* Susan Caldis as STEM Ambassador for Science and Technology Australia co-hosted national symposia with Dr Grant Kleeman to initiate dialogue with leaders from the discipline about the geography and STEM recommendation. As a result, Susan was invited to be Guest Editor for this edition of the journal.

I would like to thank Susan for accepting this invitation, updating the geography community on where this work is at, and providing the network of authors who kindly accepted to contribute to this publication.

This volume contains four papers from a variety of people engaged in STEM-related activities in geography. The first paper by Caldis and Kleeman outlines the background to the STEM project in geography and reports the findings from the symposia held over the last year. These findings include conceptualising geography as the *science of place*, recognising the connection and contribution that geospatial technologies could offer STEM, and various mechanisms to make geography in the STEM field more visible (for example, this edition of the journal). Caldis and Kleeman offer several recommendations for action in this space in terms of learning, teaching and research as well as other visibility mechanisms such as the appointment of a Chief Geographer. This paper also details the presentations at the symposia – and the next two papers in this edition are published outputs from those presentations.

**GeoSTEM: “The Urban Mess” Interdisciplinary Learning in a Project-based Learning High School Environment** by Parnis and Hendry, teachers at Parramatta Marist High School. The article showcases a geography STEM integrated initiative at the western suburbs school in Sydney. This project focuses on issues of urbanisation, sustainability and design within a local context, in line with the New South Wales syllabus Stage 5 Changing Places. Specifically, students explored data, statistics and processes associated with population projections and considered engineering and technological advancements that allowed sustainable urban designs for the future. This initiative is an example of real-world problem-solving which engaged students and showed the complementary nature of geography and STEM.

The third paper is written by Dr Kate Selway; Superstar of STEM, Senior Lecturer and Australian Research Council Future Research Fellow at Macquarie University. Selway, coming from an earth scientist perspective, advocates for geography to be part of STEM for three reasons: (1) it would help students pursue and achieve their own goals; (2) it would help interested students find fulfilling careers in areas of national skills shortages; and (3) it would help develop a population and future leaders who will make successful and well-informed decisions. In relation to the first reason, Selway is particularly interested in how mathematics and such geographical skills, such as geographic information systems (GIS) and online mapping tools, can be integrated to solve problems. She maintains that, in a world where big data is prevalent, having these STEM/geographical skills would be fruitful. In the second reason, Selway points out the unique skills geographers have which, when combined with STEM skills, could rectify shortages in our workforce in such fields as environmental monitoring, mineral exploration, and geospatial science. And lastly, how individuals with STEM/geography backgrounds can not only be active global citizens but become the decision-makers for the future.

The last paper was an invitation extended to Professor Graciela Metternicht – Chair of the National Committee for Geographical Sciences. This paper by Teece et al. showcases a project (Copernicus for Sustainable Agriculture in...
Australia or COALA) that promotes the adoption of satellite earth observation products and services for sustainable agriculture in Australia. In this project researchers, curriculum developers and teachers co-designed activities tailored to specific educational outcomes of the New South Wales syllabus. This is an example where the newest technologies from the European Space Agency aided the development of problem-based learning activities for the classroom. In this paper, the authors encouraged getting new scientific research into high school curricula for the benefit of all stakeholders.

Many thanks to both the writers of the papers and the book reviews. Many thanks also to Geoffrey Paterson as proof-reader and Reviews Editor of the current volume. The book review titles reflect a range of topics in geography that teachers and researchers alike should find useful and interesting. AGTA looks forward to contributions to the next edition of the journal Volume 35, 2022. Details will be forthcoming.

A note from Susan Caldis, Guest Editor

Geographical Education is the peer-reviewed journal of the Australian Geography Teachers Association. Over the years, each editorial team enables important international and national debates in geographical education to be showcased by a range of scholars.

Since 2018, Associate Professor Terri Bourke and Associate Professor Rod Lane have worked tirelessly to bring rigour, relevance and diversity to the forefront of each edition. Themed sets of papers which span empirical, theoretical and personally reflective domains are carefully curated to promote dialogue and challenge readers to consider their thinking and practice in and about geography education. In 2018, the focus was on assessment; in 2019 on innovation as Geographical Education celebrated its 50th year. In 2020, the cross-curriculum priorities of the Australian Curriculum were given prominence in a geography education context while in 2021 the spotlight is given to geography and STEM.

This year, it has been a pleasure to take on a Guest Editor role and work alongside Terri. I am immensely grateful for the opportunity to learn, and to continue the journey of a recommendation for geography education in Geography: Shaping Australia's Future. To see symposia presentations take on a new form as a publication offers further reach and opportunity for dialogue about the future of geography education.

In signing off my Note from the Guest Editor, I would like to do so in my recently acquired role as AGTA Chair. On behalf of the AGTA Board, I would like to extend our sincere appreciation and gratitude to Terri and Rod for their years of service to the journal. In 2018, Terri and Rod commenced their term as co-editors of Geographical Education. In 2020 Rod departed Australia and academia to pursue new career opportunities in New Zealand. Terri continued to lead the journal during 2021, however, this edition does conclude the “Terri and Rod era”. Terri and Rod embraced the co-editor role as a team. With their combined vision, scholarship, and professionalism, they have greatly enhanced the quality, relevance, and visibility of Geographical Education. Thank you for your leadership of the journal, your collegial approach, and for your sustained interest in the work of AGTA. As a Board, we wish each of you every success in your future endeavours and look forward to new opportunities for our paths to cross.
Recognising Geography As a Partial STEM Subject: The Journey So Far

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Abstract

In 2018, the National Committee for Geographical Sciences released *Geography: Shaping Australia’s Future: a strategic plan for the discipline of geography*. Throughout the strategic plan, the contribution of geographical understanding and research to Australia’s environmental, economic, and social wellbeing is made clear, and a series of recommendations unfold to guide future directions and planning for the discipline. The Australian Geography Teachers Association (AGTA) took leadership of actioning the recommendations from Chapter 13, “Geography in Australian Schools”. The purpose of this paper is to report on the context and journey so far for the recommendation about geography as a partial STEM subject, including the outcomes from a recent national symposium.

Context and journey so far

*Geography: Shaping Australia’s Future* includes a chapter entitled “Geography in Australian Schools”. The chapter highlights the importance and contribution of geography education, an overview of geography in the Australian Curriculum, and the importance of subject knowledge in geography including within teacher education. Recommendations in the chapter include advocating for geography to become core learning up to Year 10 at a national scale, improving the provision of geography methodology units in initial teacher education programs, building awareness about the extent and implications of out-of-field teaching in geography, developing a case for geography to be recognised as a partial STEM subject, and strategies to increase collaboration between school and university geography.

To develop a case for geography to be recognised as a partial STEM subject, the authors of this paper devised and embarked upon a three- to five-year plan of dialogue-creation and awareness building with key stakeholders from within the discipline which is still underway and from which outcomes are still emerging. Once complete, the intent is to synthesise outcomes in conjunction with the literature to present a case to Ministers for Education about the recognition of geography as a partial STEM subject in a school setting.

The three- to five-year plan includes the publication of journal articles (2018, 2019), participation in Science Meets Parliament (2019 and 2022), design and conduct of a national symposium (2020), design and conduct of a national series of conference sessions (2021–2022), provision of feedback to curriculum authorities during curriculum review processes (2020–2021), and a special issue of a journal, such as *Geographical Education*, to focus on geography and STEM (2021). Whilst each item in the plan has occurred or is currently underway, pandemic-related disruptions have delayed the conduct of a national series of workshops although one workshop was held in New South Wales during May 2021.

The national symposium was important for bringing the discipline together to discuss views and advice about the recommendation for geography to be recognised as a partial STEM subject. The national symposium was generously funded by the Institute of Australian Geographers (IAG), the Geographical Society of New South Wales (GSNSW) and the Australian Geography Teachers Association (AGTA). The National Committee for Geographical Sciences (NCGS) wrote to the authors of this paper in their support of the symposium and ensured their attendance and contribution to the debate during discussion time.

The following report from the national symposium was endorsed by the Councils of IAG, GSNSW, AGTA, and NCGS between December 2020 and May 2021. Each presenter from the symposium has verified the capture of their speech or presentation as an accurate capture.

The authors of this paper, who were also the conceptualisers and hosts of the national symposium, commend to you the following report – *Report from the national symposium: The visibility of Geography in the STEM field and...*
its contribution to STEM education. To conclude the paper, there is an update about actions arising from the symposium and an outline of a way forward to continue the dialogue-creation and awareness building about geography as a partial STEM subject.

Report from the national symposium: The visibility of Geography in the STEM field and its contribution to STEM education

1. Executive summary
A national online symposium, entitled The visibility of Geography in the STEM field and its contribution to STEM education was envisioned and enacted as part of a planned response to a recommendation of the strategic plan Geography: Shaping Australia's Future (National Committee for Geographical Sciences, 2018).

The National Committee for Geographical Sciences (NCGS) and Australian Geography Teachers Association (AGTA) develop a case for submission to the Ministers of Education for geography to be recognised as partially a STEM subject (NCGS, 2018, p. 87).

The symposium was conceptualised as a repeat series for manageability in an online form; it was jointly funded by the Australian Geography Teachers Association (AGTA), the Geographical Society of NSW (GSNSW) and the Institute of Australian Geographers (IAG). There were four symposia held with a repeat program. From here-on, unless otherwise indicated, the series of symposia is referred to as the symposium.

Ninety delegates attended overall. The purpose of the symposium was to initiate a national dialogue with discipline leaders to determine areas of concern and opportunity around the Geography and STEM recommendation. The symposium discussion was framed by three overarching questions which helped inform the contributions made by a range of invited speakers. The main points arising from the symposium discussion include the need to view the discipline holistically; the need to enhance the discipline’s visibility by branding and promoting it as the “science of place”; and advancing the argument that Geography makes an important contribution to STEM. There are two recommendations for further action, each accompanied by a range of possible strategies.

2. Background
Geography: Shaping Australia’s Future (National Committee for Geographical Sciences [NCGS], 2018) is the strategic plan for the discipline. Chapter 13, “Geography in Australian Schools”, identifies a series of recommendations to promote the subject and assist with its future positioning in the context of school education, initial teacher education programs, curriculum development, career pathways and the connection to the discipline at the university level. One of these recommendations relates to Geography and STEM.

The recommendations in Chapter 13 are being actioned by Directors of the Board from the Australian Geography Teachers Association (AGTA). In 2019, Susan Caldis and Dr Grant Kleeman, who also hold respective roles as a STEM Ambassador for geography education and Member of NCGS, co-authored an advocacy and awareness-raising paper about Geography and STEM. In 2020, Susan and Grant conceptualised and co-chaired an online symposium where discipline leaders had the opportunity to discuss areas of opportunity and concern about Geography and STEM.

The symposium operated as a three-hour, repeat-program series, offered on four separate occasions via Zoom in October and November 2020. Discipline leaders from the academy and school-based geography education were invited.

Three overarching questions provided a structure for comment, advice and reflections. The symposium program included an opening address, a panel session and a group discussion.

Three professional associations generously provided financial sponsorship of the symposium: AGTA, GSNSW and IAG.

3. Aim/Rationale
The visibility of Geography in the STEM field and its contribution to STEM education was a national online symposium, envisioned and enacted as part of a planned response to raise awareness about a recommendation in Geography: Shaping Australia’s Future (NCGS, 2018). The recommendation called for the development of a campaign to have Geography to be recognised as a partial STEM subject (NCGS, 2018, p. 87).

In response to this recommendation, the national symposium aimed to:

• commence national dialogue with discipline leadership groups from the academy and school-based Geography education,
• discern areas of alignment and difference between discipline leadership groups and, in so doing, develop a shared view of the discipline and subject,
• propose possible next steps for future action and, in so doing, assist with:
  − actioning a second recommendation from the strategic plan. That is, to develop and increase the “collaboration between school and university geographers” (NCGS, p. 87),
  − providing advice “from-the-field” to the NCGS and AGTA for future use in a position paper targeting Ministers for Education.

4. Presentation of key messages arising from the symposium series

The purpose of this section is to present the key messages arising from the 2020 Geography and STEM symposium series. An analysis in response to literature will occur in an upcoming paper. Key messages are presented in response to the three overarching questions used to frame discussion at each symposium.

Question 1: What is “my Geography” and how does “my Geography” fit into the STEM field?

Question 1 relates to the theme of visibility. Discussion at each symposium emphasised concern about the extent and implications of out-of-field teaching, particularly in response to the diminished identity of Geography as a rigorous, relevant and growing subject in schools. The diminishing identity of Geography as a discipline was also discussed in response to its dispersed and fractured representation across university faculties. Symposium delegates agreed there was a need for the discipline to be emphasised holistically and not divided into physical and human Geography. There was also agreement about the need to clarify and promote a clear identity and an accurate view of the discipline. This includes calling ourselves “Geographers” and identifying university departments, disciplines and programs as Geography, and for Geography to be badged, within the school curriculum, as both a science and a social science. To do so, would assist with the identification of a clear pathway for study, research, career identification and specialisation opportunities within initial teacher education.

Geography as the science of place was posed by Professor Iain Hay as a starting point for discussion about the clear, accessible and consistent messaging about the identity of Geography. Amongst delegates at the second and subsequent symposiums, the conceptualisation of Geography and the “science of place” was well received. For the visibility of Geography to be enhanced, symposium delegates agreed there is a need to:

- identify the distinctiveness of the discipline and subject in schools,
- know who we are as Geographers and as a discipline,
- develop internal and public clarity about the discipline of Geography including its representation in schools,
- emphasise the necessity for the in-field teaching of Geography,
- clarify the study and career pathways as an extension of Geography in schools (AGTA’s careers website project).

Question 2: What are the impacts and implications of “my Geography” in the STEM field?

Question 2 relates to the theme of contribution. A majority of participants focused on the use of geospatial technologies and how the data and information generated is interpreted, with a particular focus on place, space and interconnection. The use of geospatial technologies becomes an important connector and contributor of Geography-STEM and therefore enhances the impact of Geography. Most discussions focused on agreement about committing to key points already raised and identifying potential next steps.

Question 3: How can I use my spheres of influence to enhance the visibility of Geography in the STEM field and its contribution to STEM education?

Question 3 focused on activities related to spheres of influence. At the symposium and in post-symposium reflections received via email, the following ideas were put forward from individuals about how to enhance the visibility of Geography in the STEM field and its contribution to STEM education:

- Geography teachers to explore options for the design and delivery of a Geography and STEM unit across Years 7–10 to establish or expand a Stage 6 (Year 11–12) cohort.
- GTANSW&ACT shared a specific strategy, “VisCIS” to embed a Geography and STEM focus into professional learning activities and resources. “VisCIS” stands for Visibility (where do you see Geography in STEM?), Contribution (what does Geography offer to STEM?), Impact (what could happen to geographical learning as a result of a STEM emphasis?), and Sphere of Influence (what can we do to promote Geography in STEM?).
- AGTA Board members suggested the establishment of a Geography and STEM section on the website and incorporation of
a Geography and STEM careers emphasis into the revitalised Careers in Geography project and put forward the idea of a Chief Geographer being appointed to complement the role of Chief Scientist.

- Associations/Societies to collaborate more authentically and regularly.
- Journal editors in attendance committed to a Geography and STEM-focused theme for a special issue or equivalent in 2021.
- Lecturers from initial teacher education identified possibilities for reviewing their methodology units to identify and connect learning and assessment items between Geography and STEM.

Overall key messages arising from group discussion:

For action: developing a holistic and distinctive identity as Geography and Geographers, consider the branding and perception of Geography; lobbying for the co-badging of Geography as part of Australian Curriculum review processes.

For emphasis: strategies for action regarding the impact, contribution and the transformation of Geography.

Of concern: the extent of out-of-field teaching, the extent of division occurring between physical and human geography, the lack of identification of GeoSTEM-related careers within Geography.

5. Recommendations for action

The formal recognition of Geography, in both policy and practice, as a contributor to the STEM field will be a long-term educative journey for all those within, adjacent to and beyond the discipline. While the appointment of Susan Caldis as STEM Ambassador for Geography Education remains in place for the foreseeable future, it will be necessary for consistent, connected and clear national messaging and advocacy to occur from Geography stakeholder groups, including NCGS, IAG, AGTA, GSNSW, Royal Geographical Society of South Australia (RGSSA) and Royal Geographical Society of Queensland (RGSQ), for example in developing submissions for an upcoming curriculum review.

The development and presentation of a report to Ministers for Education from NCGS and AGTA in response to the Geography and STEM recommendation of the strategic plan could potentially occur during 2022. Such a timeframe would allow for an evidence-base to develop from the 2020 symposium and follow-up events proposed for later in 2021, in addition to analysis of theoretical examinations and existing empirical studies.

In response to the key areas for action arising from the symposium, the co-chairs put forward the following recommendations (see Table 1) to the NCGS for their consideration, advice and/or endorsement.

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<td>1. To address the identity, branding and perception of Geography.</td>
<td>1.1 Following the success of the 2020 symposium, co-chairs are to design, organise and implement a follow-up event to connect stakeholders and progress discussion about the Geography and STEM recommendation. Representatives from the NCGS could attend and present an opening address in a known capacity and/or offer a series of provocations for discussion. For example, for the suggestion from Professor Iain Hay at the 2020 symposium, Geography as the science of place, becoming a starting point for discussion about the identity and branding of Geography. 1.2 For representatives from NCGS, AGTA, IAG and other interested associations/societies to jointly author papers for journals and media such as The Conversation, in response to the IAG Conference theme Remembering, Reimagining Geography. The focus of papers could explore the identity of Geography, the impact of Geography and its contribution to the STEM field, the importance of Geography being a co-badged subject in curriculum development, schools and initial teacher training, together with possibilities for a potential appointment of a Chief Geographer.</td>
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<td>1.3 For the NCGS to provide a short statement of support as appropriate, for the establishment of a Geography Education focused IAG study group and IAG/NZGS conference stream; for the NCGS to nominate a representative to be a panel-session discussant should the conference session be approved. For example, Susan Caldis intends to approach IAG about establishing and convening a study group for Geography Education to cover research, action, policy and decisions which are important to the future directions of geographical education in schools, higher education, and initial teacher education because identity of the discipline, awareness about Geography and STEM, implications arising from out-of-field teaching are important areas of focus. Susan and Professor Jennifer Carter have already submitted a session proposal for a Geography Education conference stream to occur at the upcoming IAG/NZGS Conference to include focus on Geography and STEM.</td>
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<td>1.4 The editorial team from Geographical Education, journal of AGTA, are suggesting the theme for the 2021 volume be How can STEM be enhanced by Geography? The editorial team plans to invite papers from the 2020 symposium panellists and other interested Geographers and/or researchers. The 2020 symposium co-chairs suggest they approach the editorial team requesting an invitation be extended to the NCGS to contribute an article and compose a foreword to the special issue in advocacy of the Geography and STEM recommendation.</td>
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<td>2. To lobby for the cobadging of Geography as a subject of both the Sciences and Humanities during the 2021 Australian Curriculum review process. The review is led by the Australian Curriculum, Assessment and Reporting Authority (ACARA).</td>
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<td>2.1 Selected AGTA Directors are already liaising with ACARA Curriculum representatives about proposed revisions to the Australian Curriculum: Geography. Once public consultation occurs during April and May 2021, a round-table discussion between representatives from NCGS, AGTA, IAG, GSNSW, RGSSA and RGSQ is proposed. The purpose and outcome are to develop a combined report and ensure alignment occurs between separate reports from each representative group, that puts forward an evidence base to demonstrate the contribution and impact of Geography and argue for the positioning of Geography as a co-badged subject within the Sciences and Humanities. Reports can be made available on relevant websites. The strategy will also assist to address Area for Action #1.</td>
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Appendices

Appendix 1: Attendees
The symposium series was invitation-only for reasons of expertise, spheres of influence and manageability of symposium size. Invitations were extended to:

- Committee, National Committee for Geographical Sciences
- Council, Geographical Society of NSW
- Council, Institute of Australian Geographers
- Board, Australian Geography Teachers Association
- Council, each AGTA affiliate (up to 5 representatives)
- Head of School/Department/Discipline of Geography at universities across Australia
- Geography Methodology lecturers in initial teacher education programs
- Editors for *Australian Geographer*, *Geographical Education*, and *Geographical Research*
- President and a representative, Royal Geographical Society of Queensland
- President and a representative, Royal Geographical Society of South Australia
- Eminent academic geographers who may not be included in already issued invitations
- Geography educators are known to be enacting Geography-STEM initiatives in a school that may not be included in already issued invitations.

An invitation was offered to international colleagues who expressed interest in the symposium in response to social media posts. The following international colleagues attended:

- President, Geographical Association, United Kingdom
- Editor-in-chief, RIGEO journal, Turkey
- A North American based wetlands ecologist, Homeward Bound delegate, and curator of *StoryTellers of STEMM* podcast.

Appendix 2: Program of speakers
Co-chairs: Susan Caldis and Dr Grant Kleeman

Opening address: Mr Trent Zimmerman MP, Federal Member for North Sydney electorate

Panellists (alphabetical order):

- Dr Karen Joyce: Education Director, She Maps; Geospatial scientist and Senior Lecturer, James Cook University
- Dr Emma Lee: Trawlwulwuy Woman, Aboriginal and Torres Strait Islander Research Fellow, Indigenous Affairs for land and sea management, Swinburne University of Technology
- Ms Kimberly Parnis: Geography teacher, Teaching and Learning Advisor, Parramatta Marist High School
- Professor Ian Rutherfurd: Fluvial geomorphologist, School of Geography, University of Melbourne; Immediate Past President, Institute of Australian Geographers
- Dr Kate Selway: Superstar of STEM; Earth scientist and Senior Lecturer, ARC Future Research Fellow, Department of Earth and Environmental Sciences, Macquarie University
- Professor Michael Solem (Co-Director, National Centre for Research in Geographical Education, Texas State University; Senior Education Advisor, American Association of Geographers).

Appendix 3: Summary of presentations

The opening address
Mr Trent Zimmerman MP is aligned with Susan Caldis in her STEM Ambassador role; he agreed to provide an opening address. In so doing, Mr Zimmerman MP spoke about his surprise that Geography is not already formally part of STEM-related discussions in policy and practice. He then provided some advice about how to proceed with actioning the recommendation from *Geography: Shaping Australia’s Future*. Mr Zimmerman MP complimented the quality of the strategic plan and drew on it to speak about what he saw as the strength of Geography – its multidisciplinary nature; he also spoke about the importance of science, technology and innovation to government priorities.

Key points of advice focused on being able to articulate the contribution of Geography to the STEM field and develop a national approach and message. Such advice was framed in the following way:

- being clear and succinct about what Geography is and where the Geography is evident in STEM-related Government priorities – remember you will be needing to share this information and persuade policymakers and stakeholders who are not from your field,
- having an evidence base to demonstrate where geographical understanding and research will make a contribution and have an impact on STEM-related Government priorities,
- keeping the end-user in mind – whether the end-user be a teacher, a school student,
a researcher, or a practitioner in the field, how will they benefit compared to now by Geography being represented as a STEM subject; how will the discipline overall and Geography as a subject in schools benefit compared to now through being recognised as a partial STEM subject,

- remaining connected with organisations and people of influence such as Science & Technology Australia, local MPs, and Susan as STEM Ambassador for geographical education.

Speakers in the panel session (in speaker order)

Professor Michael Solem presented the Geography-STEM related experience from the United States of America. The focus was given to strategies of success in response to the following areas:

- connecting Geography, Environmental Science and Social Science through integrative concepts, scientific inquiry, problem-solving skills, GIS,
- developing an American Association of Geographers GeoMentoring program to better connect Geography academics, Geography teachers and industry representatives from Geography-STEM related careers,
- the enactment and outcomes of ongoing National Centre for Research in Geography Education-led research around Geo-progressions focused on maps, use of geospatial technologies, and spatial thinking,
- the importance of naming and identifying Geography in courses, departments, careers.

Dr Karen Joyce presented the dichotomy between the perception and reality of Geography. As a result, the presentation leaned heavily into the theme of visibility – what and where is the Geography in STEM. Dr Joyce used a “pub-quiz” activity to demonstrate the public perception of Geography as being only about capital cities, flags and identification of places on a map, and therefore not being a science, technology, engineering or mathematically oriented subject. Dr Joyce used her work in drone education and the use of other geospatial technologies to demonstrate Geography as a science due to its inquiry focus, spatial reasoning, place-based analysis, and human-environment interactions.

Professor Ian Rutherfurd presented the mutual benefits of Geography and STEM – Geography good for STEM and STEM good for Geography. To do so Professor Rutherfurd covered curriculum topics in school-based Geography, targeting demography, landcover and land use, climate, topography – and articulating the need to be clear about science and numeracy. Geography requires a scientific skillset to ask the right questions and to interpret, understand and apply data and information across the discipline, not just in so-called physical geography. Therefore, Geography is a science as it uses the scientific method and capabilities of inquiry, gathering and analysis of data and information. Spatial science capability is a key contributor to employment and careers from a Geography angle which enhances its contribution to the STEM field.

Dr Kate Selway presented the nature of her work in earth science through the lens of how she understands Geography to contribute and have impact on the development, communication of, and action upon findings. Dr Selway also presented a challenge to geographers to understand and agree upon what it is that the discipline contributes to the STEM field, and to determine whether or not Geography wishes to include more STEM in curriculum development processes.

Kimberley Parnis presented a GeoSTEM project-based learning initiative focused on Changing Places for Year 9. Conceptualised as the Urban Mess, Kimberley wanted to encourage her students to engage in real-world problem solving through the lens of geographical thinking. Emphasis was on place, space, sustainability and interconnections. Technology became a tool of learning to facilitate inquiry and communication. Through building awareness of Geography as a driver of/contributor to STEM education, through the collaborative design of the Urban Mess between the Social Science and STEM departments, it is hoped such a project will transform understanding about and appreciation of Geography amongst students, parents/ caregivers and colleagues so that a Stage 6 Geography class will become viable by the time these students are considering study/career pathways and choosing subjects for Years 11/12.

Dr Emma Lee presented the impact of Indigenous knowledges and ways of being from Country – land and waterways – related to Geography and STEM. Dr Lee emphasised the need for a holistic approach to knowledges (western and Indigenous) and knowledge transformations through its impact on Country and assistance to communities. Indigenous strategies of learning, by doing and keeping Country at the centre of knowing and being, will enable knowledge to bring communities together and to keep the discipline of Geography together as we look towards and have responsibility for the future. To weave STEM, Geography and Indigenous knowledges together to create a big net, an umbrella for cultural safety and respectful knowledge will show how each
knowledge becomes important and has an impact that is strategically aligned to transform the political, social and scientific world. Geography can be a leader in the STEM field by using connections between Indigenous and Western knowledges, not separating such knowledges. A connected approach between knowledges (Indigenous, Western, geographically-related, STEM-related) will create change and encourage belonging by drawing together all knowledge and not distinguishing or diminishing the cultures we belong to. Exclusions and barriers to knowledges are not helpful to future world order, the future in which Geography and STEM together will have a great impact.

This is the end of the report from the national symposium: The visibility of Geography in the STEM field and its contribution to STEM education.

Conclusion

Progress has occurred, with several of the proposed actions from the national symposium now being realised. For example: this paper appears in a geography and STEM themed edition of Geographical Education (1.4); a proposal was accepted for a conference session on geographical education at the 2021 IAG/NZGS Conference with papers presented by scholars from Australia, Japan, Turkey, Germany and the United Kingdom (1.3); liaison has occurred with curriculum authorities prior to, and during, national consultation on a review of the Australian Curriculum: Geography (2.1); and instead of a round-table discussion, GSNSW, IAG, NCGS and each AGTA affiliate provided a written submission to outline concerns with the way geography is represented in the curriculum and suggest appropriate amendments (2.1).

Unfortunately, pandemic-related disruptions have slowed progress on other initiatives. The nationwide conference sessions were designed to repeat the focus and questions of the 2020 national symposium with geography teachers around Australia during 2021, culminating in a plenary session at the AGTA Conference. Due to ongoing travel restrictions this part of the program has been put on hold until 2022. Despite this setback, real progress has been made in the repositioning of geography as a partial STEM subject. There is certainly a growing awareness of the contribution geography can make to STEM among key curriculum decision makers.

References


List of abbreviations

AAG American Association of Geographers
ACARA Australian Curriculum, Assessment and Reporting Authority
AGTA Australian Geography Teachers Association
GIS Geographical Information Systems
GTANSW&ACT Geography Teachers Association of New South Wales and Australian Capital Territory
GSNSW Geographical Society of New South Wales
IAG Institute of Australian Geographers
IAG/NZGS Institute of Australian Geographers and New Zealand Geographical Society
NCGS National Committee for Geographical Sciences
NCRGE National Centre for Research in Geography Education
RGSO Royal Geographical Society of Queensland
RGSSA Royal Geographical Society of South Australia
STEM Science Technology Engineering Mathematics
GeoSTEM: “The Urban Mess”
Interdisciplinary Learning in a Project-based Learning High School Environment

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Abstract
Parramatta Marist High School is a school in Western Sydney, New South Wales, that has over 14 years of experience in project-based learning in Stages 4 and 5 (Years 7–10). Over this period, projects have been constantly developed, redeveloped and improved by teachers based on their experience and feedback from their colleagues and their students. Growing out of this feedback cycle, GeoSTEM (an integration of geography and STEM) was formed to utilise complementary skills and concepts from both subjects in order to develop projects that better engage and reflect student learning in the 21st Century. In 2019, the first GeoSTEM project titled “The Urban Mess” was delivered to Year 9. This project focused on issues of urbanisation, sustainability and design within a local context, through the lens of the Stage 5 Changing Places unit. Through computer-aided design and fabrication, local geographical issues were exposed and resolutions proposed with the final products utilising laser-cut overlay maps to represent the various solutions.

Keywords: Project-based learning; GeoSTEM; integrative STEM

Educational Context
Parramatta Marist High School (PMH) is a Catholic, comprehensive, all boys secondary school located in Western Sydney, New South Wales, Australia. The school employs project-based learning (PBL) across all teaching disciplines in the junior and middle school curriculum in academic Years 7 to 10 (ages 12 to 16). The implementation of PBL began in 2008, after finding students in Year 9 were struggling to engage with syllabus content in a deep manner. In addition to reigniting student engagement with their classes, PMH wanted to best prepare students for life after school, “developing important ‘21st Century skills’, such as communication, collaboration and creative thinking” (Parramatta Marist High School, 2021).

The Buck Institute for Education (2021) identifies seven essential project design elements in their Gold Standard PBL model: a challenging problem or question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision, and a public product. At PMH, the school has aimed to fulfil each of these elements in the projects that are designed and implemented across Years 7 through 10. This includes the integration of such key learning areas (KLAs) as Human Society and its Environment (HSIE), English, and Religious Education. Essentially, projects will generally involve the integration of two of these KLAs (when a natural fit between the knowledge and skills can be found) whilst some projects are stand-alone, drawn from a single subject. For example, Year 9 students complete an integrated History and English project titled “Tales of War”, in which students study the Australians at War unit through the lens of two related texts, A rose for the Anzac boys by Jackie French and Photographs in the mud by Diane Wolfer for each respective KLA. An example of a stand-alone project includes the Year 8 project “Water in the World” where geography runs by itself for the duration of the project. In these scenarios, classes will have 60 students in the one classroom setting, with two teachers, one from each of the corresponding KLAs, acting as learning facilitators.

Unfortunately, due to a number of factors (and in line with the statewide trend), geography at PMH has struggled to gain the interest of students in Stage 6 with the last senior class running in 2013.
At first glance, the key inquiry questions for this work unit (based on urbanisation and migration) do not appear to fit within what most consider a traditional STEM framework (Zeidler, 2016). Although they lean more towards the human side of geography, an integrative STEM approach aims to contextualise learning for students in ways reminiscent of the real world (e.g., interdisciplinary and “messy”). In The Urban Mess unit, students are required to ‘investigate the management and planning of Australia’s urban future’ with consideration given to population projection and its associated strategies for sustainable management (NESA, 2015). The PHS project has been named as such to imply the wicked problems that students face when grappling with the complexities and issues of urban sprawl and its management. In more detail, students explore the data, statistics and processes associated with population projections and consider the engineering and technological advancements allowing for sustainable urban designs at a given point in the future. These pieces of knowledge, processes and inquiry skills are inherent to both domains of geography and STEM.

To the geography teacher, implementing sustainable practices for inevitable population growth could not be any more relevant and is very clearly a real-world problem but how does one get their students to see this as well? The Urban Mess sought to do this by presenting students with a project focused on their own local context within the Sydney Basin and thereby creating those authentic connections to an existing and challenging problem. The driving question underpinning the term-long 10 week project was “How can we design urban places that can sustainably cater for an increasing population?” The purpose of the driving question in a project is to act as a rudder, guiding students to make corrections over the course of the project. In line with PBL practices, the defined summative task, or end product, for students was to develop an urbanisation plan for the future of the Greater Sydney Region with a target of the year 2036, inspired by the New South Wales Government’s A metropolis of three cities – the Greater Sydney Region Plan (2017). Within that defined end product, students were free to collaborate in groups and present their solution for this project in the form of a laser-cut overlay map designed with Adobe Illustrator (Savery, 2006). An example of an end product, with four layers of perspex each representing a different sector within the Greater Sydney Region – transport, population distribution, community facilities, and green spaces – is shown in Figure 1. Students had to take into consideration the projected population growth and how they could and would cater for this expansion with regards to the spatial

The Urban Mess

The first task after deciding on geography and STEM integration was to look at the respective syllabi and decide which aspects of both would be best suited to developing this project. It was decided that geography would be the main driver for the content, and STEM would provide support for both students and teachers in terms of the development and application of the targeted skills. Due to timetabling constraints, two geography team teachers would be present in the class at all times with the STEM department providing support in the form of flipped instructional videos and fabrication. Whilst there were many options and possibilities across the Stages 4 and 5 work units, it was decided that the first project would focus on the Changing Places unit from the Stage 5 syllabus (New South Wales Education Standards Authority [NESA], 2015).

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distribution of these four sectors. Supplementing their design was a presentation justifying their urban plan and explaining how this would provide a sustainable future for Sydney.

Figure 1. Prototype of laser-cut perspex overlay map end product.

The project included scaffolding from both the geography and STEM teachers to support students (who required it) in developing this project. Whilst the project was solely focused on the geographical content and skills, and facilitated by the geography teachers like any standard geography project, the STEM department assisted in developing videos and supplementary materials on how to use Adobe Illustrator, and joining timetabled geography lessons where possible to run workshops. Given many students were already familiar with Adobe Illustrator from their compulsory STEM courses in Years 7 and 8, there was still a need to provide scaffolding for intermediate and advanced learners. Additionally, geography teachers took the opportunity to be upskilled in similar programs and offer optional workshops with smaller groups of students within the Hive (the school’s dedicated STEM fabrication space). This was enabled by geography team teachers working with two classes run concurrently.

Thoughts and Considerations about the Project

Based on student feedback collected at the end of the project, students were highly engaged and found that its structure helped them to see the real-world application of the geography course content. Whilst the laser-cut perspex design provided an engaging tangible facet to the project, it also helped students to develop skills in mapping and understand concepts of spatial distribution and sustainable practices. However, teachers observed that whilst the local context was most certainly helpful, students struggled to conceptualise the size of the Greater Sydney Region, and proposed that future iterations of the project focus on a smaller area, such as the Parramatta Local Government Area.

Remembering that the “public product” at the end of the project is a critical component of Gold Standard PBL (Buck Institute, 2021), further improvements to the authenticity of the project and greater connections to the real world need to be considered for the future. This could include fieldwork within the area of focus (such as an excursion into the Parramatta Central Business District) as well as inviting comments and critiques on the students’ project solutions from such experts as a local urban planner or council member.

Another consideration is that the project was more costly (than class-based projects) and rather time consuming. For example, the scheduling of the laser cutting and etching of pieces of perspex for 180 students was a significant undertaking. However, the school is in the fortunate position of having invested in the STEM space and therefore able to run such a project for its students allowing them access to facilities such as a laser cutter, 3D printers and support staff. Ultimately, the end product for this project could be transferable to a digital overlay map designer or, if wanting a tangible product, utilising overhead transparencies making this project possible for those without access to these facilities.

It could be argued that this unit of work could remain a standard, stand-alone geography project, however, by taking an interdisciplinary approach we can highlight the relevance and connectedness of geography through such cross-curriculum priorities as sustainability, and investigate them through the lens of STEM (Salter & Maxwell, 2020). Moreover, this project demonstrates how much symmetry the discipline of geography has with integrative STEM approaches in both the skills and concepts as developed and explored by students. Whilst it is true that geography provides a literal and metaphorical place for these concepts to be investigated, STEM also provides complementary skills and concepts as well as some of the vehicles in which these concepts can be presented. And here is where the lines begin to blur (Caldis & Kleeman, 2019). For example, consider the suggestions above regarding optional presentation formats for the project. A geography class does not have to have
access to a lasercutter in order to undertake this project. If they were to create overlay maps using a digital program or overhead transparency sheets, this would still be very much a GeoSTEM project in action. Students can still meet the identified cross-curricular outcomes and target the desired concepts and, therefore, the common goal of solving real-world problems and exploring concepts embedded in science, technology, engineering and mathematics and geography still remains.

In conclusion, this interdisciplinary project, The Urban Mess, demonstrates the complementary nature of geography and STEM by affording students the opportunity to engage in authentic, challenging, problem-solving scenarios and engaging them in both disciplines through sustained inquiry. Whilst this is simply one example, the possibilities of other GeoSTEM integrations in junior geography classrooms are varied, whether it is through a PBL approach or perhaps even more traditional approaches.

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STEM in Geography Education – an Earth Science Perspective

Dr Kate Selway
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Introduction

In the Australian school curriculum, geography is housed within the humanities and social sciences. This classification affects the content within the curriculum, the backgrounds of teachers and their professional development opportunities, and also the expectations and subject choices of students. As an earth scientist working in the Australian university sector, my research is closely linked to geography and I teach many undergraduates who had their passion sparked during geography lessons at school. From this perspective, I suggest three reasons why the expansion of STEM (science, technology, engineering and mathematics) skills in the school geography curriculum would be of benefit.

1. It would help students pursue and achieve their own goals.
2. It would help interested students find fulfilling careers in areas of national skills shortages.
3. It would help develop a population and future leaders who will make successful and well-informed decisions.

1. The expansion of STEM skills into geography teaching will help students to pursue their goals.

If a keen high school student were to type geography into the search bar of the Good Universities Guide (www.gooduniversitiesguide.com.au), they may be surprised at the diverse range of university degrees they are directed towards. While someone wanting to study chemistry could be confident they should do a science degree and someone wanting to study history will almost certainly do an arts degree, our student looking for a geography major has a more ambiguous path. They will be directed to a Bachelor of Science at the University of Melbourne, but to a Bachelor of Arts at the University of Adelaide. At the University of Queensland, geography sits within the School of Earth and Environmental Sciences, while at Macquarie University it sits within the School of Social Sciences. This range of paths reflects the broad range of areas of focus within geography, which include both human geography and physical geography and span the arts and the sciences. However, our current school curriculum, focused on the humanities and social sciences, may not be fully preparing students for these future options.

Students who choose to study geography at school are often interested in questions like how humans interact with their environments, how environments change, and how that change can be monitored and mitigated. From the perspective of an earth scientist, I would argue that an enhanced emphasis on STEM skills within geography teaching in schools will support students to understand and address these questions and to pursue further study. These skills would include, but not be limited to, improved numeracy and confidence with maths, statistical analyses, programming and data processing, GIS and online mapping tools, familiarity with the scientific method, and an understanding of earth science, chemical, physical and biological analytical tools (Figure 1).

In many cases, answering geographical questions requires STEM skills. This is clearly true for physical geography but many questions in human geography also require thorough statistical analyses and an ability to tap into big data. For instance, Wolf et al. (2021) argue that quantitative analysis in human geography can help developments in the field become more replicable, inclusive, specific and open. Expanding the inclusion of STEM in the school geography curriculum would highlight the importance of quantitative skills to students and better equip them to successfully solve problems. In the lifetimes of our current students, in which incredibly vast volumes of data are likely to be collected, those who have the ability to access, analyse and understand that data will be able to create much more significant and effective change than those who do not.

The application of STEM skills to topics in geography, in which students are already interested, may also help improve student
confidence and self-efficacy in STEM (e.g., Rittmayer & Beier, 2009). For instance, if a student successfully applies a mathematical tool like a linear regression to a geographical question that concerns links between income and population density, their overall confidence in maths is likely to improve. Given that geography majors at so many Australian universities are within the Bachelor of Science, it is also likely that more students will choose these majors and continue to pursue their geography education if they are exposed to more STEM at school (e.g., Moakler & Kim, 2014). Inclusion of more STEM skills within the geography curriculum may therefore be expected to improve students’ effectiveness as geographers, their willingness to continue with geography study, and their perceptions of their STEM skills.

2. The expansion of STEM skills into geography teaching will strengthen Australia’s capability in vital areas.

The diversity of departments in which geography is housed at Australian universities highlights the diverse fields that benefit from the unique skills of geographers. Australia is facing a skills shortage in many fields that are relevant to geography. Indeed, in June 2021, surveyors, cartographers, spatial scientists and geotechnical engineers were added to the Australian Government’s Priority Migration Skilled Occupation List, a list of only 41 occupations defined as those that fill critical skills needs. These recently-added jobs, which involve tasks like analysing satellite imagery to track bushfire risk, or finding groundwater to ensure it is not polluted by construction, are likely to be appealing to many school students who are interested in geography. Importantly, these jobs also require STEM skills. For instance, algorithms need to be written to filter the satellite data and inversions need to be run to find the groundwater.

There is no doubt that many of the students in our schools who are passionate about geography have the capability to be our future surveyors and spatial scientists. However, without a focus on STEM skills within the geography curriculum, they may not recognise that these career paths match with their interests and may not feel confident to take on the university-level STEM subjects they need to become qualified. As a specific example, in earth sciences, we currently face a skills shortage of people working in sectors such as environmental monitoring, mineral exploration, and geospatial science. We also face low student numbers at universities which have led to reductions in offerings including closures of earth science departments at Macquarie University and the University of Newcastle. These closures are likely to exacerbate future skills shortages. Earth science has many of the same attributes that attract students to geography: a goal of understanding the world around us, monitoring environmental change, and an opportunity to conduct fieldwork and to travel. If the STEM-based links between geography and earth science were made clearer to students at school, perhaps more students would be motivated to study earth science at university and Australia would be able to meet its skills needs.

3. Engaged citizens need to understand human impacts on the world with a solid STEM base.

Although only some of our geography students will go on to work in geography-related fields, all of them will hopefully go on to become engaged global citizens, helped by their geography training. The current dual crises of the COVID-19 outbreak and of climate change highlight how important it is to have leaders and a population who can understand science as well as human impacts and responses. Geography is in a unique position to train upcoming generations in understanding and balancing these concepts, so long as STEM skills are included in the geography curriculum.

The COVID-19 pandemic has been a stark example of the need for leaders to follow medical advice and the need for the population to have a STEM literacy to understand the situation and risks that face them. Those with better STEM and health literacy report less confusion about coronavirus information (Okan et al., 2020), and are more likely to support public health measures and make safe decisions. Australia’s early success in dealing with the pandemic is partly due to the strong policy focus on listening to the medical advice (Bernard et al., 2021) and the population-level support for public health measures (e.g., Pickles et al., 2021). Arguably, the approach of Australia to climate change has been a contrasting example, where policy has not followed scientific advice (e.g., Taylor, 2014). Particularly on a topic such as climate change, where political and media messaging is often contradictory and confusing, STEM literacy among the population is vital if people are to assess competing claims that will affect their actions (e.g., Leiserowitz & Smith, 2010; Tranter, 2020).
The challenges of tackling both COVID-19 and climate change also clearly illustrate that science by itself is not enough to overcome such complex problems. Instead, successful solutions also have to carefully consider how people interact with their environment and the impact of policies on citizens. For instance, COVID-19 medical advice may suggest locking down a city, but broader consideration will ensure only doing this with flexibility that will allow people to continue working, to stay healthy, and to remain supportive of the public health measures (Altiparmakis et al., 2021; Cairney & Wellstead, 2021). Addressing climate change requires disruptive shifts in energy production, agriculture, manufacturing and transport that affect jobs, industry practices, communities and individual lifestyles, so successful solutions require complex social and economic policies that must be guided by the social sciences (e.g., Shove, 2010). After decades of politicisation of climate change, entrenched attitudes can limit the impact of additional scientific information (Kahan et al., 2012). Australia is arguably yet to embark on the path of building successful climate policy in the way it has done, relatively successfully, for COVID-19 policy (e.g., Morton, 2018).

The contrasting responses to the COVID-19 and climate change crises demonstrate how important both STEM literacy and social science literacy are for Australia’s government to make effective policy decisions and for Australia’s population to support those decisions. The school geography curriculum is in a unique position to train Australians to understand and balance the science and the human impacts of that science. A deeper integration of STEM skills into the geography curriculum would strengthen the ability of geography to develop Australia’s citizens and future leaders, as well as helping students to find fulfilling careers in areas of skills shortages and to pursue their own interests in Geography.

Figure 1. Venn diagram illustrating some of the overlaps between STEM, physical geography and human geography.
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Making It Happen: An Experience of Using Earth Observation-Based Research Outputs for Engaging High School Students in Novel Technologies for Sustainable Agriculture

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Abstract

Educational policy and management emphasise the role of science (e.g., earth science, geography) as a fundamental aspect of societal advance, but student enrolments at universities in these disciplines remain low. This commentary explores ways to foster more collaboration between university academics and high school teachers to implement STEM-related curriculum through hands-on exploration of novel Earth observation (EO) technologies. To this end, we develop project-based learning activities through the Copernicus applications and services for low impact agriculture in Australia (COALA) project, an international venture of eleven partners seeking to promote the adoption of products and services for sustainable agriculture in Australia, underpinned by satellite technology from the European Copernicus programme. We reflect on our experiences developing project-based learning activities, and particularly on the benefits and obstacles we faced.

The Australian Government’s National Science Statement (2017) envisages a society “engaged in and enriched by science”, recognising that science is fundamental to the nation’s economy (p. 4). The importance of science and technology for Australia’s future development is further reinforced in the 2030: Prosperity through innovation report commissioned by the Australian Government (Innovation and Science Australia, 2017). These messages add to voices from academia warning on the future impacts of poor university enrolments in these areas of learning (e.g., Geoscience on the chopping block, 2021). Back in 2014, The Conversation published a series of articles on “How will science address the challenges of the future?”. One of those articles argued that government plans to continue building a stronger and resilient Australia require engineers and that, at present, there were too few students studying STEM subjects at higher levels at high school, too few going onto engineering at university, and a shortage of engineering skills across the economy as a consequence” (Sahajwalla et al., 2014). This reflection can be extended to include earth and geographical sciences, also affected by a decreased enrolment at university (Cohen, 2018; Geoscience on the chopping block, 2021).

The debate on how best to engage high school students in science and technology (the STEM–STEMM initiatives, see Box 1) has been ongoing for over a decade (e.g., English, 2016, 2017) and is well summarised (Corrigan & Lancaster, 2020; Johnson et al., 2020; Kennedy et al., 2018; Panizzon & Corrigan, 2017). Many reports highlight what STEM is about (Corrigan & Lancaster, 2020; Lyons & Quinn, 2015; see Box 1), why STEM subjects are important (Corrigan & Lancaster, 2020; Panizzon & Corrigan, 2017), and include suggestions on how STEM education can be part of school curricula (Corrigan & Lancaster, 2020).
In this commentary, we argue that in spite of the body of knowledge reported in peer-reviewed literature, faculty and university strategies to reach out to schools and promote science, technology, and engineering still lag practical guidance. In this regard, we maintain that through engagement with high school curriculum developers, we could further use research outputs that advance disciplinary – or inter-disciplinary – knowledge to promote engagement with science and technology (which we call “double dipping”). However, the research grant writing process needs to accommodate, and budget for, funding and time to develop activities and foster collaborations with high schools. Our argument underpins recent experiences enabled by a research project (Copernicus for Sustainable Agriculture in Australia or COALA) that promotes the adoption of satellite earth observation products and services for sustainable agriculture in Australia.

Earth observation from satellites, airborne or drone platforms has evolved over the decades. Its use has been democratised (such as in Google Maps, Google Earth), and it has made its way into high school geography and earth science textbooks and curriculum. However, as a fast-evolving technology, it can be difficult for teachers to keep up-to-date with the latest application developments and, importantly, to design hands-
on activities for the classroom. Guidelines for research funding from the European Community request a well-developed strategy for communication and dissemination of results (Metternicht et al., 2020). The current project introduced a concept of legacy that enabled us to co-design activities tailored to specific educational outcomes of the New South Wales syllabus as described hereafter.

Case study: The COALA project and communication of science outputs

The essential pillar that underpins COALA (www.coalaproject.eu) is the Horizon 2020 program (European Commission, 2020) that promotes the use of Copernicus, the European Union earth observation and monitoring program. During the 36 months scheduled for completing this project, 11 partners, including academic institutions, small and medium enterprises in Australia and Europe, are developing mechanisms for sharing European knowledge and expertise in the field of EO-based applications for agriculture with Australian institutions. The overarching aim is to support more sustainable use of water and nutrients in the advanced agricultural systems of Australia. Water conservation is vital in Australia, an already dry continent. As climate change continues, we will face more dramatic and frequent droughts. COALA aims to provide long-term assistance for long-term issues that lie at the core of human agriculture, farming, and climate concerns. For this reason, we determined that we would not merely communicate short-term drivers but long-term scale visions. We wanted to consider what will be left behind and how this research could impact future generations.

Conditions of the grant require preparing a communication and dissemination plan adapted to various relevant target audiences (Metternicht et al., 2020). We designed a communication and dissemination plan centred around “legacy”. One aspect of legacy, in this context, involves direct engagement with high school students, tailoring research outputs to engage them in the classroom with current remote sensing technologies used for on-farm management. Compelling legacy narratives are curated throughout the projects, where those involved consider the end-result and focus on moments of shared engagement and development (Khan & Fatma, 2019). The best legacies are held up by those who want success to continue by inspiring and fostering trust with stakeholders and future stakeholders (Trudeau & Shobeiri, 2016).

The need to tailor communication for legacy audiences has been established; for example, a survey by Herington et al. (2019) found that 50% of Australians perceived science as inaccessible to the public, and they thought that the current dialogue between scientists and the public is not meaningful, and is insufficiently resourced. In a similar vein, a more focused example on knowledge about water conservation by Roseth (2006) found that while over 93% of respondents agreed that water must be carefully conserved, 20% of respondents reported that they do not know how to save water. These results show that the public is interested in science and new knowledge, which is also underexploited. The communication focus towards creating legacy is one of the ways COALA plans to transfer knowledge.

Collaboration for implementation of earth observation technologies in support of teaching about sustainable development: co-creation of project-based learning materials. The COALA demo

The New South Wales Agricultural curriculum (New South Wales Education Standards Authority, 2019) aims to help students understand what – and how – technology could support them in their future as farmers. However, teachers often lack time, being stretched thin to keep up to date with the latest technology of a rapidly evolving field. The COALA project communication team contacted a curriculum developer in the New South Wales Department of Education to ascertain the curriculum requirements for high school students in the area of Agricultural Technology and to co-create authentic activities for the students, aligned with expected outcomes of Stages 5 (years 9 and 10, see Box 3).

We jointly developed an interactive activity that required students to use a demo of our platform to investigate the application of satellite data to agriculture, using the newest satellites of the European Space Agency. These data are open access for Australian businesses, including the farming sector. Students used the tools and research data from our earth observation digital activity (Copernicus for Sustainable Agriculture in Australia, 2021) in a series of engagements directed to help them answer questions related to Stage 5 learning objectives. The expected learning outcomes focused on collecting and analysing agricultural data and communicating results using various technologies.

In developing these class lessons (Copernicus for Sustainable Agriculture in Australia, 2021), a few issues became apparent which structure the discussion and reflections that follow hereafter.
Lessons learned and reflections

Researchers of STEM disciplines often lack the time to develop resources tailored to school students

Dissemination of research outputs that focuses exclusively on academia as beneficiaries, often forgets to direct resources in terms of time and finance to promote technologies and emerging research to the public. In grant applications, publicly funded researchers (e.g., Australian Research Council and other Category 1 grants) often need to articulate the national benefits (social, economic and environmental) expected to be delivered from the research project. Typically, outputs associated with national benefit relate to advancing knowledge or enhancing understanding of the discipline. National benefit tends to be measured by metrics such as the number of publications in peer-reviewed journals of high impact factor, and restricted to developing academic potential or publishing in academic journals. Nevertheless, our nation benefits when we strengthen the links between universities and high school students. These links are essential when STEM subjects, such as earth science or geography, have been slashed in response to university restructuring (Geoscience on the chopping block, 2021; Selway, 2021).

In our experience with this project, we found that it is not standard for projects to consider legacy as a key aspect of communication and dissemination. PBL allows students to engage in authentic activities with driving questions using technologies to demonstrate their understanding (Hasni et al., 2016; Thomas, 2000). By providing our platform for use and working with curriculum developers, we helped to design a PBL lesson for the classroom. When PBL is implemented well it can benefit students in helping them develop increased understanding and knowledge application. A key factor in how well these PBL activities are implemented is “academic rigor”, which should allow students to improve their higher order thinking skills while being aligned to content and curriculum, and give students the opportunity to reflect on and revise thinking (Boston & Wolf, 2006; Edmunds et al., 2017). The rigour of these activities was improved by working together, since we could provide the platform and the specialist expertise while the curriculum developer provided both pedagogical and curricular expertise.

Models of engagement are insufficient

While university management and professional associations raise concerns about low enrolments in STEM subjects, not much thinking and action have been devoted to exploring and articulating pathways for how university research, supported by public funding, can provide as part of its outputs, materials to support teachers in the implementation of curriculum related to STEM subjects in high schools. When academics do reach out to schools, it is often limited to delivering lectures or talks (Cridge & Cridge, 2015). This lack of engagement can partly relate to a vague reward system for academia to engage in service to the community – high school teachers in this case. Furthermore, teachers, eager to have hands-on activities for their students arising from the latest research at universities, often lack proper channels to contact university researchers. In the case of the COALA project, serendipity (e.g., informal networks, chance talks with staff of the New South Wales Department of Education) led to the collaboration with high schools.

Although service is one of the three pillars of scholarship (with teaching and research), the Global University Network for Innovation found that young academics in some universities are “discouraged from following an engaged scholarship career pathway” (Hall, 2014, p. 308). More to the point, Vuong et al. (2017) mention that many higher education institutions in the United States are criticised for emphasising the importance of collaboration between university scholars and local communities to address economic or social challenges. That situation extends to Australia, as the Productivity Commission (2017) acknowledges the need for “more closely aligning the interests of universities

<table>
<thead>
<tr>
<th>Box 3: Expected outcomes of Stage 5 Agricultural Technology of the New South Wales curriculum.</th>
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<tr>
<td>AG5-2 explains the interactions within and between agricultural enterprises and systems</td>
</tr>
<tr>
<td>AG5-4 investigates and implements responsible production systems for plant and animal enterprises</td>
</tr>
<tr>
<td>AG5-6 explains and evaluates the impact of management decisions on plant production enterprises</td>
</tr>
<tr>
<td>AG5-12 collects and analyses agricultural data and communicates results using a range of technologies.</td>
</tr>
</tbody>
</table>

(New South Wales Education Standards Authority, 2019)
with those of the people they serve – students and taxpayers – could be one mechanism to drive improvements in student outcomes” (p. 27).

With funding bodies adopting more specific rules on communication and dissemination of research outputs, entry points for better articulation and translation of research results to hands-on activity in support of teaching in high schools may open. In the case of the COALA project, the European Commission Horizon 2020 scheme funding states that “project beneficiaries must promote the action and its results, by providing targeted information to multiple audiences (including the media and the public), in a strategic and effective manner and possibly engaging in a two-way exchange” (European Commission, 2017). These evolving requirements by funders to demonstrate broader research impacts has elucidated barriers and incentives (financial and non-financial) for academic faculty to engage in knowledge translation and research utilisation (Jessani et al., 2020).

Professional learning opportunities for teachers: bridging the gap

Teachers must be STEM literate and confident to teach competently and bring a real-world application of expertise to the classroom (Ledbetter, 2012). We propose that, if university researchers work with teachers to help develop demos and tutorials ready for the classroom and demands of the curriculum, as suggested by the National Committee for Geographical Sciences (2018), more applied science could end up in classrooms (Hennah, 2019), which may increase enrolments, particularly for regional and remote schools.

Several examples of formal opportunities for researchers to work with schools have arisen recently in Australia; for example, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is working with researchers to partner mentors into schools to provide visits and help years 9 and 10 students connect with researchers (CSIRO, n.d.-a). Some students can likewise get into universities to work with researchers doing research projects for their science extension projects (University of New South Wales Science, 2021). CSIRO is also working to help teachers work with researchers and stay up-to-date with their STEM Professionals in Schools program which matches teachers and STEM professionals to help increase knowledge and confidence in STEM (CSIRO, n.d.-b). Research into programs like these show greater scientific literacy for students, a higher likelihood of engaging with interest in STEM, and for teachers to increase their confidence (Forbes & Skamp, 2012). It is not only the students and teachers who benefit, as the STEM professionals often report increased enjoyment and passion (Tytler et al., 2009). The curriculum developer we worked with sought out STEM professionals to develop the curriculum, but our connection was ad hoc, through personal networks, not a professional program.

Concluding remarks

That universities should engage more with schools has been highlighted in previous research. Through this commentary, we present a narrative experience and reflections that align with recent reports and research calling for re-evaluation of incentives and modes of engagement for enhancing faculty engagement with high school educators, (Jessani et al., 2020; Productivity Commission, 2017; Vuong et al., 2017), as one way to foster more STEM enrolments at universities.

As the face of university education is changing (Kinash et al., 2021; Matthews, 2021), a unique opportunity opens for extending those winds of change to university outreach activities to schools (McLaren & Kenny, 2015). We should re-assess incentives and barriers for university researchers to engage with STEM teachers and support quality science teaching – an essential component in sustaining the scientific interest of schoolchildren (Cridge & Cridge, 2015).

We need to get new scientific research into high school curricula to learn and benefit from current research and technologies. Practical engagement is critical with practical sciences like agricultural technology. By granting access to current university research on fundamental sciences, we present a unique learning opportunity for the next generation of agriculturalists. Collaborating with high school teachers is one way to develop students’ scientific literacy and bring research directly into schools. Incentives from universities (and research granting bodies) on “expected outcomes” of projects should include – and recognise – time spent to develop research findings into the curriculum of high schools. This kind of dissemination helps democratise research findings beyond the academic ivory towers and journal paywalls.

Acknowledgements

We thank Samantha Jarret for working with us to develop these educational resources. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 870518. BLT would like to acknowledge the Bedegal people, the traditional custodians of the land on which she works.
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Fieldwork is such an integral part of geography so when a resource such as this book came along, I was very excited. When I first saw this text, I noticed that it was very visual and included several ways GIS can be integrated. It is not a large text which makes it quick to look through, and each fieldwork clearly identifies the context, method, data collected and how the data can be presented for analysis.

The start of the text explains the importance of fieldwork in geography classrooms today and is based on a geographical inquiry cycle. Following this there are 11 fieldworks each presented concisely over a double page.

The fieldwork topics pushed my thinking outside of the coastal or urban fieldworks that I have done quite frequently. This text provides examples on how fieldwork data can be collected and presented on topics such as smell and mood mapping as well as some physical geography for coasts.

My favourite creative fieldwork from this resource is the Urban Sound Wheel from Chapter 6, sound mapping. This really prompts students to consider all of the areas in an environment that contribute to noise levels and data can be analysed through a noise map and rose diagrams.

Overall, this is a fantastic resource that I intend to use with middle and senior geography classes.

Elise Walker
Wilderness School, South Australia

John Huckle is a name that is well known around geographical education. He has been a teacher, writer, challenging thinker and textbook author for a number of decades. So, when a new book of his is published, it is a cause for excitement – what will John write now?

This book is the first that I’ve seen in this form – self-published as a PDF and available free of charge through Huckle’s website. It is also a large book – over 430 pages.

But what a book? It begins with a Preface which is so much more than the normal preface in that it lays out Huckle’s approach and identifies seven considerations that underlie his approach to what he calls critical school geography – critical social theory, critical pedagogy, relevance, curriculum making, internationalism, open source and professional development.

In a telling statement, he identifies radical democracy as the key theme running through the book. The Preface also puts the book centrally in political debates in the United Kingdom and, while this could be a distraction for us, there is so much in this book of value to geography teachers in the antipodes and everywhere.

This is followed by an Introduction that puts the book into the context of Huckle’s educational and political philosophy. It is impossible to summarise the nature of this discussion. It is laden with challenging ideas for all educators, both in terms of why they are teaching geography and how they are doing it.

This then leads into the central part of the book – nine curriculum units and eight more chapters discussing issues in geography and education. The units and chapters are
interspersed so that each unit follows a discussion and is related to it. The nine curriculum units are: 1. Venezuela’s Bolivarian revolution and its impact on healthcare; 2. Spatial divisions of schooling; 3. Happiness and equality – UK and Finland compared; 4. Homelessness: causes and solutions; 5. The future of work; 6. Urban farming in Chicago, Nairobi and Bristol; 7. China’s Belt and Road Initiative and its impacts on Xinjiang and East Africa; 8. Becoming a young British Muslim woman: the significance of place; 9. Paying for the transition to sustainable development: the role of international tax reform.


The nine curriculum units contain a wealth of ideas for teachers. Each contains a curriculum plan (key ideas, inquiry questions, key understandings, and six curriculum headings – key concepts, key values, key skills, learning outcomes, learning activities, and assessment tasks), Links to UNESCO guidance for sustainable development, a key feature of Huckle’s perspective, preparation steps, possible procedure, activity sheets, and each of these contains extensive resources that provide links to internet websites and other sources.

Each of the eight chapters along with the Introduction are an astonishingly rich source of ideas in education, geography and social understanding that, typically for Huckle, are strongly challenging as they critique so much of present practice. They could stand independently as a statement of Huckle’s thinking at this time. But the way each of them is then followed by one of the units, in which many of the ideas expressed are put into practice, provides a strength of direct relevance to what happens in geography classrooms. Despite the apparent abstractness of much of Huckle’s thinking, central to all his work is how this will affect the lives of students – how can they be empowered to understand and control their own lives in a future that is both unknown and more challenged by controlling influences?

While Huckle’s book is located in the context of British politics and schooling, it is highly relevant to geography teachers everywhere and very much up to date.

Critical school geography, by being so directly accessible to everyone, enables us all to face the challenge of Huckle’s thinking.

Bill Stringer
Balwyn North, Victoria

Deep dive into deep sea.


If you like any of his previous “Explore the World” books, you’re going to love this latest publication in the Tim Flannery series – Deep dive into deep sea.

Tim seems well experienced to present this foray into the deepest parts of our amazing oceans having spent many hours diving in and around Port Phillip Bay, and his personal anecdotes add an authentic flavour to the biological science focus of the book. Written for younger readers but equally appealing to anyone with an interest in the natural world, this book is an awe-inspiring and sometimes frightening look at the weird and wonderful marine creatures that inhabit every layer of the ocean’s depths, from the twilight zone to the deepest trenches and the abyss.

After a cleverly-designed contents page and short introduction, the book is organised into clearly defined chapters, each one exploring a different part of the ocean according to depth. The marine inhabitants of each ocean layer are illustrated, albeit not always according to scientific detail, and described in amusing ways so as to engage younger readers and keep them hooked.

The text is dynamic, enveloped in variously shaped and coloured text boxes that cause the eye to move across and around the double-page spreads to identify interesting scientific and historical facts. Catchy subheadings, designed for greatest impact and drawing on contemporary references to lure the reader, include: You’ve got a friend in me heading a paragraph describing Sea Pig communities and Walk this way heading in a section explaining octopus mobility. The pages in each different chapter are bordered by a slightly different hue, and as the depths increase, so does the depth of the blue colour. This makes it easy to flick through the pages and locate a particular section if desired. The final pages include an uncluttered index and a comprehensive glossary of terms used in the book.

This text could be used to illustrate animal evolution and adaptations and to explore how environmental conditions impact on species behaviour and survival. Deep dive into deep sea is also a good example of dynamic text construction and how to effectively communicate non-fiction concepts and ideas to a younger audience in an interesting and imaginative way. Explorer Spotlight text boxes include some geographic focuses such as mid-ocean vents, underwater mountains and rifts. Sub themes that appear throughout the text also include: ocean resource use (such as manganese mining); deep sea exploration and the technology required to accomplish this; and the scientific inquiry method. A table on page 113 also lists the deepest trenches in the world including name, location and depth in metres. This could be used as a data table example.
True to the author’s life work, this text also contains a clear but subtle environmental theme. Facts about climate impact on coral and declining whale numbers are just a few of the ways that Tim reminds the reader about their responsibility for ensuring the ocean remains a habitat full of amazing diversity for the future.

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Handbook for teaching and learning in geography.
Edited by Helen Walkington, Jennifer Hill, and Sarah Dyer. Edward Elgar, 2019,
520 pages, hard cover, ISBN 9781788116480
https://www.e-elgar.com/

The Handbook of teaching and learning in geography is primarily targeted at teaching in higher education, however it has some broader appeal in grappling with key issues in geography teaching. The book includes chapters from influential tertiary level geographical educators from the United Kingdom, Australia, New Zealand, United States and Canada.

The book is organised into three parts, broadly corresponding to the three years of undergraduate education. Part I is “Pedagogies to support the transition into higher education”. Of particular interest to teachers in this section are the chapter by Simon Tate and Peter Hopkins on student perspectives on academic and social transitions to university. This chapter will be helpful for teachers supporting students preparing for university, particularly for first in family students who can find this transition more challenging. Graham Butt contemplates the “gap” between school and university education in the United Kingdom. This chapter provides food for thought in how we can better connect school and university geographical education in Australia. The terrific chapter by David Conradson from New Zealand, on providing supportive learning environments, provides insights on how to create such learning environments. Other useful chapters in this section consider fieldwork, ethical thinking and teaching in an interdisciplinary context.

Part II discusses pedagogies to facilitate more autonomous learning. While the discussion is much more targeted to university education, the themes of some chapters will be highly relevant to the kinds of discussions generated by teaching aspects of the high school geography curriculum. These include the chapter by James Esson and Angela Last about learning and teaching racism, the chapter by Zoe Robinson on responsibility and sustainability, and the chapter by Ian Fuller and Derek Hopkins on student perspectives on academic and social transitions to university. The chapter by Michael Solem, Niem Tu Huynh and Joseph Kerski on teaching geography students about careers is based in North America but provides lots of useful starting points for communicating to students about potential geography careers. Some geography teachers might also find it useful in communicating to career advisors about the diversity of opportunities provided by a geographical education.

The book is very pricey indeed and probably not of sufficient utility to justify purchase by most teachers (or university lecturers). For those with access to the book via a library it would certainly be worthwhile exploring some of the chapters.

Associate Professor Kathleen Mee
The University of Newcastle

Hyper-socialised: how teachers enact the geography curriculum in late capitalism.
By David Mitchell. Routledge, 2020,
210 pages, soft cover, ISBN 9781138339101
https://www.routledge.com/

This book makes an important contribution to the small literature on the political economy of school geography. It is novel in the way it attempts to offer a more nuanced periodisation of the shifts in that political economy, and make links with contemporary debates about knowledge and the curriculum. Though it takes Britain as its focus, the arguments and themes resonate in Australia and New Zealand, where neoliberalism has made its mark on schooling and teachers’ work.

Nearly four decades ago, John Huckle (1985) reminded geography teachers that contrary to what they might think, the content of school geography is not determined by geography teachers or educationalists. Instead, school geography earned its place in the curriculum because it met the needs of capital for accumulation and legitimisation. Geography’s role was to socialise young people with the skills and attitudes required to take their place in the labour market, and to provide an overt ideology that hid the way that space was used to hide the nature of capitalist social relations and the exploitation of nature.

Huckle was writing as capitalism was making an uneasy transition from social democracy to neoliberalism. He would have been only dimly aware of the dramatic changes in teachers’ work that were to come. Whereas in the 1980s the state was actively
undermining teachers’ professionalism, by the mid-1990s teachers were being re-professionalised, granted permission to become pedagogical experts and take on their role as creative, autonomous professionals. This was within strict limits of course; calls for teachers to be open, flexible, and creative chimed with the post-Fordist reimagining of social relations. Capitalist schooling was cool, relations between staff and students more relaxed, and teachers were co-learners on the educational journey.

Elements of these new teacher identities are evident in the teachers that David Mitchell studied and interviewed in his study of four geography departments in London. No lack of agency here – these are intelligent, actively engaged, autonomous professionals, working hard to show their students why geography matters. There are differences of course (some departments coming closer to management injunctions and others finding ways to maintain true to their vision of geography as a subject) but this reflects the variegated landscape of schools.

They were all mindful of the changed nature of students and the need for engagement and relevance. In this sense, Mitchell gives us a snapshot of how geography teachers have readjusted to the new conditions of late capitalism. His argument is that these teachers are hyper-socialised; the forces shaping their work are determined elsewhere. This means that, on the whole, they “enact” rather than “make” the curriculum.

David Mitchell offers us a compelling (if a little bleak) picture of contemporary geography teaching. It would be good to try to pick out elements of how the curriculum might be changing to reflect different accounts of where capital is going next, but that is for further work. In the meantime, Hyper-socialised puts the political economy of school geography back on the map.

Professor John Morgan
University College London-Institute of Education,
University of Auckland

References

This book is not about cartographic geography, where space may be calibrated and quantified with positivistic certainty, nor is it replete with artistic hachuring and extravagant marginalia. Rather it is akin to the efflorescence of cultural geography that began to bloom thirty-odd years ago. Peter Jackson (1989) draws in turn from cultural studies where, in turn, Stuart Hall (1973, p. 13) referred to “maps of meaning into which any culture is organised” in an examination of the relationship between culture and a “television language” and his maps that were suffused with power and ideology.

The authors Bill and Jenny Bunbury chart understandings and misunderstandings between European and First Nations cultures over the two centuries of European occupation of Western Australia. The authors show sensitivity to others reminiscent of humanistic geography’s inclination to see the world from another’s point of view, or historical geographers that dwell on everyday lives and aspirations of the many rather than “the annals of kingship and conquest and the deeds of great men” (Lowenthal, 2015, p. 14). Or, as one anthropologist points out to another, not only “the crooks and brutal exploiters, but the honest and intelligent agents of colonialism need be accounted for” (Fabian, 1990, p 339, cited in Thomas, 1994, p. 15). Their emollient approach to the persistent and ever-present divides between the views of settler and First Nations people is admirable. An approach that is well expressed in the rapprochement between farming and Noongar communities after the 2015 unveiling of a memorial to the Kukenarup massacre of the 1880s (p. 155), and the apparently close relationships between British soldiers and the original inhabitants at King George Sound in the early decades of the 19th century (pp. 1–34).

Many maps employs both a temporal and spatial approach. Chapter 1 is set in the early 19th century in the immediate surrounds of King George Sound (present day Albany) where the Menang met the new strangers. Chapter 2 saw First Nations people of the new Swan River colony declared “British subjects” and then rapidly deprived of their land as six hundred British settlers arrived in 1829 and still more settlers arrived in this colony and further south in Augusta-Vasse (present day Cape Leeuwin, through Margaret River to Busselton). Chapter 3 concentrates on the early 19th century, the arrival of missionaries, movement beyond the coastal plain and over the Darling escarpment, south along the coast to Bunbury and north to New Norcia. In Chapter 4, set towards the end of the 19th century, European settlement expanded into the vast expanses of northern parts of Western Australia: Gascoigne, Pilbara and Kimberley.
A common strand in cultural geography in the 1990s was unequal relations of power. Sites of oppression and discrimination are transformed into spaces of resistance, seen not only through fighting back against power but also through resilience “refusing to be wiped off the map of history” (Pile & Keith, 1997, p xi). This is most particularly evident in Chapters 5 and 6. Firstly, examining First Nations voices living under the strictures of the Aborigines Act 1905, experiencing family breakdown, the destruction of traditional life and the ignominy of “taking the children away” (p. 253). Secondly, looking back at two centuries of dispossession and the notion, for First Nations people, that “we have survived”. Similar sentiments are expressed in Afterthoughts (pp. 305–308) that include some perceptive comments from a selection of interviewees and a section on the Uluru Statement from the Heart.

The effects of power relations can also be examined through another arena, settler colonialism. Rather than being framed as a historical event, where the settler colonists have “come to stay”, and “the process of depriving the traditional owners of their land was gradual but inexorable” (p. 62), settler colonialism endures, undergirds and shapes outcomes in settler societies. It exists long into the future, for example, in the chambers of Australian parliament with unedifying and frankly racist debates about the Mabo judgement and the Native Title Act 1993 (Whatmore, 2002). There are those that eschew the use of “settler states” entirely. Howitt (2020, p. 208) expresses his discomfort with the term because it implies that ownership is vested in the settlers, those who have inherited the benefits of conquest and colonialism by means of theft, enslavement and oppression. Many maps helps clarify the situatedness, the particularity and uniqueness, of settler colonial practice over two centuries across Western Australia, where hierarchical social relations still expedite the dispossession of First Nations people from their land and from their self-determining authority. The text also assists in examining what has been termed the affective geography of a postcolonising nation seen through expressions of loss, hurt, anger, shame, guilt and resentment in connection to rituals of apology, reparation and reconciliation (Gooder & Jacobs, 2002, p. 201). These sentiments and rituals are reflected in the various comments in Afterthoughts and the Uluru Statement from the Heart (pp. 305–309).

Another theme that emerges through Many maps and through much geographical writing relates to the process of racialisation (Kobayashi, 2003). The discussion of savages versus civilised humans (pp. 7–13, & 125) belies a far more extended discussion of race in human geography (Anderson, 2007; Kobayashi, 2003). Whereas race today is generally thought of as a socially constructed idea and that we all live racialised lives, (Jackson, 2003, p. 40) the notion of racial primitivism in New Holland (pp. 7, 12) prefaced the childlike or bestial breakdown, the destruction of traditional life and the ignominy of “taking the children away”. Thus, the prevalence of many polygenist theories of separately created races and the construction of distinct racial hierarchies was envisaged. The rise of scientific racism in the mid-19th century, based on the pseudo sciences of phrenology (p. 54) and craniology, reinforced the notion that First Nations people were examples of the earliest stages of human evolution, where at the turn of the 20th century, “the natural custom of their race is one of vagrancy” (p. 196). Further, the exotic character of Australian flora and fauna that defied European classification, where its people were conceived as an integral part of nature, apparently unable to till the soil nor pasture animals (pp. 7, 221), challenged the ontological separation of humans from non-humans to the extent that race was conceived as innate difference (Anderson, 2007). Thus, the prevalence of many polygenist theories of separately created races and the construction of distinct racial hierarchies according to their perceived relative worth. Humanity was thus divided into biologically permanent significantly different (innate) types (races) with the most inferior and subordinate at the bottom, First Nations people, (pp. 61, 164–165) and the most powerful and superior, the Europeans, ascendant (pp. 175–176).

More fundamental to geography is the concept of space. At one level it can be argued that Cook’s expedition to New Holland exemplifies absolute space while First Nations people see space in relational terms (Hutchinson, 2020). Moreover, it is possible to expand the concept to examine the transparent space of the European settlers which contrasts with the apparently more opaque space of First Nations people. McKittrick (2006, p. 6) explains that transparent space refers to space that is readily observed, i.e., what we see is knowable and readily decipherable, a space free of traps or secret places. More importantly, transparent space privileges the socio-scientific white masculinity of the European settlers, and denies the more opaque material and metaphysical geographies of First Nations people. Hence, the carving up of First Nations land into discrete envelopes of private property – land ownership regimes that were defended by the Colonial Office. McKittrick argues that transparent space is contestable. It becomes a site of resistance for black geographies, both in conceptual and material terms. It becomes the very terrain of political struggle. Many maps contains many examples of the material geographies of First Nations people in relation to farming, fish traps and bush tucker (pp. 10, 31–32, 55–57, 72–73, & 122) and metaphysical geographies where fence lines containing odd, smelly animals “severed the walking, the song and dance lines” (p. 32).

Finally, another way of reading Many maps as a geographer relates to studies of fire in Australia. This time taken from an orientation towards physical geography, biogeography and an emerging field of pyrogeography (Bowman, 1998; Bowman & Murphy, 2011). Bowman (1998) showed that a growing body of research has shown that Aboriginal fire use is skilful and responsible for the functioning of ecosystems that were encountered by European colonists, exemplified by the efficacy of fire in producing the luxuriant grass sprinkled with yellow buttercups found near Mount Barker in 1829 (p. 24). Head (1994) in a paper on Aboriginal fire use in Northern Australia found that Aboriginal people, who have been forbidden to light fires, were distressed by prohibitions on starting landscape fires. By the 1840s it had become illegal for Noongar to light fires (p. 82) but as Noongar Elder Lynette Knapp remarked, “When you re-burn, we say, the land is reborn” (p. 31). In the 1850s, beyond the Darling Range, according to historian Don Garden, the settlers rewarded local tribes with gifts of...
sheep and flour for a corroboree, when they consented to stop burning the bush (Garden 1979 cited in Many maps, p. 143).

Bowman (1998, p. 390) maintained that fire was a powerful tool that Aborigines used methodically and purposefully over the landscape. Misunderstandings between European and First Nations cultures can be illustrated by the fact that traditional owners, returning to country to live on “outstations” in the Kimberley in the 1980s, once again used fire as “the best tool for regenerating and managing the country” (p. 287) whereas a hundred years earlier the settlers thought that the natives were trying to “burn them out” (p. 180).

As the back-cover blurb accurately recounts: “The First Australian Nations mapped their world in terms of a spiritual and environmental relationship to country and an animate sense of being. The maps in European heads often explored ways to obtain wealth for the Australian earth. Many maps traces both misunderstandings of land and culture in a continent that we both inhabit”.

This text is highly recommended for geography teachers across the curriculum.

Nick Hutchinson
Sydney, New South Wales

References


As we delve further into the 21st Century, there is an ever-increasing importance placed on graphics and interactive technology, both in our everyday lives and in schools.

Paul Duncum’s new text Picture pedagogy: visual culture concepts to enhance the curriculum provides a fantastic perspective into the importance of graphics and visuals and how they can be used and understood for their intended meaning and audience.

As a teacher of design and photography as well as geography, I always ask students to examine the idea(s) behind the photographer or designer’s work to understand and acknowledge why the graphic or visual we are looking at came to be. What is its purpose and shock value? Will it be of value or use to others? Are infographics just a poster graphic or are they designed to be studied in detail like an artwork in a museum?

Duncum identifies that not all teachers place the same importance on visual communication skills and that students
need to have a stronger understanding of the importance of visuals and why they are so addictive, especially in the era of TikTok and Facebook social media platforms converting society to visual communication.

Picture pedagogy explores a variety of different social issues not only significant in geography, but also delves into the realms of the arts, languages, English, STEM and social studies suitable for middle and senior school curriculums.

The book is engaging from beginning to end, exploring the notions of still photography, film, media representations, infographics, visual literacy, genres and visual culture as an ever-expanding topic of debate and social change. Duncum explores how in the classroom you can unpack the notions of visual seduction and aesthetics in graphics to consume the viewer and establish the difference between glancing and analysing the messages behind graphics ranging from the Art of the Renaissance to the Art of Film and importance of story in the world cinema.

Students of 2021 are visual learners and in a world of such frequent and ever-changing social media, teachers need to understand the importance of the power in visuals communicating information. As social beings, we learn not just through words, but through body language, interpretations and engagement, most of which is learned through the eyes and senses, which is why visual culture is the focus of this text.

At the end of each chapter there are guiding questions and activities you can use with your students based on any of the 10 topics highlighted in the text. If you teach geography, this resource would be relevant to the Australian Curriculum looking at the notions and ideas of interconnections, visual literacy, culture and social responses, ethical agendas and the aesthetics essential to conveying knowledge and ideas to others.

Michael Pretty
Salisbury East High School, South Australia

Powerful geography: a curriculum with purpose in practice.
https://www.crownhouse.co.uk/

Mark Enser’s book is a thought-provoking and challenging call to arms for geography teachers.

It demands of them, in Part 1, that they identify the purpose behind their teaching of geography and, in Part 2, that they fulfill this purpose through the means by which they deliver the geography curriculum in practice.

Neither of these tasks is simple but, for geography teachers burdened by overly prescriptive and constantly changing national curricula, micro-managerialism, and pedagogical and political fads and fashions, this volume offers teachers both a partial explanation of the maelstroms in which they currently operate and some suggestions on how they might regain some agency and coherence in their own teaching practice.

Part 1 Purpose homes in on the geography curriculum through a consideration of what schools are for (Chapter 1), approaches to knowledge (Chapter 2), the historical development of school geography (Chapter 3) and “the shift in the ownership of curriculum creation from academic geographers through curriculum experts to politicians” (p.53), a process through which the subject of geography is all but lost sight of (Chapter 4), before articulating, in Chapter 5, a purpose for the geography curriculum. This purpose is based on the discipline’s big ideas (e.g., space, place, scale etc.) and the (geo)capabilities (e.g., a better understanding of the natural and social worlds, the ability to go beyond the limits of one’s personal experience etc.) that it can offer to those who study it.

Part 2 Practice begins by contending that the content (Chapter 6) of geographical curricula should impart powerful knowledge which provides new ways of thinking, helps pupils to explain and understand the world, gives them power over what they know, enables them to join in conversations and debates, and gives them knowledge of the world. This requires a purposive selection of the places chosen for study (Chapter 7), of the sequencing (Chapter 8) of the topics included in the curriculum, and of the activities (Chapter 9, Doing geography), such as fieldwork, that the students undertake. In Chapter 10 (Geography for the 21st century), Enser acknowledges that geography curricula are constantly changing in a changing world but, as he argues in his conclusion (Chapter 11), it is only though the purposeful imparting of powerful knowledge that the process of “putting the (geography) teacher back into education” (p.169) can occur.

Although this work is written from a British perspective, the issues and concepts raised therein are equally relevant in the Australian context and the work of Australian geographer-educators such as Alaric Maude and David Wadley are extensively cited.

Powerful geography is a stimulating and provocative read which should give any Australian geography teacher considerable food for thought and, ideally, action.

Professor Roy Jones
Curtin University, Perth
Rivers: the lifeblood of Australia.
By Ian Hoskins. National Library of Australia, 2020,
317 pages, hard cover, ISBN 9780642279569

The well-known travel writer George Farwell lamented in his 1967 book Australian landscapes that “No one has yet written of Australia in terms of its rivers” and pointed out how incongruous that neglect was, given the dryness of most of Australia and the pivotal role rivers played – and continue to play – in the human history of the continent.

Farwell’s insight still holds half-a-century later, and Ian Hoskins’ book on ten Australian rivers (or, more accurately, seven discrete rivers, a coupling of one river and its nearby cousin, and one massive river system) is a long-needed step in redressing that oversight. So how do you start to review such a potentially important book? Three topics stood out as matters that I thought I needed to address: (1) the choice of individual rivers; (2) the way in which each river or river system was treated from a factual perspective; and (3) the enjoyment the book might offer to the reader.

Even a country as dry as ours has a plethora of rivers, some permanent, some intermittent or ephemeral: the Geographical Names Board of New South Wales lists 439 rivers in that state alone. On what basis would you choose which ones to include and which ones to omit: on the basis of physiography, or climate type, or drainage basin, or seasonal flow regime? Each approach would throw up a different suite of rivers, and on page 29 Ian says that his choice was made in order to “traverse the history of Australia’s rivers and the human relationships to them” and that “they collectively span the continent”.

The rivers thus examined are the Yarra, the Snowy, the Clarence, the Murray, the Ord, the Molongolo and the Franklin, as well as the South Alligator and East Alligator (considered together), and the vast array of semi-permanent streams in the Channel Country of south-west Queensland. This choice inevitably raises the question of what rivers, or types of rivers, have been omitted. In my mind the Finke of central Australia stands out as an important omission, and there’s nothing from the massive south-western expanse of the country. But this is inevitably a personal choice and I fear that an author is probably going to be damned no matter whatever the selection.

In terms of the second matter, Ian’s treatment of the various rivers is always illuminating: for example, his analysis of why the Snowy River was developed so intensively in the mid-20th century – for hydroelectric power to fuel burgeoning postwar industry, to meet irrigation needs in the Murray-Darling basin, as a matter of national security – is even-handed and informative.

The third criterion: well, the book is beautifully written and beautifully illustrated. The text flows along as seamlessly as a languid, lowland river in its floodplain, and the photographs, maps and other images present as much a pleasant surprise on each new page as the view you get when rounding a bend in a coastal river and gazing on a new reach.

Criticisms? Really only two. The first is that, as an ecologist, I’d like to have seen the place of rivers in the Australian landscape given greater emphasis in the introductory chapter. From an ecological perspective, rivers are not just the water in the stream channel: they are also its riparian zone and its floodplain, and the infinitely complex connections of the surface water with groundwater via the hyporheic zone. But this criticism must be tempered with the recognition that Ian takes an openly historical and social approach to his subject, and there are many ways to skin a cat. Second, a short collation of essential references for further reading at the end of each chapter would not have gone amiss, as this would allow the reader to follow-up the specific river system that took his or her fancy.

So, would I recommend this book? Yes, wholeheartedly. At just under $50 it is a bargain, especially considering the exceptional standard of production: printed on high-quality paper, section-sewn binding, hundreds of full-colour figures. As a resource for geography teachers, it is well-nigh unique with regard to providing a social introduction to our country’s rivers.

Dr Paul I. Boon
School of Geography, The University of Melbourne

Slowdown: the end of the great acceleration – and why it’s good for the planet, the economy, and our lives.
By Danny Dorling. Yale University Press, 2020,
339 pages, hard cover, ISBN 9780300243406
https://yalebooks.yale.edu/

Slowdown provides an optimistic view of the future and significant data to suggest that the growth we have experienced across the world is slowing down. As a result, the future may look different to the one we expect.

The book is divided into twelve chapters, each of which explores a specific topic such as debt, data and fertility and how their trends over time suggest, for the most part, a slowdown. The book also contains an appendix which explains how to draw and read the timelines that are prevalent within the book. The timelines are very different to traditional timelines and allow total change as well as the rate of change to be analysed.

The first chapter provides context for the future chapters by providing a brief history of population change including data detailing the current deceleration of population change. The
second chapter provides interesting case studies from around the world that students could easily connect with, providing reasons for moving to the countryside. This could be useful in the Year 8 classroom, when teaching migration and push and pull factors.

Dorling examines patterns of housing, automobile, and student debt, detailing their deceleration, using interesting case studies from the United States and United Kingdom.

Climate is analysed by providing an insightful overview of CO$_2$ emissions from 1750 to 2018 and contrasting these patterns with those of data and debt. The chapter on temperature examines the effects of the CO$_2$ emissions and Dorling uses a variety of data sets to demonstrate the linear relationship between carbon emissions and a rise in temperature. Demographic data such as population growth and slowdown are analysed at a worldwide perspective as well as specific areas of the world such as India and Japan.

The chapter on fertility follows a similar rhythm to the other chapters, providing data from around the world and specific areas to compare fertility rates. Economics provides interesting data on a wide variety of data sets such as Gross Domestic Product, the price of gold, and housing prices to determine trends, and geopolitics looks at the influence of politics on society.

The last two chapters consider life and people and examine topics such as loss of biodiversity, inequality, worldwide life expectancy, and city centre growth.

*Slowdown* would be useful as a teacher resource, particularly in Year 10 and above. The book covers a wide variety of geographic concepts, in particular environment, interconnection, sustainability, scale, and change. It provides excellent data and interesting information which could be adapted for use in the classroom. Dorling has incorporated snippets of interesting information in each chapter as well as quantitative data to illustrate his points, which make the book easy to read and understand. I recommend this book.

Sarah McGill
Perth, Western Australia

Flannery cements the discussion with comparisons to the ongoing COVID-19 pandemic, describing particularly how governments can act when faced with an immediate threat to lives. The book is particularly relevant given the recent release of the Sixth Assessment Report by the Intergovernmental Panel on Climate Change.

The book starts with a discussion of the effects of current Australian Government policy on climate change and the additional concerns that come from the 2019–2020 megafires that occurred just prior to the COVID-19 pandemic. Calling this section “The Great Australian Tragedy”, Flannery compares the lack of action on reducing the impacts of climate change with the fast action that has occurred in responding to the pandemic. He particularly goes into his concerns with the connection between the Australian Government and the fossil fuels sector and how the need to act on climate change comes down to reducing (and stopping) emissions from fossil fuels.

The second part of this book goes into “The Three-Part Cure”, describing the need to end Australia’s reliance on fossil fuels, the need to adapt to the increasingly hostile climate in Australia, and the need to use drawdown pathways to reduce the carbon dioxide concentration in the atmosphere. Flannery’s passion on the need to reduce the amount of coal being burned for electricity was obvious and I found the discussion of the use of hydrogen, as a major clean fuel source for the future, very interesting and informative.

Flannery’s discussion of different drawdown measures (seaweed, carbon capture and carbon negative materials), compared to a vaccine for climate change, ended the book in a positive tone, indicating measures that can be taken to remove carbon dioxide from the atmosphere. The final actions summary helped to summarise his key arguments from the book and can be used as a call to action for what must be done by the Australian Government to act on this pressing crisis.

The link between the Climate Crisis and the COVID-19 pandemic helped to contextualise the inaction on climate change compared to the threat of the pandemic. It also discussed how quickly governments can act when required, which is in direct opposition to the action on the Climate Emergency. The discussion of methods to divest from fossil fuels is interesting and shows how we in Australia can very clearly reduce our reliance on this energy source.

I would recommend this book as an excellent additional information source for senior secondary geography teachers to continue their professional development on climate change. Whilst there is a significant political context, it coherently describes what must be done to solve this ever-increasing issue.

Catherine Holmes
Xavier College, Victoria

Tim Flannery’s *The climate cure: solving the climate emergency in the era of COVID-19* covers the issues currently being faced by Australia in the Climate Crisis, as well as a thorough discussion of actions that must be completed to reduce this threat.
The power of geography: ten maps that reveal the future of the world.
352 pages, hard cover, ISBN 9781783965953
https://eandtbooks.com/

Tim Marshall’s 2016 book Prisoners of geography aimed to explain global politics using ten case studies accompanied by maps. In this sequel, as the subtitle suggests, his purpose is to use ten maps to “reveal the future of our world”. Marshall, an experienced foreign correspondent, uses his background to explain the issues facing these locations. The scale of these studies is different, instead of covering continents and large regions of the world, here the concentration is mainly on specific countries. Eight countries, one region (the Sahel), and Space, all of these places containing the ingredients for possible future conflict, are included.

Each self-contained chapter follows the same pattern starting with a relief map of the specific place and its surrounding region; a description of its main physical features and how these factors have influenced its history, are still important and may influence the future activity. Other factors considered include: access to resources or conflict over resources, demography, climate and climate change, and the influence of culture, in particular, religion and ethnicity, and local and global politics.

Marshall outlines his main argument in the Introduction:

Geography is a key factor limiting what humanity can and cannot do. Yes, politicians are important but geography is more so. The choices people make, now and in the future, are never separate from their physical context. The starting point of any country’s story is its location in relation to neighbours, sea routes and natural resource . . . Geography is not fate – humans get a vote in what happens – but it matters. (pp. xiii–xiv).

The main issues addressed include: Australia (relations with the United States and China); Iran (Shia/Sunni rivalry and influence in the Middle East); Saudi Arabia (impact of declining use of oil); United Kingdom (post-Brexit future); Greece (conflict with Turkey and the migrant crisis); Turkey (conflict with Greece, refugees, emerging power in the region), The Sahel (refugees, desertification, terrorism); Ethiopia (regional and internal conflicts and control of water resources); Spain (regional separatism); and Space (ownership and possible conflicts).

The chapters on Greece, Turkey and the Sahel are closely linked especially the factors influencing the movement of migrants from Africa to Europe. Similarly, the Iran and Saudi Arabia chapters examine their struggle for regional political and religious influence.

The relief maps are detailed, but the print appears to be darker than in the previous volume and some of the place names are hard to read. Not all places mentioned in the text are located on the maps and the maps being spread over double pages affects their usability.

This is a very informative and detailed book, written in a very readable, accessible style with suggestions for recommended reading. While the title hints at revealing the future, much of each chapter is taken up with historical details.

The book is highly recommended as a background resource for geography, history and global politics teachers and for the general reader interested in gaining a more in-depth understanding of world issues and the important role of geography in aiding this understanding.

John Ramsdale
Montmorency, Victoria
and their challenges to Western perceptions and assumptions, the culture clashes between Western and indigenous African norms and values, not simply in binary terms but increasing nuanced realities, invites reflection. One is continually confronted with the paradox of plenty, where the abundant natural resources of Africa have rarely been reflected in the lives of ordinary Africans. Many will find challenging their critique of neo-liberal structural adjustment impositions by the Bretton-Woods institutions, corporate corruption, the institutionalisation of exploitation in the name of development and the increasing and complex role of China in Africa.

What is invariably lost in such an overview are the individual complexities of the many different nations of Africa, based on arbitrary colonial borders, comprising many different ethnic and religious groups, varied rural and urban settings, each with its own colonial and post-independence experiences. Moreover, the case studies are almost exclusively of Anglophone countries and the bibliographies are predominantly comprised of English-language sources.

Readers will find much in this volume that resonates well beyond Africa, inviting comparisons with Asia, Latin America and the Pacific, a wealth of issues and ideas for further independent study and research.

Associate Professor David Dorward (Retired)
Honorary Associate, History Department, La Trobe University, Victoria

Why study geography?
By Alan Parkinson. London Publishing Partnership, 2020,
199 pages, soft cover, ISBN 9781913019150
https://londonpublishingpartnership.co.uk/

Written by the incoming President of the United Kingdom’s Geographical Association, this book is part of the Why study series aimed at students, parents and teachers. The series seeks to explain the range and scope of a subject at tertiary level and where it can lead in terms of careers or further study. This particular book also aims to encourage students to continue with geography studies to A level (Year 12 equivalent).

The book contains an introduction and eight chapters. The introduction sets out the seven key questions which the author seeks to address. These range from what geography involves, why it is important, what important skills and knowledge can be gained, and what careers are available which use those skills and knowledge. It was encouraging to read of the increased uptake of geography in England, Wales and Northern Ireland at both General Certificate of Secondary Education and A level which is, according to the author, a sign that the value of the subject is being increasingly recognised. The author also makes links to the global impact of COVID-19 and the importance of geographical studies in making sense of the impact of this in our globalised world.

Why geography matters more
By Peter Anthamatten. Routledge, 2020,
URL: https://www.routledge.com/

This book introduces the concepts and theories of modern cartography needed to make clear, coherent and useful maps. Students beginning tertiary studies in geospatial science are the target audience. The first part (chapters 1–3) examines the fundamental attributes of a map and the key decisions to be considered when making one. The central part (chapters 4–9) explores design principles, commonly-used projections and the types of maps they complement, current trends in 3D, animated and mobile mapping, and scholarship in cartography. The final part (chapters 10–12) focuses on the technical aspects of map production, including data gathering for input and refinement in GIS and graphics software. To conclude, the author provides samples of his fieldwork, giving the reader a feel for real-life scenarios when making maps for a client. An appendix called “Maps from the Wild” features a map gallery sourced from the internet. These maps are referenced throughout to demonstrate the diverse ways maps are used to communicate information in a globalised world.

There is a companion website to the book with practical exercises in map reading and basic map production using
Spatial analytics software ArcGIS and graphics application Adobe Illustrator. The eBook and paperback editions are reasonably priced and I see potential for use as a teacher resource to prepare content for upper secondary classes in visual arts, humanities and digital technologies. There is a series of questions at the end of each chapter to prompt student discussion.

What I found most engaging about this book was the theoretical analysis, particularly the chapters on map projections and scholarship in critical cartography. The inherent contradiction of simplifying reality through distortion and evaluating the social and political power structures at play is fascinating. Historically, maps have been used to exert control over the environment and the people inhabiting it, but the power dynamic is shifting with the average citizen able to easily access, harness and contribute to open data. They can resist control by demonstrating an alternative geographical view that promotes democratic discourse and positive social and environmental change.

In order to convey information clearly on a map it is necessary to be highly selective. This inevitably results in a subjective perspective presented by the cartographer. With a proliferation of information readily available, the author emphasises that it is all the more important to find authoritative data and use it responsibly to provide a balanced narrative that is as accurate and honest as possible.

Sarah Ryan
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