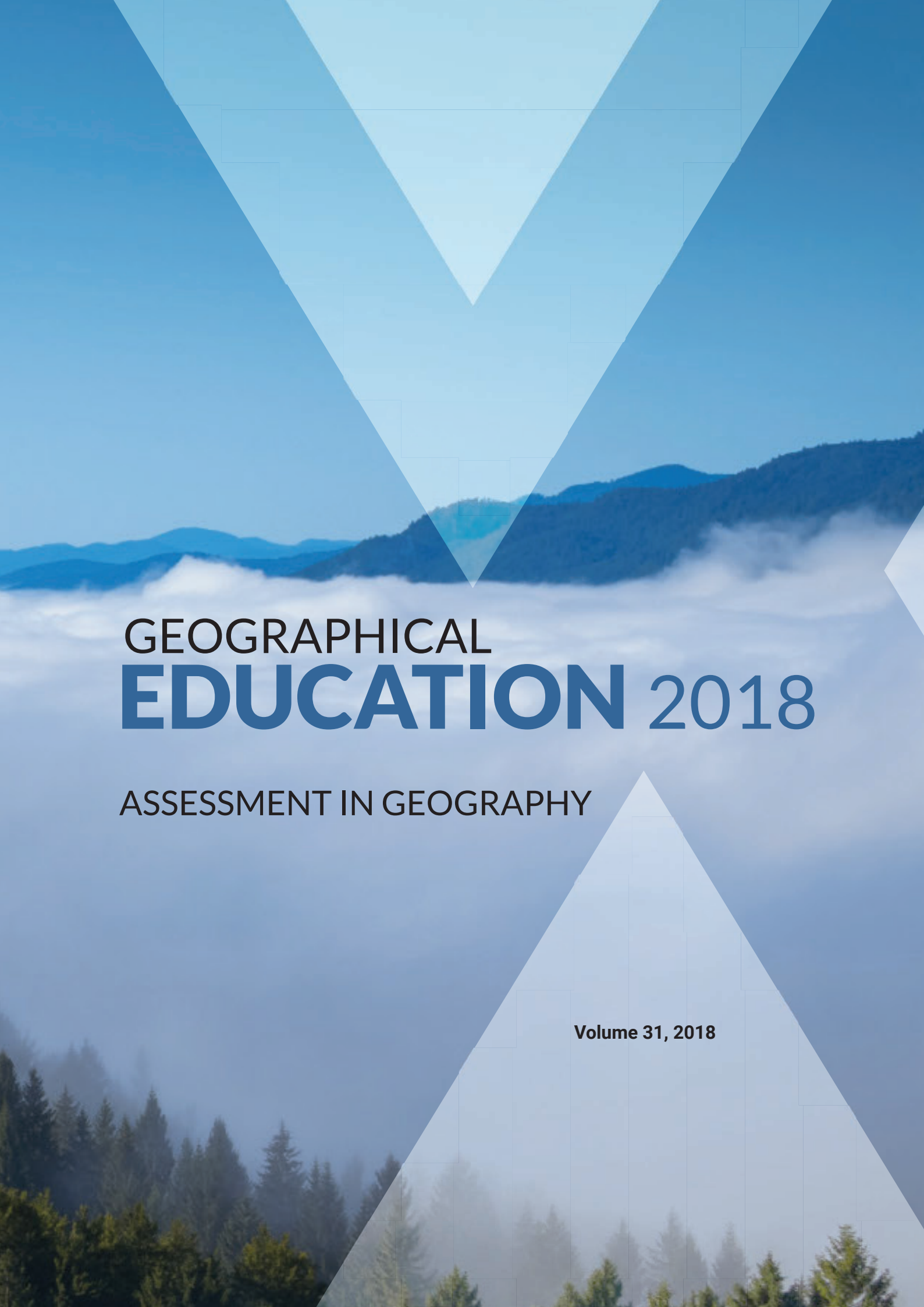

GEOGRAPHICAL EDUCATION 2018

ASSESSMENT IN GEOGRAPHY

Volume 31, 2018

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, in-service education workshops and comments on previous articles are especially welcome.
- Lesson plans, teaching units and how-to-do-it advice on classroom and field skills are also invited as long as they have relevance for a broad range of teachers across Australia.

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Headings: Major and minor sub-headings should be used to guide the reader and to break up the text.

Paragraphs: Paragraphs should start without indentation and should be separated by blank lines. All text should be left justified.

Quotations: These should be kept to a minimum and where over 40 words should be indented. These must be appropriately referenced.

End/footnotes: These should be avoided if possible.

References: Authors are requested to use the APA (American Psychological Association) style as shown in the exemplar at http://www.apastyle.org/index.aspx. All references, including internet sources, should be provided in alphabetical order on a separate sheet. The titles of journals should not be abbreviated.

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Contents

Geographical Education **is published annually and is distributed to all members of the state and territory associations affiliated with the Australian Geography Teachers Association Limited.**

The aims of the journal are to:

- encourage school, college and university teachers and all others interested in Geography to share their ideas and experiences;
- promote sound practice and encourage the developments of innovative strategies for teaching Geography in the classroom and the field;
- provide a forum for discussion between teachers on issues and direction of Geographical education;
- encourage reflection on the scope and purpose of Geography and its role as a medium for the education of young people;
- promote the diffusion of developments in Geography and examples of ways they may be introduced into Geography teaching;
- examine educational issues and trends in the light of their relevance for Geography teaching; and
- disseminate news of AGTA activities and information of national interest from state affiliates.

Review

Geographical Education is a refereed journal. Articles submitted to *Geographical Education* for consideration are reviewed anonymously by a minimum of two reviewers from the list below. Articles are selected by the editor based on the outcome of the anonymous reviews and ratified by the Journal Advisory Committee. Authors of accepted articles are sent guidelines for their final submission. Contributions to other sections such as Book Reviews and Reports are not refereed.

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Editorial

Reports

Articles

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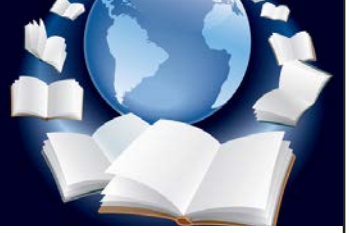

Editorial

Rod Lane and Terri Bourke
Co-editors, *Geographical Education*

Welcome to this edition of *Geographical Education* on assessment in geography. As new editors to this journal, we chose to focus on assessment in geographical education as our own previous research highlighted a gap around this topic. While we know a lot about the general principles of effective educational assessment, little is known about evidence-based approaches for assessing geographical concepts and skills. With the focus on evidence-based practice in Australia and globally, it is timely to bring assessment to the forefront of our thinking.

The papers in this volume highlight geography educators' assessment research from various parts of the world. An update is provided on an international collaboration between the United States, Australia, South Korea, Czechia, Singapore, Switzerland and the Netherlands as researchers from these countries strive to put international assessment in geography on the map. Individual papers elaborate on specific assessment projects in Singapore, the Netherlands and Australia.

The first paper reports on an international research process that has been underway since 2016 to design and develop an international geography assessment for implementation in lower secondary settings. The article provides a rationale for such an assessment, reports the findings of foundational research, and presents a provisional assessment framework. The framework will guide the specifications for tasks and tests, evaluation procedures, and measurement models. The methodology draws on an evidence-centred design, which involves a sequential approach to domain analysis and modelling. The article concludes with a reiteration of the value of an international assessment and an outline of activities moving forward.

The second paper is from Australia. In this paper Lane and Caldis report on a participatory action research project as a tool for not only enhancing pedagogical content knowledge but also improving assessment practices in school geography. Senior high school students' alternative conceptions are investigated as a foundation for developing strategies for addressing common misunderstandings and improving depth and accuracy of students' knowledge of rivers. Using an inquiry-based approach that includes fieldwork, students and teachers took part in a range of activities to support the construction of valid and reliable assessment instruments for future fieldwork activities.

The final two papers in this volume consider issues of assessment validity in geographical education. First, Chang and Seow focus on consequential validity. These authors argue that geography educators are interested in evaluating whether students are developing as active and engaged global citizens. This involves the assessment of knowledge, skills and values outcomes and requires geographical educators looking beyond student examination results. Second, Bijsterbosch examines construct validity by investigating the impact of the Dutch national examinations on the enacted curriculum and school assessment. He concludes that teachers should carefully consider the aims and objectives of the curriculum when designing internal assessment rather than using school-based assessments as practice for high-stakes examinations. Bijsterbosch claims that this practice distorts the alignment between the curriculum and assessment and results in a culture of teaching to the test.

Many thanks to both the writers of the articles 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 (migration, weather, maps, oceans and soils) and the teaching of geography (geographical thinking, inquiry-based learning and becoming an outstanding geography teacher). AGTA looks forward to contributions to the next edition of the journal Volume 32, 2019.

Chair of Directors Annual Report, 2018

Trish Douglas
Chair, Australian Geography Teachers Association Limited

In 2018, we welcomed several new Directors to the Board due to changes in the various Affiliates. As per our Constitution, Presidents of each member state or territory Affiliate are automatically appointed to the Board. Additionally, each Affiliate has a nominated Board member. Since each Affiliate has slightly different timings for their annual general meetings, Board membership changes throughout the year. The current list of AGTA Directors is maintained on our website. AGTA Executive for 2018 consisted of me as Chair with Darryl Michie (WA) as Deputy Chair. Dr Grant Kleeman (NSW) fulfilled the roles of both Treasurer and Immediate Past Chair and Anna Griffin (WA) took on the role of Secretary. In order to foster links with tertiary institutions, we have been delighted to have a member of the Institute of Australian Geographers attend our Board meetings as an observer.

AGTA Resources

AGTA's two current publications, *Geography skills unlocked* (published 2016) and *Geography literacy unlocked* (2017) continued to sell well throughout the year with an update and reprint of the former being required. A third book in the series, *Geography fieldwork unlocked* is currently in production. AGTA is indebted to Dr Grant Kleeman, for all his work in relation to these textbooks. The publication of these resources continues to provide an essential income stream for our organisation.

For a number of years, AGTA has also derived valuable income from the production of three CDs written by former Chair Malcolm McInerney. These resources, *Thinking geographically*, *Twenty-first century geography* and *Being a citizen*, will be discontinued in the coming year as the current format is no longer appropriate for use by most teachers. However, I wish to publicly thank Malcolm for his generosity in sharing his intellectual property with AGTA and for providing such well-regarded teacher resources.

Priorities for 2018–2019

At the May 2018 meeting, the AGTA Board identified the following priorities for the year:

- updating the AGTA website;
- updating the links provided on *GeogSpace* website;
- promoting geography and its relevance to STEM and digital technologies;
- active promotion of geography and its links to careers in order to encourage student uptake of the subject.

AGTA's representative work

AGTA has an important role in representing geography teachers on a range of national committees to ensure that the voice of geography educators in schools is heard. Thank you to the following people who have represented AGTA at meetings involving the following organisations:

- Australian Alliance of Associations in Education: Trish Douglas;
- Australian Federation of Societies for Studies of Society and the Environment: Rob Berry/ Trish Douglas;
- Institute of Australian Geographers: Susan Caldis;
- Australian Academy of Science's National Committee of Geography: Grant Kleeman;
- Australian Geography Competition: Jamie Clothier and Anne–Marie Gerlach.

Student Geography competitions/ activities

AGTA continues to be involved in a joint initiative with the Royal Geographical Society of Queensland (RGSQ) in the running of the annual Australian Geography Competition. In 2018, over 72,000 students across Australia participated in the competition. The competition helps raise the profile of geography both within schools and at a national level. Thank you to Bernard Fitzpatrick at RGSQ for his work in managing this event.

The top performing students in the competition are invited to participate in Geography's Big Week Out (GBWO) which forms the basis of selection for representing Australia in the International Geography Olympiad. The 2018 GBWO was again facilitated by Liam Sloan from the Geography Teachers Association of South Australia at Kangaroo Island.

A team of four students went on to represent Australia in the International Geography Olympiad in Quebec, Canada held in late July to early August. They performed extremely well, returning home with two bronze medals. Thank you to

Competition Committee member Kathryn Berg and GTASA representative Liam Sloan who accompanied the students. In 2019, China will be hosting the iGeo in Hong Kong.

Geographical Education

Geographical Education (ISSN 2204-0242) is the professional journal of AGTA and is on the DEST Register of Refereed Journals. The journal was published in print form until Volume 25, 2012. Since then the journal has been published in a digital format and is available on the Association's website.

Contributions of varying length are invited, with a maximum of 5,000 words for major articles and research reports. Shorter articles of 2,000 words, featuring classroom strategies, reflections on particular issues and practices in geography teaching, in-service education workshops, and comments on previous articles are especially welcome.

In 2018, the role of Journal Editor has been ably taken up by Dr Terri Bourke and Dr Rod Lane. Geoffrey Paterson continues in his roles of Reviews Editor and copy editor.

Geographia

AGTA's newsletter *Geographia* is used to update the broader membership on the activities of AGTA and its state- and territory-based Affiliates. This vital role was filled again this year by Julie Hearnden and Anna Hind (GHTANT). Their work in producing this high quality document is much appreciated.

AGTA Conference, October 2019

The next Australian Geography Teachers Association Conference will be hosted by GTAQ at the Gold Coast from October 1–4 2019 with Rebecca Nicholas fulfilling the role of Conference Convenor. The 2019 conference theme is "The Innovative Geographer". In an ever changing world, the study of geography has become increasingly important. The technologies needed to collect, manage and represent our world are constantly changing. The proliferation of *big data* and the everyday use of spatial technologies means that geography teachers need to innovate in the classroom to ensure their students have the 21st century skills they will need to be successful beyond high school. However, innovation is not only linked to technological change. Geography teachers must also be innovative in their subject knowledge, curriculum development and pedagogy, to ensure students are engaged, and develop critical, creative and collaborative skills both in the classroom and in the field.

The 2019 AGTA conference program will provide opportunities for teachers from across Australia and beyond to share and reflect on their own innovations in the geography classroom. The social activities, including Welcome Drinks and the Conference Dinner, will provide an ideal opportunity to network with fellow geographers from across the country. I hope to see many of you at what promises to be an exciting and valuable professional development.

Thank you

On behalf of the Board, thank you to Rob Berry who has continued to manage the AGTA website, even when travelling. Thank you to all the AGTA Board members for their work in the past year, particularly the AGTA Executive. Being a Board member brings with it considerable responsibility and demands on personal time.

At the Annual General Meeting held on 28 October 2018, the following people were elected to the AGTA Executive for 2019:

Chair: Trish Douglas
Deputy Chair: Darryl Michie
Treasurer: Grant Kleeman
Secretary: Anna Griffin
Immediate Past Chair: Grant Kleeman.

I trust AGTA will continue to play a significant role in the strengthening of geographical education across the country in the year ahead.

An Assessment Framework and Methodology for a Trends in International Geography Assessment Study (TIGAS)

Michael Solem
National Center for Research in Geography Education, USA
Joseph Stoltman
Western Michigan University, USA
Rod Lane
Macquarie University, Australia
Terri Bourke
Queensland University of Technology, Australia
Chew Hung Chang
National Institute of Education, Singapore
Kathrin Viehrig
University of Applied Sciences and Arts Northwestern Switzerland

Abstract

Since 2016 an international research process has been underway to design and develop an international geography assessment for implementation in lower secondary education settings. One of the crucial steps in this process is the development and validation of an assessment framework that models the content and cognitive dimensions of geography education to enable internationally valid, reliable, and fair measures of geographic constructs. This paper provides a rationale for an international assessment in geography and reports the findings of foundational research that produced the provisional assessment framework. Our methodology draws on the evidence-centered design to educational assessment development, which involves a sequential approach to domain analysis and modelling. The framework will guide the specifications for tasks and tests, evaluation procedures, and measurement models. The article concludes with a reiteration of the value of an international assessment and an outline of the activities moving forward.

Introduction

The authors are members of a study group established in 2016 to design and develop a Trends in International Geography Assessment Study (TIGAS). The idea for TIGAS originated in April 2014, when Hans Wagemaker, an evaluation consultant with International Association for the Evaluation of Educational Achievement (IEA), visited Professor Joseph Stoltman at Western Michigan University. IEA coordinates the international administration of Trends in International Mathematics and Science Study (TIMSS) and other international comparative assessments including the Progress in International Reading Literacy Study (PIRLS), International Civic and Citizenship Education Study (ICCS), and the International Computer and Information Literacy Study (ICILS).

Conversations between Wagemaker and Stoltman led to a recognition that geography would be a prime candidate for an IEA assessment. That meeting was followed with a proposal to the IGU Commission on Geographical Education (IGU-CGE) in Krakow, which approved the formation of a Task Force (Dr Rod Lane, Dr Terri Bourke, and Professor Joseph Stoltman) charged with studying the feasibility of an international geography assessment. Lane and Bourke were assigned to complete a needs/interest survey for a geography assessment modelled on TIMSS; this survey confirmed the strong interest of the international academic geography education community (Lane and Bourke, 2016a). The findings of the survey were delivered to IEA and discussed with the TIMSS, IGU-CGE, U.S., Asian, and European constituents to ascertain the best grade/age level for an international assessment. Based on information gathered from this process, IEA concluded that an assessment for lower secondary education (learners aged 13–14 years) would be the most viable option for an international geography assessment.

Rationale and Significance

There are many reasons why the proposed international geography assessment is needed. First, the assessment should encourage thinking about geography education in an international context. International collaboration is a major driver of research and discovery in the geography discipline, yet educational research in the field is almost always conducted in a national rather than an international context (Lane & Bourke, 2017). Current national, state, and provincial geography assessments were largely developed to inform domestic educational priorities, and the data they produce tend to focus on localised or regional content knowledge lacking global relevancy. TIGAS will produce an assessment that is consistent with the transnational epistemic qualities of the discipline. The project's research, design, and development activities will identify and measure geographic content and practices that represent academic outcomes that all young people need for understanding issues and processes operating across multiple scales of society and the environment (e.g., global climate change, natural hazards such as earthquakes and hurricanes, the impact of urbanisation on the availability of resources, the effects of industrial pollution on ocean ecosystems, human migration, and globalisation).

An international geography assessment would be expected to capture the depth of students' ability to think geographically beyond their local or national perspectives. As with other sciences, the nature of geographic knowledge is conceptual, theoretical, and contested. An international assessment of students' use of geographic information, facts, concepts, processes, and models is necessary to reveal how geography is understood and practised by students within diverse global contexts. This is important because no single country can resolve issues, such as global climate change, facing the world's people, places, and environments. It is unquestionably in the national interest of all countries for students to learn geography at a world standard and for educational policymakers to work cooperatively with other countries to raise the quality of geography education internationally. From this undertaking, participating countries stand to gain a citizenry capable of making more informed decisions and a workforce possessing the geographic knowledge, skills, and abilities needed to address global issues through multilateral action.

Over time, the trend data from the international geography assessment may well facilitate the development of new theories of geography learning by supporting investigations that are at present difficult or impossible to conduct, including questions such as:

- How is geography education implemented in participating countries?
- What is the extent and variation of students' geography education knowledge within and across participating countries?
- What is the extent of engagement with geography education in different spheres of society and what are the related factors within and across countries?
- What beliefs do students in participating countries hold regarding geographic issues in modern society and what are the factors influencing variation in students' dispositions?
- How are schools in the participating countries organised with regard to geography education and what is the curricular association with students' learning outcomes?
- Which beliefs do teachers in the participating countries hold regarding geographic education?

Having comparative data from an international geography assessment is the best possible way of evaluating the future capacity of students to engage internationally with the perspectives of their peers and participate as globally-minded individuals able to work cooperatively and collaboratively on issues that threaten Earth's diverse environments. Yet unlike subjects such as mathematics and science, there is currently no reliable international source of assessment data informing policymakers about what students in lower secondary school know and are able to do in geography that will help them live productive and informed lives when they complete school.

It is true that some widely recognised geographic concepts and knowledge are currently present in TIMSS Earth Science and Biology topics (e.g., weather patterns, natural resources, and anthropogenic changes to natural environments). However, many of these earth science and biology items lack a spatial or geographical context. An international assessment in geography would capture those elements of human geography that are at present not a focus of existing international assessments.

In many countries, geography lessons receive less attention in favour of subjects that are tested in international comparative studies such as the Programme for International Student Assessment (PISA) and TIMSS. Although these international assessments have been critically debated (Lane & Bourke, 2016b), it cannot be denied that they generate a strong scientific and societal source of information that is valuable for planning, policy formulation, and researching the relationship between school curricula and society.

In practice, we acknowledge that some observers may simply use the comparative data from an international assessment to rank nations on the basis of student achievement. Even so, the intent and deeper value of this project will come in the form of long-term trend studies informing what all nations must do to elevate the capabilities of students to take on the shared challenges of this day and age.

Evidence-Centered Design for TIGAS Development

TIGAS will require an assessment framework developed as a data-based document, relying on both quantitative and qualitative data from literature reviews and surveys. An evidence-centered design (ECD) for substantiating the framework theoretically is required. ECD is a structured approach to assessment development that views assessment as an evidentiary argument of what students know and can do (Brennan, 2010). The overarching research question is: *What characteristics of assessment design, implementation, and delivery enable internationally valid comparisons of what students in lower secondary education settings know and are able to do in geography?* This question is fundamental to the further development of TIGAS. Each step will be informed by ECD, which has five components with distinct roles in a comprehensive assessment process (Mislevy & Haertel, 2006).

a. ***Domain Analysis:*** This involves gathering substantive information about the domain to be assessed. For TIGAS, domain analysis will involve an international comparative analysis of geography curricula in lower secondary education with a broader sample to identify threads of geographic content and practices which extend the preliminary survey.

b. ***Domain Modelling:*** This step involves expressing the assessment argument in narrative form based on the domain analysis. We anticipate this narrative will specify geographic content and practices that the participating countries expect of students in lower secondary education.

c. ***Assessment Framework:*** Following domain analysis and modelling, the provisional framework will be further developed, expressing the assessment argument in structures and specifications for items and tasks, evaluation procedures, and measurement models. This framework will include geographic content and cognitive dimensions.

d. ***Assessment Implementation:*** This step is designed to implement the assessment including presentation-ready items and tasks and calibrated measurement models. Implementation of the international geography assessment will be conducted digitally to support items which utilise geo-visualisation and mapping technologies.

e. ***Assessment Delivery:*** The final activity in ECD involves coordinating the interaction of students with items and tasks, followed by assessment scoring, and reporting. It is planned for the IEA to manage this coordination within and between participating countries.

As the ECD model is followed, national assessments from different countries will provide sources from which to assemble prototype items for field trials and subsequent analysis. *The International Charter on Geographical Education* (IGU-CGE, 2016) served as a major source for the identification of assessable content for the assessment framework. The Charter was developed by the international community of geography educators, and thus is a definitive statement regarding geography education content internationally.

Assessment prototypes will need to meet criteria established in the assessment framework and serve as models for constructing equivalent items. Prototype items will be sourced from a variety of geography-related assessments and publications produced in different countries. These include TIMSS/PISA Geoscience subtests; The International Assessment of Educational Progress (U.S. Department of Education et al., 1992); the IGU InterGeo Project (Lambert & Purnell, 1994; Niemz & Stoltman, 1993); Global Geographic Literacy Study (National Geographic Education Foundation, 2002) and research on geographic educational assessment by Gerber (2001). Furthermore, the research will draw from assessment literatures on spatial thinking and reasoning (e.g., Chung, Cannady, & Kremer,, 2015; Huynh & Sharpe, 2013; Lee & Bednarz, 2012) and systemic thinking (e.g., Mehren et al., 2016; Viehrig, 2015; Viehrig et al., 2017).

The geoscience and geography education communities have also produced a variety of studies dealing with learner conceptualisations, for example, the geoscience concept inventory by Libarkin and Anderson (2005) and studies regarding topics, such as water (e.g., Ben-Zvi Assaraf & Orion, 2005; Reinfried, Tempelmann, & Aeschbacher, 2012), avalanches (e.g., Rempfler, 2010), tsunamis (Etterich, 2013), cyclones (e.g., Lane & Catling, 2016; Lane & Coutts, 2012), and the polar regions (Adamina, 2008; Conrad, 2012).

Viehrig and Lane are currently exploring options to use wiki technology (http://geoconcepts.geographyteachereducator.com) to collect central results and implications of different studies and make them accessible not just for the item designers within TIGAS but also for teachers and preservice teachers.

The following is a summary of work completed by the TIGAS Study Group between September 2016 and June 2018, in preparation for Phase 1 (Assessment Framework Development). This prior work focused primarily on the first two components of Evidence-Centered Design (domain analysis and domain modelling) and involved an international curriculum survey and preliminary analyses of assessment prototypes. This work resulted in a provisional assessment framework and will inform further development of the framework and item development scheduled in Phase 1.

Summary of Work Completed (September 2016 to present)

Curriculum survey

In September 2016, a survey was conducted of the eight members of the TIGAS Group to identify geographic concepts and content threads common to 8th-grade geography classrooms in South Korea, The Netherlands, Czechia, Switzerland, Singapore, Australia, and the United States. The survey questions were:

1. What type of curriculum document is used in your country for 13/14 year olds?
2. Is geography taught as a stand-alone subject for 13/14 year olds?
3. What geographical contemporary issues are present in your curriculum document for 13/14 year olds?
4. What domains are addressed in the curriculum document for 13/14 year olds?
5. What conceptual knowledge and understanding should 13/14 year old students in your country/state have learned?
6. What skills should 13/14 year old students in your country/state have learned?
7. Which representations do students in your country/state work with by age 13/14?
8. What elements of enquiry should students in your country/state work with by age 13/14?

The following is a summary of the data analysis.

Seventy-five percent of respondents had a national curriculum document where geography was taught as a stand-alone subject in lower secondary schools. The other twenty-five percent were specific to provinces, cantons, counties, departments, or regions.

The contemporary geographical issues common within the curriculum documents in the seven countries were: urbanisation; energy supplies and management; environmental quality; hazards and disasters; global change; population dynamics/migration; sustainable development and climate change. With regard to domains, the most often cited were climatic geography; population geography; economic geography; geomorphology; urban geography and cultural geography. All were common to the seven countries. The key concepts identified in the curriculum documents are shown in Table 1 together with examples of the language indicative of the concept.

With regard to skills, the curriculum documents from the seven countries focused on making decisions, working cooperatively, solving problems, making judgements, developing generalisations, identifying questions and issues, processing, interpreting and evaluating data, and collecting and structuring information. Students were expected to work with a range of visual representations including: graphs, tables, diagrams, maps, renderings from Geographic Information Systems (GIS), and photographs. Listening skills for verbal information narratives in printed materials were deemed very important skills. Most countries required students to work with quantitative, in addition to various forms of qualitative, data including cartoons, photographs, comics, transcripts and satellite images. Finally, the elements of geographical enquiry were central to curriculum documents in each country.

Review of Select Assessment Items

Next, the TIGAS Study Group analysed selected geography assessments from the U.S., Australia, and Singapore in an effort to categorise them according to targeted ability, item characteristics, and confounding factors (Edelson, Shavelson, & Wertheim, 2013).

Targeted ability refers to the substance of what an item assesses, spanning content, skills, and cognitive ability. The focus here was on students' geographic conceptions and content applications. This involved the creation of a comparison matrix for organising the international pool of geography assessment items. The matrix described the item types, stimuli, topic areas, depth of knowledge areas, and skills represented in the assessment items. *Item characteristics* describe how an assessment task is presented to the learner, including the setting, instructions, structure, and graphical representation in the stem or answer choices. *Confounding factors* were also identified.

Table 1: Key concepts from the curriculum analysis

Concepts	Examples
Space	'Spatial phenomena', 'extend their competencies regarding spatial topics', 'orient themselves spatially', 'preserve spatial foundations', 'spatial thinking'
Region	'Recognise diversity in different regions' 'Dynamic regional diversity'
Scale	'Interested in geographical issues of local, national and global contexts' 'Deep geographical knowledge of their own locality'
Interconnection	'Deal with connections and relationships' 'Relationship of humans to their natural and shaped environment' 'Human-environment interactions' 'Combined natural science/social science' 'Physical geographical aspects combined with human geographical aspects'
Change	'Development of humans and societies – reconstruct the past from the present to get orientation for the future'
Time	'Change in human/physical processes over time'
Sustainability	'To give thought to the future' 'Sustainable development' 'Contribute to the development of an environmentally and economically sustainable and socially just world'

This included the flaws in item design that needed to be corrected because they undermined item reliability, validity or fairness. Whilst the process only involved three countries, it enabled us to develop an approach for how this can be done on a much larger scale in the future.

The TIGAS Assessment Framework

During a Swiss National Science Foundation funded workshop in Windisch, Switzerland (September 10–12, 2017) a draft of the Assessment Framework was developed. In general, the framework was adapted from the principles used in TIMSS 2011 (Mullis, Martin, Foy, & Arora, 2012) and 2015 (Jones, Wheeler, & Centurino, 2013). Consideration was given to current international research and initiatives in geographic education, such as the International Charter on Geographical Education on which the curriculum survey outlined above was based (IGU-CGE, 2016).

The geography assessment framework is organised around two domains: a content domain and a cognitive domain.

The *content domain* includes four subdomains.

1. Earth's structure, physical environments and natural systems: including weather and climate, landforms, earthquakes and volcanic activity, and ecosystems.
2. Human environments and socio-economic systems: including population and settlements, economic processes, society, identities and conflicts.
3. Human-environment interactions and systems: including human activity and its relationships with processes in the atmosphere, hydrosphere, lithosphere and biosphere.
4. The world in spatial terms: including procedural knowledge, geographic methods and skills, and using such different visual representations as maps and satellite images.

The *cognitive domain* addresses students' abilities to think, demonstrate skills, and take action geographically along three cognitive processes.

1. **Knowing:** recalling, describing and providing examples, for example, knowing geographic facts, concepts, relationships and processes.
2. **Applying:** comparing, classifying, relating, interpreting, explaining or using models by applying knowledge of geographic facts,

concepts, relationships, procedures and methods in familiar contexts or in tasks that include the information needed for students to familiarise themselves with the specific spatial context.

3. **Reasoning:** analysing, synthesising, evaluating, generalising, inquiring, and extending knowledge and understanding to new geographic contexts.

The provisional framework can be found on the TIGAS project webpage at http://www.tigas2023.com/2018/tigas-assessment-framework-draft/

To elicit feedback from the international community about the draft framework, a social lab was conducted in Lisbon at the IGU-CGE Conference. The term *social lab* is used to describe the process of bringing together a diverse group of stakeholders to create new insights and to collaboratively explore, frame and co-create solutions to complex challenges. In social labs, emphasis is placed on dialogue, listening carefully, sharing ideas and prototyping solutions. The provisional framework that resulted from the Switzerland Workshop in 2017 was presented to participants using the following process as the social lab strategy.

1. Mapping the system: participants were introduced to the draft TIGAS framework.
2. Questioning existing approaches: The social lab participants collectively reflected on the domains and subdomains in the TIGAS framework by discussing and responding to the following prompts.

    a. Do you agree with the core concepts that have been outlined to represent the content domain?
    b. Do you think that anything is missing, should be changed or deleted (think about your country's curriculum document)?
    c. The content domains are elaborated as outcomes. Do you think that the cognitive level is appropriate for Grade 8 (13–14 years old)?
    d. With reference to the content domain, do you believe that the target percentages in terms of assessment time are appropriate for Grade 8?
    e. With reference to the cognitive domain, do you believe that the target percentages in terms of assessment time are appropriate for Grade 8? (Please note that we adapted the model for the TIMSS framework for descriptions of the cognitive domain).
    f. With reference to geographic practices, do you think that the framework captures the skills fundamental to the discipline of Geography? What would you note that appears to be missing?
    g. What other feedback do you have regarding the TIGAS framework?

Discussions were audio recorded and transcribed verbatim. Analysis of the social lab transcript will inform the next iteration of the framework. Further consultation will take place on the revised document. This is a work in progress. The authors encourage readers of this paper to provide feedback on the provisional framework by completing the questionnaire located on the TIGAS webpage as a continuation of the social lab: http://www.tigas2023.com/

Draft schedule for further development

To advance the process of developing the international geography assessment, the TIGAS group has planned four phases of design and development beginning in July 2018 (Figure 1). The Assessment Development Committee will consist of geography educators and geography education researchers from the participating countries, the co-Principal Investigators, and senior personnel including the lead Educational Testing Service (ETS) assessment developer. The ETS test development team will include the lead assessment developer, two assessment developers, fairness and editorial reviewers, a psychometrician, a statistical data analyst, a research scientist, as well as administrative and information technology staff who will be responsible for preparation of the assessment forms.

The TIGAS project's research, design, and development will emulate the collaborative process managed by the TIMSS & PIRLS International Study Center at Boston College. The participation of both IEA and Boston College personnel will enhance the probability that the internationally-validated geography items being developed will be ready for presentation and acceptance when the TIMSS National Research Coordinators next meet in 2021. Secure assessment items in TIMSS appear with every iteration or are modified as necessary to reflect changes in the scope of national curricula and to ensure comparability with prior TIMSS assessments. New item development is performed by TIMSS National Research Coordinators through a process that is dedicated to ensuring that the assessment materials can be translated accurately and used to measure comparable student outcomes in mathematics, science, and literacy skills. Because the proposed geography assessment will have no current international precursors, all of the items will need to be empirically-tested in international field trials.

Figure 1. Overall Timetable for TIGAS Design and Development

Phase 1. Assessment Framework Development	Phase 2. Item Development and Pilot Form Assembly	Phase 3. Pilot Assessment	Phase 4. Analysis and Reporting
2018–2019	2019–2020	2020–2021	2021–2022
Convene Assessment Development Committee (ADC) to author and review assessment framework.	Item selection. ADC review of pilot items, ETS content, fairness, and editorial reviews of pilot items.	Preparation of assessment forms for electronic administration. Preparation of administration software training for proctors.	Preliminary item analysis. Standard setting; Factor analysis; Item Response Theory; Differential item functioning and bias review. Final item analysis.
Select prototype items from national and provincial assessments.	Assessment forms assembly. ADC review of assembled forms.	Deployment of assessment software to pilot administration sites.	Preliminary exam score reporting. Committee review of scoring, assessment report development, and pilot program evaluation.
External reviews of assessment framework.	External review of assembled forms by assessment experts.	Assessment administration at pilot sites.	Pilot assessment report dissemination.
Item writing workshop; Item writing assignments.	Translation of assessment forms from English to national languages of non-English speaking countries.	Preparation of assessment data for analysis. Scoring of constructed response items.	Preparation for international geography assessment deployment during TIMSS 2023.

Conclusions

This paper provides a rationale for an international assessment in geography and has reported the findings of foundational research that produced a provisional assessment framework for TIGAS. A schedule for the further development of the framework and TIGAS assessment has been outlined. This development process affords a number of opportunities. These include building capacity for long-term innovative assessment research in geography education. Teachers and policymakers need current research data to make informed decisions about the educational needs of young people. There will also be opportunities for advanced level graduate students and early career scholars to develop original dissertations and postdoctoral research studies in such areas of psychometric research as item response theory, factor analysis, cognitive diagnostic modelling, and differential item and assessment functioning (Price, 2016; Penfield & Camilli, 2007; DiBello, Roussos, & Stout, 2007). Data from the international geography assessment will additionally support efforts to develop geography curricula focused on social and environmental issues operating across local, national, and international scales.

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Participatory Action Research: A Tool For Promoting Effective Assessment and Building the Pedagogical Content Knowledge of Secondary Geography Teachers

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This paper describes the results of an action research project undertaken as a partnership between Macquarie University and Geography teachers from an independent school in regional New South Wales (NSW), Australia. The project focused on the teaching of river landforms and processes, a component of the Biophysical Interactions topic in the NSW Stage 6 Geography syllabus. The aim of the research was to provide four teachers with feedback about depth and accuracy of students' content knowledge, the teachers' knowledge of common student conceptions, and the extent to which the school's fieldwork program promoted cognitive disequilibrium and constructive confusion, affective states required for deep conceptual change. This feedback was used as a prompt for professional reflection and to stimulate conversations about improvements that could be made to the teachers' knowledge and practice. The findings suggest that this form of action research can be an effective tool for enhancing teachers' pedagogical content knowledge (PCK) including their knowledge of evidence-based assessment practices in Geography.

Background for the study and review of the related literature

It is now well understood that students construct mental models (or pre-instructional conceptions) about how the world works prior to formal instruction. Some of these conceptions are consistent with current expert thinking in the discipline and can act as bridges to further understanding (Greca & Moreira, 2000). Other mental models, however, may appear to be incomplete or theoretically incorrect to a discipline expert. These ideas, known as alternative conceptions, (Arnaudin & Mintzes, 1985; Dove 1999; Lin & Cheng 2000) have a number of common characteristics. Firstly, alternative conceptions are robust and difficult to shift through instruction because they have been constructed from the learners' personal experiences and are continually reinforced by everyday interactions with family, friends and the media. Secondly, they are widely held by students and adults and are neither idiosyncratic nor culturally dependent. Thirdly, they have a significant impact on learning processes because they act as a lens through which learners interpret and decode information in order to construct meaning (Driver, Squires, Rushworth, & Wood-Robinson, 1994). Finally, these ideas are used to solve real world problems and therefore appear to the learner to be functional, plausible and evidence-based.

In order to promote deep understanding, it is argued that Geography teachers need to develop a deep knowledge of the ideas commonly held by students in specific topics and of evidence-based strategies for diagnosing and addressing these ideas (Clough & Driver, 1986; Dove, 1999). This knowledge forms an important component of teachers' PCK (Lane & Coutts, 2015; Berry, Friedrichsen, & Loughran, 2015; Shulman, 1986). According to Shulman (1986, p. 10), an understanding of alternative conceptions that students develop prior to formal instruction, and the instructional conditions necessary for overcoming these beliefs, should be 'at the heart of our definition of needed pedagogical knowledge'. Knowledge of students' alternative conceptions is foundational for the development of strategies and representations for addressing students' common areas of misunderstanding. Equally, this knowledge is important for the development of valid and reliable assessments for diagnosing and addressing students' learning in schools. There is a significant body of

research in science education demonstrating that instruction is most effective when it is informed by an understanding of the common alternative conceptions that students hold in specific topic areas (Park & Oliver, 2008). It is argued that teachers with well-developed knowledge in this area are in a better position to make sense of students' actions and beliefs and to develop strategies for addressing these ideas through instruction (Magnusson, Krajcik, & Borko, 1999).

Despite the importance of this knowledge base, recent empirical studies demonstrate that both Geography and science teachers have very limited knowledge of students' alternative conceptions across key areas of the curriculum and lack awareness of the importance of these ideas in the learning process (Lane, 2015). Teachers with an understanding of the role of alternative conceptions often lack knowledge of instructional strategies for diagnosing and addressing these ideas in real classroom settings (Lane & Coutts, 2015; Lane, 2015). In a study of experienced secondary Geography teachers from 16 comprehensive (non-selective) state, independent and catholic schools across three regions of Sydney (Sydney east, Sydney north and Sydney central, as defined by the NSW Department of Education and Communities), Lane (2015) found that many of the teachers were unaware of the importance of students' alternative conceptions in the learning process and/or held non-constructivist views of learning. Teachers with transmissionist beliefs about learning, for example, believed they could address misconceptions by telling students what they needed to know. The teachers lacked models of effective diagnostic assessment of students' ideas, and knowledge of evidence-based strategies for diagnosing and addressing these ideas. These findings are similar to those documented in science education (Berg & Brouwer, 1991; Halim & Meerah, 2002; Morrison & Lederman, 2003).

In response to the above the authors, in collaboration with the social science department of an independent school in regional NSW, developed a participatory action research project (PAR). The aim of the project was to help staff reflect on and improve their knowledge of alternative conceptions, diagnostic assessment approaches, and evidence-based strategies for improving students' depth and accuracy of understanding. PAR involves collaboration between academics, teachers, and community/organisation members to pool knowledge and develop solutions to problems (Greenwood & Levin, 1998; MacDonald, 2012). Several studies have shown PAR to be an effective approach for promoting professional learning in schools and initial teacher education programs (Burke, 2013; Draper, et al., 2011; Erdas-Kartal et al., 2018; Hales, 2017; Kemmis, McTaggart, & Nixon, 2014). In particular, these studies highlight the strengths of PAR as a tool for:

- improving collaboration and promoting the development of a community of practice – a group of teachers and academics who share a common goal of supporting student learning (Draper et al., 2011);
- promoting peer and student feedback (Burke, 2013);
- increasing the frequency and complexity of teacher discussion about professional practice (Hales, 2017); and
- shifting teachers' mind-sets and preconceptions (Erdas-Kartal et al., 2018).

Few studies, however, have looked at the role of PAR as a tool for assisting in-service secondary teachers to reflect on and improve their PCK, particularly their knowledge of, and work with, students' preconceptions. A review of the literature identified only three studies of this type. All were in science education. The first study in this area, conducted by Eilks and Markic (2011), aimed to improve the PCK of 10 chemistry teachers by engaging them in a PAR project with science education researchers over a six-year period. The results showed improvements in the PCK of the teachers including their attitudes towards teaching, and their ability to reflect on and improve their knowledge of learners and of strategies for promoting conceptual change. The second study (Williams, Eames, Hume, & Lockley, 2012) demonstrated how 'content representations' (CoRes), providing a holistic overview of an expert teacher's PCK in a particular topic, can be used as a tool for developing the PCK of early career science teachers. The most recent study in this area by Wongsopawiro, Zwart, and van Driel (2017) used a PAR approach to develop the PCK of 12 secondary science teachers. The teachers learned about new instructional strategies and assessment methods through literature reviews and discussions with peers. They also analysed and reflected on student learning as it happened in the classroom, and developed understandings that helped them select and apply instructional strategies to further promote student learning.

Methodology

In the project, the authors worked collaboratively with the Geography teachers of an independent school in regional NSW to gather and analyse data in order to improve the teachers' PCK and the effectiveness of their fieldwork program. This study, like most action research, involved a cyclical process of research, reflection and

action (Kemmis et al., 2014). In each step of the process, the authors worked in partnership with the teachers to design and execute the project. The teachers outlined the issues that they were interested in, drafted research questions, and developed a method that would enable their questions to be answered. Following discussions with the teachers the following research questions were proposed:

1. What are students' existing conceptions about river landforms and processes? What is the accuracy and depth of their understanding?
2. What knowledge do Geography teachers have of students' existing conceptions and how do they use this knowledge in the classroom?
3. To what extent does the fieldwork program promote cognitive disequilibrium and constructive confusion?
4. What do the research findings suggest about adaptations that could be made to current pedagogy?

The project involved four phases:

1. **Phase 1 –** Assessment of students' depth and accuracy of knowledge of river features processes.
2. **Phase 2 –** Assessment of teachers' knowledge of students' common alternative conceptions and evidence-based strategies for promoting conceptual change.
3. **Phase 3 –** Assessment of the extent to which the fieldwork activity stimulates cognitive conflict.
4. **Phase 4 –** Assessment of teachers' responses to the data from Phases 1 to 3.

The phases of the project are outlined in greater detail below.

Description of the research context and participants

The research was conducted at an independent school in regional NSW. The school, with a population of over 1000 students, has an excellent reputation for its Geography program especially the quality of its fieldwork. For over twenty years, the school has consecutively offered the Stage 6 Preliminary and Higher School Certificate (HSC) Geography courses. In 2018, there were two classes of students completing the Preliminary Geography course in Year 11 (n = 43) and two classes of students completing the HSC Geography course in Year 12 (n = 30).

In alignment with syllabus requirements, the first 45% of course time focuses on Biophysical Interactions. This unit involves the investigation of biophysical processes and their contribution to sustainable management within a chosen sphere, and the examination of a related issue affecting a specific environment. The teachers responsible for the design and delivery of the program decided to focus on river regulation in the hydrosphere using an inquiry-based learning approach that included fieldwork. To effectively develop knowledge and understanding about biophysical processes in a riverine environment, students require an understanding of such threshold concepts as erosion, deposition, and the water cycle. The fieldwork program for this topic was designed to provide an immersive learning experience about these core concepts and to serve as a foundation for further investigation of a riverine environment within the Year 12 topic Ecosystems at Risk.

The participants in this study were purposefully sampled. There were four specialist Geography teachers and forty-three students who were completing the Preliminary Geography course in Year 11. The students comprised boarders (48%) and day-students (52%). There was an even split of boys and girls in the group. All students had studied Geography across Years 7 to 10 in accordance with the requirements of the New South Wales Education Standards Authority. The teachers participating in this study were all full-time, permanent members of staff who were accredited to teach Geography at the Stage 6 level. Two of the teachers were teaching both the Preliminary and HSC Geography courses. All of the teachers and students participated in the study voluntarily. They were informed that they had the right to withdraw from the study at any time and that their reponses would be deidentified in any publication of the data.

Phase 1 – Baseline data collection from students

The first phase of the project aimed to collect baseline data about students' depth and accuracy of knowledge about river landforms and processes. Consistent with the advice of Brewer (2008) and Brown and Hamner (2008), the study applied a range of assessment techniques to gain a rich and detailed image of the students' underlying conceptions. Forty-three students completed a questionnaire and drawing tasks designed to identify common alternative conceptions related to river processes. The 28-item questionnaire consisted of true or false items and a confidence scale. Students were asked to mark each item as either true or false, and place a cross on the scale to indicate the degree of confidence in their response. Each item was developed from the literature on students' intuitive ideas about river landforms and processes, and the questionnaire was validated by a hydrologist and an Associate Professor in Geomorphology.

The next step involved a sample of the students (n =10) participating in a semi-structured interview and drawing task. Students who answered more than 10 of the questionnaire items incorrectly were invited to participate in the interviews as they were most likely to hold robust alternative conceptions about river features and processes. A scaffolded approach was adopted for this phase starting with a drawing task and open-ended questions, followed by specific probing questions. The instructions asked participants to complete a diagram of a river, include labels to identify the direction of flow and key landform features, and explain their diagram as if they were speaking to a classmate or friend. Data analysis for Phase 1 involved ranking the questionnaire items in terms of difficulty (proportion of the sample answering each item incorrectly) then triangulating these data with the results of the drawing task and semi-structured interview. This enabled the identification of common alternative conceptions amongst the student group. Ideas were considered to be reliable when they were consistent across the questionnaire, drawing task and interview.

Students' interview responses and drawings were also analysed to determine their depth of understanding using the SOLO (Structure of the Observed Learning Outcome) taxonomy (Biggs & Collis, 1982). The SOLO taxonomy describes changes in the way learners structure their oral and written responses as they develop understanding. According to Biggs and Collis (1982), individuals develop the capacity to communicate in more complex ways as they learn. This involves both quantitative changes in the amount of detail provided as well as qualitative differences in structural complexity and integration. A five-level taxonomy to describe this sequence of development in the *quality* of students' responses shows that levels of complexity in understanding vary from *pre-structural* (where individuals miss the point or simply rephrase the question), through to *relational* and *extended abstract* levels where learners are able to explain the links between key concepts (relational thinking) and conceptualise key ideas at a higher level of abstraction (Biggs & Collis, 1982). Each additional level of the taxonomy subsumes and extends the levels below it as demonstrated in Table 1.

The SOLO framework was operationalised in the study through the development of a protocol for classifying the structural complexity and depth of students' responses as shown in Table 2. Classification judgments were made on balance using evidence from multiple data sources including students' questionnaire responses, their drawings, and answers to the semi-structured interview questions.

Phase 2 – Assessment of the teachers' knowledge of students' common alternative conceptions and evidence-based strategies for promoting conceptual change

The teachers' knowledge of students' ideas, and of instructional strategies for addressing common alternative conceptions, were assessed using semi-structured interviews. During the interview, teachers were asked, "What incorrect ideas about river landforms and processes would you expect the typical Year 11 student to hold prior to formal instruction?" and "What strategies do you currently use to improve the depth and accuracy of the students' understandings in this topic?" Data collected from these interviews were used to classify the teachers' level of understanding of

Table 1: Features of learners' responses at each stage of the SOLO taxonomy (Biggs & Collis, 1982)

SOLO Stage	Features of learners' responses typical of each stage
Pre-structural	Here learners are simply acquiring bits of unconnected information, which have no organisation and make no sense.
Uni-structural	Simple and obvious connections are made, but their significance is not grasped.
Multi-structural	A number of connections may be made, but the meta-connections between them are missed, as is their significance for the whole.
Relational	The learner is now able to appreciate the significance of the parts in relation to the whole.
Extended abstract	The learner is making connections not only within the given subject area, but also beyond it, and are able to generalise and transfer the principles and ideas underlying the specific instance.

Table 2: Protocol for classifying the structural complexity of responses

SOLO Stage	Features of students' responses typical of each stage
Pre-structural	Provides broad, non-specific or tautological responses. Misses the point and provides little evidence of relevant learning.
Uni-structural	Identifies or focuses on one concept relevant to river landforms and processes. Deals with terminology but little more. Can memorise, identify, recognise, quote, recall or recite the details of one relevant concept.
Multi-structural	Describes or lists two or more concepts relevant to river landforms and processes. Demonstrates a quantitative increase in knowledge from the uni-structural level. Focuses on knowledge telling rather than integrating ideas. Can describe, list, report, discuss, illustrate, select, narrate or outline the relevant facts and concepts.
Relational	Provides a cohesive, internally consistent explanation of river landforms and processes. Demonstrates a qualitative difference in understanding over multi-structural responses. Integrates conceptual components by explaining the relationships between two or more concepts. Can apply knowledge in familiar contexts, integrate ideas, analyse causal factors, and explain links.
Extended abstract	Demonstrates an ability to apply understanding of river landforms and processes to new contexts – can generalise, theorise or hypothesise. Demonstrates creative and/or original thinking.

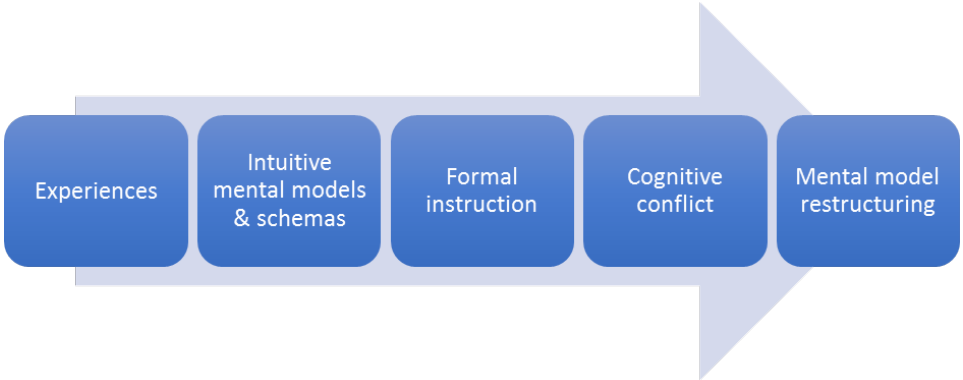
students' ideas and their awareness of evidence-based approaches for promoting conceptual change.

Phase 3 – Assessing the extent to which the fieldwork activity stimulates cognitive conflict

The aim of Phase 3 was to determine the extent to which the fieldwork activities promoted cognitive disequilibrium and constructive confusion. Cognitive disequilibrium, as defined by Calvo and D'Mello (2011, p. 19), is "a state of uncertainty that occurs when an individual is confronted with obstacles to goals, interruptions of organised action sequences, impasses, contradictions, anomalous events, dissonance, incongruities, negative feedback, uncertainty, deviations from norms and novelty". These authors argue that cognitive disequilibrium is essential for any deep learning or radical conceptual change. Constructive confusion is an affective state that is likely to occur when learning such complex concepts as erosion and deposition on meanders. While confusion is often seen as undesirable because of its potential to induce frustration and boredom, recent research highlights the vital role confusion can play in student learning (Arguel & Lane, 2015) (see Figure 1).

The fieldwork excursion involved 43 students canoeing for half a day along the Macquarie River in New South Wales. Along the way, they made several stops to discuss river landforms and processes as well as evidence of human impact. During the fieldwork experience the authors observed the types of activities given to students, noted the questions students asked,

Figure 1: The role of preconceptions and cognitive conflict in the learning process

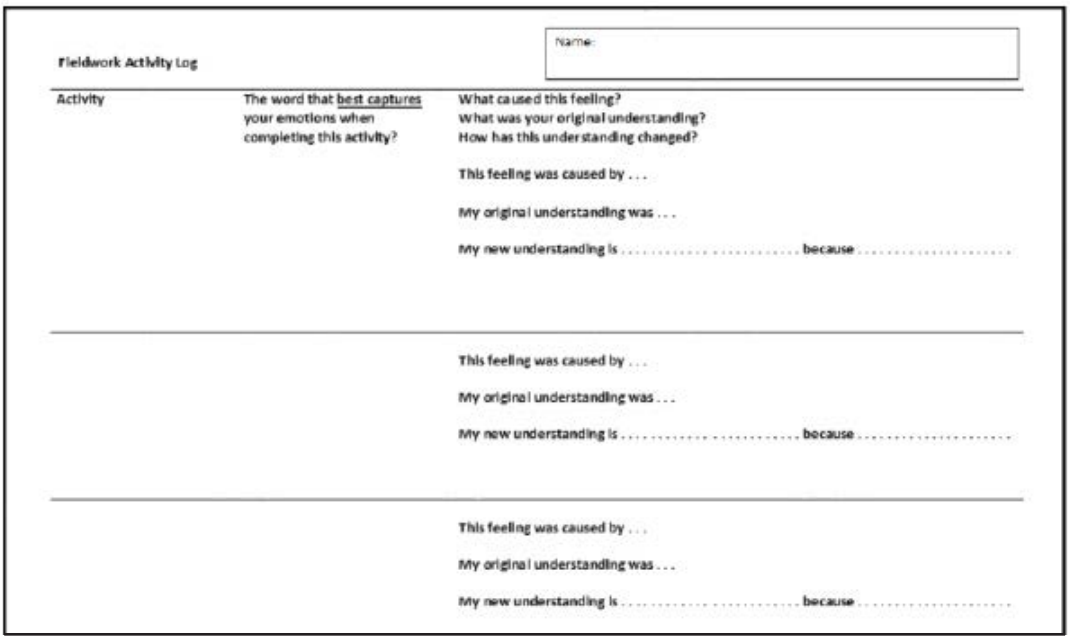


and the explanations provided by their teachers. At each stop, students were asked to think about the activities completed, the types of emotions experienced (affective states) when completing these activities (see Table 3), and any realisations made as a result of the activities. Students recorded their responses on a Fieldwork Activity Log (Figure 2). The frequency of self-reported

Table 3: Definitions of emotions experienced during the learning process (D'Mello & Graesser, 2012; D'Mello, Lehman, Pekrun, & Graesser, 2014)

Emotional term	Definition
Anxiety	Being nervous, uneasy, apprehensive or worried about the participation in or completion of a task.
Boredom	Being restless or feeling tired due to a lack of interest in the activities or content of the task, or because the task is either too difficult or too simple.
Confusion/uncertainty	Being unsure about how to proceed; having difficulty understanding the activities or content of the task.
Curiosity	Being interested in acquiring more knowledge or learning more deeply about the activities or content of the task.
Delight	Being satisfied when challenges with the task are conquered or goals are achieved.
Engagement/flow	Being interested in the results of the task and wanting to remain involved with the task.
Frustration	Being dissatisfied or annoyed with the activities and content of the task because frequent mistakes are being made or there are regular interruptions preventing completion of the task.
Surprise	Being in a state of wonder or amazement, especially from an unexpected activity, learning episode or occurrence in the task.

Figure 2: Fieldwork activity log


Fieldwork Activity Log

Name:

Activity

The word that best captures your emotions when completing this activity?

What caused this feeling?
What was your original understanding?
How has this understanding changed?

This feeling was caused by . . .

My original understanding was . . .

My new understanding is . . . . . because . . . . . .

This feeling was caused by . . .

My original understanding was . . .

My new understanding is . . . . . because . . . . . .

This feeling was caused by . . .

My original understanding was . . .

My new understanding is . . . . . because . . . . . .

affective states (emotions) at each of the fieldwork stops was calculated and presented in graphic form (see Figure 4).

Phase 4 – Assessment of the teachers' responses to the data collected in Phases 1 to 3

Two weeks following the fieldwork excursion, the authors revisited the school to discuss the findings of the research with the Geography teachers and to promote collaborative reflection on these data. The one-day workshop provided feedback about Phases 1 to 3 and focused on research questions 1 to 4. During the workshop, the authors engaged the teachers in conversations about the data and in discussions about evidence-based conceptual change strategies suitable for topics in physical Geography. The discussions were audio recorded and transcribed. Responses were analysed and organised around the following themes:

1. Research findings that surprised teachers.
2. Lessons from the PAR process.
3. Changes teachers planned to make to their pedagogy.
4. Other reflections or observations about the project.

Results

Phase 1 – Assessing students' accuracy and depth of understanding

Student alternative conceptions about river landforms and processes

The incorrect responses to the questionnaire shown in Table 4, triangulated with the drawing task and responses from the semi-structured interviews, highlighted alternative conceptions about the following themes: source, direction and flow of water in a river; change over time in river processes; and the nature of groundwater.

Within this theme, three main alternative conceptions were identified. These included a belief that rivers flow inland from the sea (held by 19% of students); all rivers end in the sea (held by 26% of students); and the hemisphere in which the river is located determines the direction of flow (held by 23% of students). These beliefs were consistent with those elicited from students' drawings and their responses to the semi-structured interview questions.

Figure 3 provides an example of a student diagram showing an example of an alternative conception related to the theme of direction and flow of a river.

Examples of student interview statements related to this theme include: "I just reckon they [rivers] would, they are not going to flow out to the sea, they start from the sea and go inland." (Participant 5), and "All rivers end in the sea because on maps you see them go all the way through and you don't see them end anywhere" (Participant 4).

Additionally, a cause and effect relationship between "hemispheres" and "river flow" was evident in a number of the students' responses. Interestingly, one participant connected this belief to popular culture.

> Participant 4: I just thought maybe it's got something to do with toilets
>
> Interviewer: Do you mean the spin?
>
> Participant 4: Yes, it might be like that, it might all flow in the same direction . . . I saw it on The Simpsons and it is all the same in that hemisphere

Many of the students understood that the source of the river was at the top of the catchment but held the conception that the water always came from melting snow "Like when it rains and the snow melts and stuff, that's how it works [river flow] . . . the Blue Mountains have snow in the winter" (Participant 2).

Figure 3: The ocean is the source of water for a river

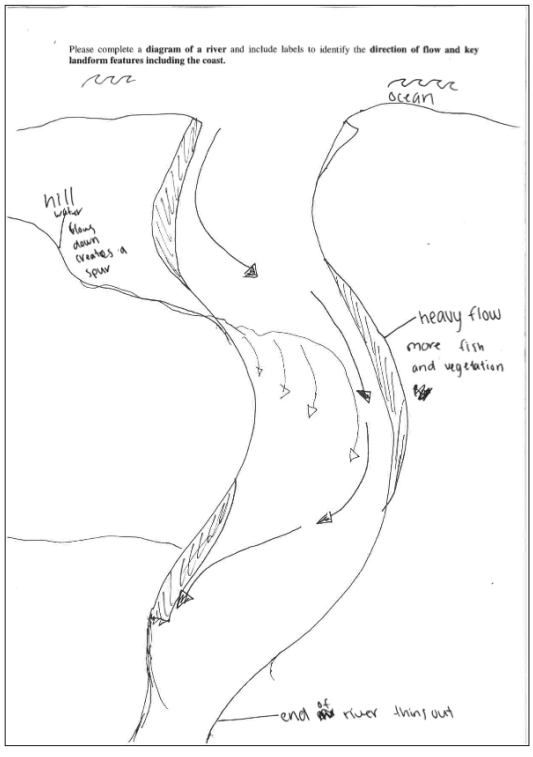


Table 4: Percentage of students providing incorrect responses to each questionnaire item Misconceptions are in bold.

Statement	% incorrect*
14. Moving water can only change the surface of the earth over long-time periods. Changes do not happen over short-time periods (i.e. a day or a year).	63
27. A billabong is an old river channel.	47
12. Groundwater is clean and can be drunk by humans.	37
28. River deltas are formed by accumulated sediment when they reach the ocean.	35
5. All rivers end in the sea.	26
11. Groundwater exists only in underground lakes or cracks in the rock structure.	26
2. Rivers in northern hemisphere flow south, while those in southern hemisphere flow north.	23
18. Rivers flow inland from the sea.	19
19. Natural flooding has a long-term beneficial effect on plant and animal communities.	19
20. Floodplains are a build-up of sediment deposited by rivers.	19
24. River landforms are the result of accumulated sediment and/or erosion.	19
8. Water can penetrate rocks.	16
15. Rivers can transport materials including boulders.	16
1. Rivers do not carve valleys, but only passively flow down them.	14
3. Rivers are generally fed by a network of smaller rivers or streams.	12
4. Groundwater exists within the soil or rock layer.	7
6. River landform features are a result of the interaction between water flow, rock/soil type, vegetation and shape of the land.	7
10. River flooding is unnatural.	7
26. A small stream cannot wear away solid rock.	7
7. Human activities cannot affect hydrological processes e.g. river flow, flood cycles, etc.	5
23. Rock and soil type in a river catchment can determine water quality.	5
25. River flow is caused by the wind.	5
9. Rivers move water under the influence of gravity, from high to low points.	2
13. In the course of the earth's history tectonic activity has had an influence on the path of rivers.	2
17. Water cannot carry rocks and deposit them in a new location.	2
21. Towns were there before rivers.	2
16. Erosion can be caused by wind or water.	0
22. Erosion only occurs while rain is falling.	0

*The table shows the proportion of students who responded incorrectly to each statement.

Change over time including the processes of erosion, transportation and deposition

This theme focused on the temporal aspects of river processes including erosion, transportation and deposition. The majority of students in the sample (63%) held the alternative conception that moving water can only change the surface of the earth over long time periods and believed that changes did not happen over short time periods (i.e. a day or a year). This is in contrast to scientific consensus that change in river systems can be rapid (Fryirs & Brierley, 2012).

"I think they [rivers] change over a long period of time. It doesn't take just overnight to just erode something so fast . . . it's cows and the wind that change rivers really" (Participant 7).

Students also held alternative conceptions about the processes of erosion, transportation and deposition. Few students were aware that rivers could transport materials including boulders (16%). More than 10% of students also believed that valleys predated the rivers that flow down them: "They [rivers] look like they are flowing down [valleys], not carving them" (Participant 5).

The nature of groundwater

Over a quarter of students (26%) held the alternative conception that groundwater exists only in underground lakes or cracks in the rock structure. Other students believed that groundwater did not exist at all.

> Interviewer: Groundwater exists in the rock and soil layer? True or False?
>
> Participant 8: False, because in Science we learnt there's oil [in the ground] that we humans can use . . . they are drilling the oil for human use and taking away the farmers' land.

This is in contrast to scientific consensus that the Earth's crust consists of layers of which one is a groundwater-conducting porous rock that is underlain by an impermeable layer (Reinfried, 2006). To fully understand the concept of groundwater, students need to understand that rocks can be porous and penetrable (Reinfried, 2006). Only a small proportion (7%) thought that groundwater exists within the soil or rock layer and few students (16%) believed that water could penetrate rocks, "I don't even think that's true [water can penetrate rock] because rocks are just hard surfaces" (Participant 9); and "I doubt that water can penetrate rocks" (Participant 2). Additionally, many students (37%) believed that all groundwater was clean and could be consumed safely by humans.

Students' depth of understanding

After assessing the accuracy of students' knowledge, their responses were analysed for depth of understanding using the SOLO framework (see Table 2). Most of the students held either uni-structural or multi-structural understandings of river landforms and processes (see Table 5).

Phase 2 – Teachers' knowledge of alternative conceptions commonly held by students in this topic

When asked the question, "What incorrect ideas about river landforms and processes would you expect the typical Year 11 student to hold prior to formal instruction?", the teachers responded in a variety of ways. Only one teacher was able to identify any specific ideas that may be held by students. Teacher 4 noted that students might believe that: "Rivers don't change. The river always has water flowing in it and always exists. Humans don't negatively impact upon rivers. Rivers are natural and will always be there regardless of what humans do. Fish are the only living organism in the river. The only reason you have a river is to draw water for cattle" (Teacher 4). The responses of the other teachers can be organised into three themes:

1. The students do not have alternative conceptions prior to formal instruction. I don't see the students as having any dominant ideas in what they believe about river processes (Teacher 3). That's a hard one, I don't come up against any preconceived ideas to be honest . . . I've been on Year 9 and 10 Geography which has given me the opportunity to lead in to some of this [content]. I can't really think of anything (Teacher 4).
2. There were general issues with student understandings. A number of teachers were unaware of the difference between broad areas of difficulty and alternative conceptions, for example, "I don't think they see the greater picture of rivers inside a drainage basin" (Teacher 1). It could be that students and teachers don't understand the difference or they could not articulate the idea. Additionally, Teacher 4's comment, "There would be differences in understanding between town and rural kids", could be seen as an example of teachers being unsure about the nature of misconceptions.
3. Students hold particular opinions and perspectives. Several of the teachers identified opinions and perspectives that would be held by students, rather than alternative conceptions. One of the teachers commented "a number of students from farms will have opinions about irrigation such as 'I'm entitled

Table 5: Student depth of understanding

SOLO Stage and Number of students	Written/spoken responses representative of each SOLO stage
Pre-structural *(Tautological and provides little evidence of relevant learning)*	No examples were identified.
Uni-structural (4 students) *(Focuses on a single concept)*	Interviewer: "Can human activity do anything to change the river at all?" Participant 9: "I guess, like irrigation, take water out of it."
Multi-structural (4 students) *(Describes various processes but does not link them together)*	Interviewer: "Tell me more about erosion." Participant 8: "Erosion occurs when there's not much moisture in the soil . . . then it's [soil] going to get dry and then the soil particles are going to break down, then it becomes just sand over time . . . there's also deposition . . ." Interview: "What would you expect to see when the river reaches the coast?" Participant 6: "It [the river] would spread out and end up with a harbour, like Sydney Harbour, a really big area of water that joins to the ocean." Interviewer: "Where else could rivers end?" Participant 6: "In big lakes or places where the altitude is lower."
Relational (2 students) *(Integrates conceptual components and explains the relationships)*	Interviewer: "Is flooding beneficial [for river catchments] true or false?" Participant 6: "I would say true. I think generally the flooding, as it slowly subsides, leaves sediment and stuff for the plants and it's going to have nutrients in it. If the water has been contaminated by chemicals then it wouldn't be beneficial but I think generally it [flooding] would be really good for plant and animal life as it collects nutrients for them."
Extended abstract *(Demonstrates creative and/or original thinking)*	No examples were identified.

to the water in the river, bugger the people downstream'" (Teacher participant 1). Another observed that "students can be short-sighted, blame catchment management authorities for not looking after water quality" (Teacher 2).

Phase 3 – The extent to which the school's fieldwork program promoted cognitive disequilibrium and constructive confusion

The frequency of different affective states (emotions) experienced by students at each stop during the fieldwork excursion are shown in Figure 4. The graph shows the dominance of *curiosity* and *engagement* as affective states experienced by students during the excursion. Few of the students reported that they felt confused, anxious or uncertain.

Phase 4 – Teachers' responses to data from Phases 1 to 3

In the final stage of the project, the teachers were provided with a summary of the results from Phases 1 to 3 and were asked to comment on aspects of the findings that surprised them, what they had learnt from the PAR process, changes they would make to their pedagogy, and any other reflections or observations. The teachers' responses indicated that they were surprised about two elements of the research findings. Firstly, the nature of the students' preconceptions of river landforms and processes and secondly, the lack of confusion (cognitive disequilibrium) generated by the fieldwork activities. The nature of the students' ideas were particularly alarming for several of the teachers who found it difficult to believe that students could construct mental models that were so inconsistent with expert thinking in the discipline.

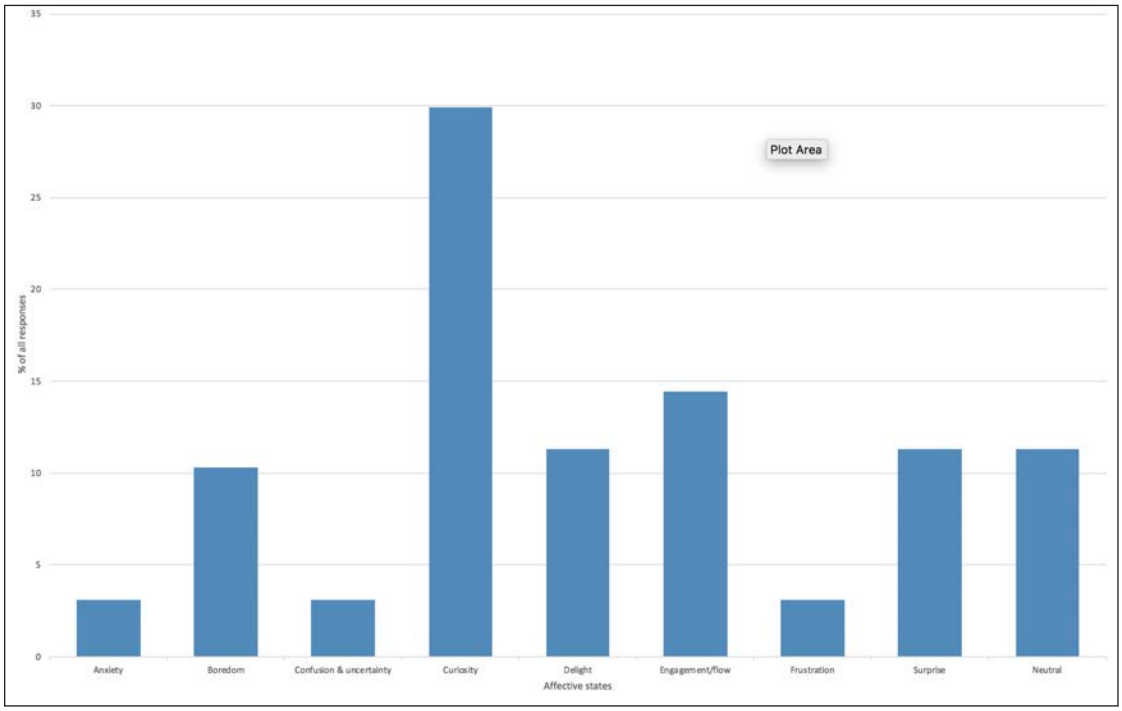
> The results of the student surveys highlighted some misconceptions that I found alarming. Students not knowing which direction rivers flow was particularly surprising for Year 11 students. Having taught river systems to Year 8 and 9 students in the past, this is a concept I have taught before and felt would be straight forward, or a "given", for Year 11 students to understand (Teacher 1).

> [There were] a few surprises, for example, water flowing inland from the coast was a big one . . . [and] students' lack of knowledge about erosion, deposition, water flow, cross sections, and upper-mid-lower sections of a catchment (Teacher 2).

> The [misconception about] direction of flow of rivers was most surprising, even alarming.

> Their limited understanding of the role of topography and river processes . . . that was the "fall off your chair" moment for me. I was really amazed at that [finding] . . . The students do have preconceptions and I cannot assume they have a solid

Figure 4: Reported affective states during the fieldwork activity



conceptual foundation to start with (Teacher 3).

The second aspect of the data that surprised the teachers was the reported affective states during the fieldwork activity. The results suggest that many of the students were curious about their experiences on the fieldtrip, however, few of the activities prompted the confusion and uncertainty associated with cognitive disequilibrium and conceptual change (D'Mello & Grassier, 2014). Comments made by students in their fieldwork activity log (Figure 2) suggested that contextual factors such as "lack of food" and the social nature of the fieldtrip dominated their attention. Both of the teachers leading the fieldtrip were surprised about this finding which prompted reflection about changes that could be made to future fieldwork activities.

When asked about what they learnt from the research process, all of the teachers noted the need to regularly review, critique and adjust their practice. The teachers' responses focused on the need to create opportunities for students to share their knowledge at regular intervals throughout a teaching, learning and assessment program. The PAR process also made them aware of the non-linear nature of student learning and the role of student-teacher relationships in the conceptual change process.

> My key learning came from the reading regarding the cognitive space students must be in to truly change their understanding of a concept. Finding the root cause of a students' misconception and shattering this to correct their understanding seems the most important first step to improved learning (Teacher 1).

> I learnt a hell of a lot from the research process . . . I take student prior knowledge for granted as being quite linear. [The] analogy of student conceptions being a bowl of spaghetti I think is fantastic. The research illustrated to me most definitely that my assumptions were incorrect. Just because they [students] have done this [rivers] before does not mean they will understand it. I assumed their understandings were linear when the reality is that nothing is straight forward about their understandings. The role of their environment is so important – farming background or what they had heard their parents say (Teacher 3).

> You have prompted us to think "how is my teaching going and how are [students] learning based on that [my practice]?" . . . It comes back to junior Geography [which is] an opportunity to develop a relationship with the students. If you taught a kid in Year 9 and 10 and you have a relationship with them and they choose your subject in Year 11 and 12 you're continuing a relationship, and that is a factor that is at play with most teenage boys and girls which is important to their learning and engagement (Teacher 2).

During interviews, teachers identified a number of changes they had already made to their practice or planned to make in the future. The teachers responsible for delivery of the Year 11 course noted the need to modify the learning and teaching program to ensure that students have a sound understanding of the core concepts prior to the fieldtrip. They planned to achieve this through the use of a number of evidence-based conceptual change approaches. One of these strategies was the use of Socratic questioning:

> As a result of the research project I have introduced strategies that challenge students to think and talk through their understanding with simple prompting questions, such as "What makes you say that?" Students hate these questions because you can almost visibly see their brains switch on and dig through their thoughts . . . But it's effective. In addition, modelling concepts, using diagrams accurately or utilising fieldwork as the process for shattering misconceptions will be my preferred methods moving forward, rather than reading text, passively watching videos or even lecturing concepts (Teacher 1).

Other teachers planned to use targeted feedback, peer instruction and scale models of physical processes to address students' misconceptions.

> I have moved towards providing better feedback from class activities and assessments, which can improve students' learning & understanding. I am thinking about pre-tests to get an idea of the start point for students (Teacher 2).

> We have new activities [for class time]: the bull-ring, peer to peer learning, and feedback. In the bull-ring activity, Year 12 students teach Year 11 for 5 minutes then swap roles. This activity provides an opportunity to see what prior understandings the students have [as they] unpack the idea . . . If you have a "teaching" student state a misconception (such as rivers flow inwards from the ocean), the "listening" student is likely to say "Can you explain this?" and often, the teaching student struggles to do so. I [as the teacher] don't need to be the fount of

all knowledge, because the students learn from each other (Teacher 2).

We have changed the teaching and learning in response [to the research findings]. I did a lesson where students build a catchment out of sand, empty some water bottles in to it and look at how water flows through different areas of the catchment. I did this post-fieldtrip but will obviously be doing this at the start of the course next year. I put up some of the [student] preconceptions on the board after your workshop and we discussed them as a group. The students unpacked their reasoning which helped to transform their understandings (Teacher 3).

The teachers also recognised the need to be more conscious of potential barriers to the development of deep understanding including students' existing mental models of key concepts such as transportation and deposition. As noted by Teacher 3, the study "compelled everyone in the department to think more deeply and critically about their practice in terms of what they do, how lessons are received by their students, and what can be done to further improve the teaching and learning."

Discussion

Consistent with the literature, this study demonstrates the value of PAR for assisting in-service secondary teachers to reflect on and improve their PCK, particularly their knowledge of and work with student ideas. Key areas of value include enhanced collaboration (Draper et al., 2011); the development of a community of practice (Erdas-Kartal et al., 2018); shifting mindsets and assumptions about learning (Eilks & Markic, 2011; Erdas-Kartal et al., 2018; Hales, 2017); and the promotion of peer and student feedback (Burke, 2013). These benefits of PAR are connected and provide the framework for discussion of the research findings below.

The project provided strong evidence of the capacity of PAR to challenge teachers' assumptions about learning processes, students' prior knowledge and the extent to which particular activities promote constructive confusion (Eilks & Markic, 2011). Prior to commencing the project, several of the teachers assumed that the foundational concepts covered in junior school Geography curriculum (e.g. erosion, deposition and the water cycle) would be well understood by their Year 11 students. As noted by Teacher Participant 3 – "I took it for granted that [the learning process] was quite linear". The PAR process provided a feedback loop for teachers (Burke, 2013) that prompted them to challenge many of these assumptions. Analysis of the Phase 1 data made the teachers aware that students did not have the required prior knowledge for understanding river processes and that many of the students held alternative conceptions that were likely to interfere with their learning of complex concepts in the Stage 6 syllabus. Teachers also became increasingly aware of the robust and deeply entrenched nature of alternative conceptions and the dangers of students interpreting new experiences through these erroneous understandings (Dove, 1999). The results of the PAR also challenged the teachers' assumptions about the effectiveness of the fieldwork experience as a conceptual change strategy. The data did not provide evidence of the kinds of emotional responses you would expect from students questioning and reworking their conceptions of river landforms and processes (Calvo & D'Mello, 2011). Further research is required to identify fieldwork activities that best promote cognitive conflict and constructive confusion.

The project also helped to build a community of practice and enhance collaboration within the social science department by stimulating conversations between teachers and authors about evidence-based approaches for identifying and addressing alternative conceptions (Draper et al., 2011; Erdas-Kartal et al., 2018; Hales, 2017). Consistent with the findings of Wongsopawiro et al. (2017), these formal and informal conversations formed an important part of the teachers' professional learning throughout the project. One outcome of these conversations was the identification of evidence-based approaches for improving professional practice that could be piloted with future Year 11 Geography classes. Examples of these strategies include the use of pre-tests and three-dimensional models to demonstrate river processes. The peer-teaching strategy outlined by Teacher Participant 2 is another example of an intervention developed as a result of the project to help teachers identify and address common alternative conceptions. A key strength of the PAR approach was the involvement of teachers in all stages of the research and in the process of decision making about how to respond to the data. Throughout the project, teachers developed a greater understanding about the importance of ongoing data collection about student learning and the need to reflect on the implications of these data to inform their future practice (MacDonald, 2012).

Conclusion

This paper reports the results of a PAR project which aimed to improve the PCK of in-service secondary Geography teachers. The aim was achieved by providing teachers with targeted

feedback about: their students' depth and accuracy of knowledge of river landforms and processes; their personal knowledge of students' common alternative conceptions in this topic; and the effectiveness of current fieldwork practices in promoting cognitive disequilibrium and constructive confusion. The results suggest that PAR can provide feedback that can be used by teachers as a prompt for professional reflection and to stimulate conversations and professional learning about improvements that can be made to Geography teachers' PCK, assessment practice and pedagogy for promoting conceptual change. While the authors acknowledge that this study involved a single case study of four Geography teachers, the results suggest that involvement in a PAR process can improve Geography teachers' PCK by helping them to better understand the nature of students' alternative conceptions and the importance of ongoing formative assessment. The results are also important as they add to the limited body of literature examining the nature and development of secondary Geography teachers' PCK in specific topic areas (see, for example, Lane, 2011, 2015; Reitano & Harte, 2016). What remains unknown is the extent to which engagement in PAR results in sustained changes in teachers' knowledge and practice and whether this results in measurable improvements in the depth and accuracy of students' knowledge. This is an important area for future research.

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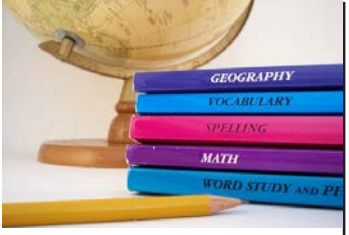

Geographical Education That Matters – A Critical Discussion of Consequential Validity in Assessment of School Geography

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Abstract

The word *test* comes to mind when a person, who is unacquainted with education discourses, reads about assessment issues. Beyond issues of reliability and validity in designing measurement constructs, assessment for school geography must result in better geographical learning. In other words, there must be *consequential validity* so that the way teachers collect information about students is aligned to the goals of improving learning. While geographical educators agree that finding out if someone has learnt what you intend for them to learn goes beyond performance in pen and paper examinations, school geography intends for children to learn beyond geographical knowledge. In fact, geographical educators are interested in evaluating if our students are better in developing skills that will help them be actively engaged and contributing citizens of the world that they are living in.

Introduction: Consequential Validity in Assessment

Assessment is important in teaching and learning because teachers need feedback on their practice and on students' learning (Voltz, Sims, & Nelson, 2010). Assessment also serves a diagnostic function, allowing teachers to identify the learning needs of different students, so as to better differentiate assessment for various student profiles. Finally, assessment serves as a means by which student progress (and teacher performance) may be reported to stakeholders including school administrators and parents. Given these different uses, it is important that assessment is reliable and valid.

While reliability in assessment refers to consistent replication of results when using a test, validity is concerned with the claims or inferences made from the test results. In other words, validity refers to how well assessment results are used in describing performance or inherent attributes of learners. Content validity pertains to the individual's "performance on a defined universe of tasks" (Shepard, 1993 p. 408), while criterion-related validity refers to test types and the predictive accuracy for performance. Construct validity is needed "when making inferences about unseen traits such as intelligence or anxiety" (Shepard, 1993 p. 409).

Stobart (2001) notes that discussions of assessment validity in the literature include whether the concept of validity should include the issue of consequences of assessment. For instance, Messick (1995) argues the validity of a test should also consider "potential and actual social consequences of applied testing" beyond the content, criterion and construct validity that statisticians refer to. He argues that all assessment has positive or negative social consequences. While standardised testing may improve student learning and motivation, and allow students to have roughly equal access to classroom content, the negative aspects include merely teaching students to pass. While content, construct and criterion-related validity are key concerns in test interpretation, the use of test results has social consequences. This position is supported by other researchers (e.g. Crooks, Kane, & Cohen, 1996; Linn, 1997; Stobart, 2001), while other researchers like Popham (1997) and Mehrens (1997) have disagreed on the grounds that the social consequences of assessment go beyond the responsibility of the test setters and should be separated from validity arguments.

In general, discussions on consequential validity focus on the impacts on students of the assessment process itself. For example, Crooks et al. (1996) identify threats to consequential validity as the non-achievement of positive consequences and the occurrence of negative impacts such as poor student motivation and assessment anxiety. Stobart (2001), building on Crooks et al. (1996), suggests that this leads to the need for a review of inappropriate standards, as well as an evaluation of aspects of the assessment process itself, including the conditions of assessment, the nature of the assessment tasks, the weighting of different aspects of tasks, and scoring criterion.

In this paper, we move beyond the social implications of the assessment process itself to explore the concept of consequential validity in terms of whether assessment in geography helps meet the desired positive consequences of geographical education. In order to do this, however, we first examine what the aims of geographical education might be.

What should we be assessing in geography?

Geography as a discipline and school subject: what matters?

A consideration of the consequential validity of assessment in geography should begin with the question of what is considered core to geography as a discipline or school subject. Unsurprisingly, there is some divergence in the literature on this issue. For instance, Brooks, Qian, and Salinas-Silva (2017) suggest that how geography is understood may vary across space. Uhlenwinkel, Béneker, Bladh, Tani, and Lambert (2017) also note a propensity for teachers, across different European contexts, to have varying understandings of geography as a natural science or as a social studies subject. This may be due to the ways in which school subjects are organised across national contexts (Brooks et. al 2017; Uhlenwinkel et al., 2017). The attitudinal and behavioural goals of geographical education have also been debated. For example, Lambert and Balderstone (2000) argue that geography teachers cannot ignore the moral and ethical dimensions of their work. However, research has suggested a split between teachers who feel a responsibility to advocate for environmental attitudes and values (Ballantyne, 1999; Grace & Sharp, 2000), and those who are reluctant to do so (Tomlins & Froud, 1994; Cross, 1998; Cotton, 2006).

It is the view of the authors, however, that despite these differences, there is some congruence in general understandings of what the goals of geographical education might be. For instance, the International Charter on Geographical Education (International Geographical Union Commission on Geographical Education [IGU-CGE], 1992, 2016) provides a basis for this discussion. Bourke and Lane (2017) identified a number of key themes in both the 1992 and 2016 Charters. These include an explication of why a geographical education is beneficial and essential to the development of a person because it "helps people to understand and appreciate how places and landscapes are formed, how people and environments interact, the consequences that arise from our everyday spatial decisions, and Earth's diverse and interconnected mosaic of cultures and societies" (IGU-CGE, 2016, p. 5). The authors also noted a discourse of concern around the environment and an emphasis on how a geographical education is important to addressing this.

> Geography is therefore a vital subject and resource for 21st century citizens living in a tightly interconnected world. It enables us to face questions of what it means to live sustainably in this world. Geographically educated individuals understand human relationships and their responsibilities to both the natural environment and to others. Geographical education helps people to learn how to exist harmoniously with all living species (IGU-CGE, 2016, p. 5).

The 1992 Charter also identified key conceptual knowledge and skills (1992, pp. 1.7–1.8), as well as ways of questioning and thinking, to be developed within a geographical education. These ideas have been further elaborated upon in the discussions around Powerful Knowledge in Geography (Stoltman, Lidstone, & Kidman, 2015; Lambert, Graves, & Slater, 2016, Maude, 2018), geographical thinking (see edited volume by Brooks et al., 2017) and GeoCapabilities (http://www.geocapabilities.org).

The discussions within geography appear well aligned to the Delors (1998) report to the United Nations Educational, Scientific and Cultural Organization, which included four pillars as key concepts to developing education for the twenty-first century. Delors (1998, p. 97) argues for an integrated approach to formal education based on the four pillars of learning including:

1. learning to know – a broad general knowledge but also depth in a few subjects;
2. learning to do – to acquire not only occupational skills but also the competence to deal with many situations;
3. learning to be – to develop one's personality and to be able to act with growing autonomy, judgment and personal responsibility;
4. learning to live together – by developing an understanding of other people and an appreciation of interdependence.

In light of the discussions on what the aim of a geographical education might be, we suggest that assessment in geography has consequential validity if it allows teachers to infer if students have truly learnt geography through knowing, doing and being. We argue that assessments in geography that indicate someone has learnt about environmental problems, but which do not help to determine the social consequences of the student's learning, may be seen as lacking consequential validity.

Defining the learning outcomes for assessing consequential validity in geography

Describing assessment consequential validity based on determining the interpretation and use of evidence of learning to know, do, be and live together may not provide practical guidelines to geographical educators. The Trends in International Geography Assessment Study (TIGAS) 2023 group (www.tigas2023.com) has been working on developing international geography assessment that meets the standards of the Trends in International Mathematics and Science Study (TIMSS) eighth grade assessment mode, in order to introduce geography for international assessment in 2023. We refer to this work (of which the first author is a member) in order to provide a broad overview of how consequential validity (as described in the preceding section) might be incorporated into assessment design.

Table 1 below illustrates Krathwohl's (2002) revision of Bloom's taxonomy of knowledge domains and cognitive processes.

Griffin and Care (2014) suggest that developmental taxonomies such as this provide generic levels of complexity and sophistication that can be used to classify and interpret task requirements and student task responses. Indeed, Krathwohl's categorisation of knowledge domains and cognitive processes indicates the need to consider both the curriculum content as well as cognitive processes for Geography in designing assessment. Teachers specify criteria to be evaluated which enables students to demonstrate the performance of those outcomes (Cohen, 1995).

Table 1: Krathwohl's revision of Bloom's taxonomy

	Cognitive Processes					
The knowledge dimensions	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual						
Conceptual						
Procedural						
Metacognitive						

(Source: Krathwohl, 2002, p. 216)

The TIGAS group has referred extensively to the 1992 and 2016 Charters in order to delineate the learning outcomes that can guide assessment in geography, in terms of both the knowledge domains and cognitive processes outlined above. The knowledge domain includes knowledge of different issues such as globalisation, urbanisation, climate change, sustainable development, and food security, across spatial, social and cultural contexts so that children will be able to face questions of what it means to live sustainably in an interconnected world. Geography's key concepts are also key components of the knowledge domain for assessment. These include:

1. location and distribution,
2. place,
3. spatial interaction,
4. region, and
5. people-environment relationships.

These concepts are infused and learnt across topics about the earth's physical structure and physical environments, as well as human environments. There is also a consideration for the changing human environments across social, cultural and economic systems. Ultimately, geography students need to demonstrate an understanding of the interactions between humans and their environment in assessment with consequential validity.

The cognitive skills that geography students need to be able to demonstrate can be derived from the 1992 Charter and include:

1. identifying questions and issues,
2. collecting and structuring information,
3. processing, interpreting, and evaluating data,
4. developing generalisations,
5. making judgements,
6. making decisions,
7. solving problems, and
8. working co-operatively.

These cognitive skills can be simplified according to Krathwohl's terms of:

1. remember,
2. understand,
3. apply,
4. analyse,
5. evaluate, and
6. create.

However, these cognitive skills cannot be considered independently from the type of information and data that geography students have to work with including:

1. maps,
2. diagrams,
3. tables,
4. graphs,
5. pictures,
6. symbolic data,
7. quantitative data, and
8. verbal information.

(IGU-CGE, 1992)

These ways of thinking about learning geography provide a frame of reference in examining the notion of consequential validity. The TIGAS group described assessment specifications based on the content and cognitive domains, as well as a geographical practices domain. These domains map back to the topics that are common across geography curricula, cognitive learning outcomes that range from simple factual recall to hypothesis testing, the use of geographical concepts like space and place, together with resources such as maps.

This work is currently being prepared for publication, but it is important to note that the notion of consequential validity is implicit in this categorisation of test items, where evidence on how well students can solve geographical problems, that have social consequences, is included. The intentional extension beyond the content and cognitive domains to include geographical practice is aligned with the Charters' aim to develop "[g]eographically educated individuals [who can] understand human relationships and their responsibilities to both the natural environment and to others" (IGU-CGE, 2016, p. 5).

Having outlined what consequential validity might look like in geography, we move on to address the notion of consequential validity at three levels.

1. Is the assessment literature in the field of geography and environmental education of social consequence?
2. How can consequential validity in assessment be built into the geography curriculum for a country?
3. What do assessment items that have consequential validity look like?

Is the assessment literature in geography of social consequence?

Chang and Aman (2017) in a recent publication analysed all article titles published in four prominent geographical and environmental education journals between the period 2010 to 2017: *Environmental Education Research*; *International Research in Geographical and Environmental Education*; *The Journal of Environmental Education*; and *Journal of Geography*. The findings show that the published research articles contribute to achieving some of the action plan items from the International Charter on Geographical Education. In particular, there was a good spread of research published on assessing knowledge, skills and attitudes. There was also a number of assessment articles on environmental issues, but there was practically no research on issues of reliability and validity.

Another article by Lane and Bourke (2017) systematically reviewed over 700 articles on assessment in geographical education. While they concluded that more needs to be done to clarify the essential geographical knowledge and skills students should develop, they also called for more work to examine "the types and formats of assessment instruments that will provide valid and reliable measures" (Lane & Bourke, 2017). The fact that both papers point to a need to discuss reliability and validity issues is not coincidental, and indicates an area of work that is much needed.

The findings from these two papers affirm the framework for discussing consequential validity advanced in this paper. Both papers identified that formative assessment, or assessment for learning, is one of the key themes of research in geographical education. Moreover, assessment can be integrated within instruction for learning (Hagstrom, 2006) as there is vast potential in formative assessments in the form of class quizzes, reflection papers, posters or project work within the classroom (Chang, 2014). These practices will "inform the process before, during and after teaching has occurred" (Voltz et al., 2010, p. 116). Indeed, formative assessment can encourage testing beyond learning to know to learning to do, be and live together. High stakes standardised testing usually drives instruction in the classroom (Voltz et al., p. 114) and there is a pursuit of head knowledge at the expense of learning to do and learning to be.

In addition, Lane and Bourke (2017) also found only five out of the 700 papers related to geospatial thinking, of which four were in secondary or university settings and one in a primary setting. Chang and Aman (2017) also reported on six papers with the term *sustainability*. These topical themes are aligned to the cognitive as well as content domains that geographical education endeavours to achieve. This is unsurprising as "students require increasing international competence in order to ensure effective cooperation on a broad range of economic, political, cultural and environmental issues in a shrinking world" (IGU-CGE, 2016, p. 3). There is also an additional statement that says the Charter is supportive of the principle set out in the UN Sustainable Development Goals (IGU-CGE, 2016, p. 1).

In sum, the international level analyses presented by these two papers indicate a dearth of empirical work that describes research on issues of consequential validity. While the authors are confident that students around the world are assessed on key issues like their understanding of global warming, their ability to discuss the positive and negative impact of climate change on local agricultural practices, and even the use of maps and photographs to demonstrate these impacts, the research indicates that much more needs to be done to tackle the issue of consequential validity in the field of geographical education.

How can consequential validity in assessment be built into the geography curriculum?

In considering how assessment could support geographical education that is of social consequence – learning to know, do, be and live together – there has been an interesting development in Singapore where levels-grading and field-based geographical investigation has become a key component of the high school geography subject over the last decade. The Singapore example used here will illustrate how consequential validity can be a part of curriculum design, at the outset.

Incorporating consequential validity through changing the assessment type

High school geography in Singapore has adopted since 2007 a levels marking approach for part of the national written examination paper (Singapore Examinations and Assessment Board, 2010). The main rationale for the change was to allow assessors to collect evidence of students' abilities to discuss and evaluate geographical problems beyond just describing or explaining them. In the past, students were required to answer 40 multiple-choice questions and four structured essay questions at the national examination for Geography. Marks were awarded for each point in the structured essay questions. The change in the curriculum, which is twinned with the change in examination format, encourages students to engage "the challenges of an increasingly globalised world . . . [and] to promote critical and creative thinking skills, and to nurture problem-solving and independent learning abilities in students" (Sellan, Chong, & Tay, 2006).

By 2014, Singapore introduced another change to the high school geography curriculum which required students to answer questions about how field-based geographical investigations can be conducted, how information and data can be collected, organised, analysed and presented, and what they can conclude based on their findings (Singapore Examinations and Assessment Board, 2014). This takes the national level examination a step towards assessment that has social consequence as the investigation framework was designed based on Roberts' (2003) cycle of enquiry. Without a shift in the curriculum that requires students to conduct field investigation, and an accompanying change in the national assessment mode and form, students would continue only to learn to know. In fact, National Institute of Education researchers (Seow, Irvine, & Chang., 2018) found that this change in curriculum assessment helped teachers to induct novice practitioners (i.e. students) into geographical disciplinary ways of knowing and doing. Field-based inquiry featured the habitual elements of a signature pedagogy that inducts disciplinary novices "to *think*, to *perform*, and to *act with integrity*" like disciplinary practitioners (Shulman, 2005, p. 52).

Emphasising the behavioural and attitudinal domains in assessment

We also argue for the need to purposefully incorporate behavioural and attitudinal domains into assessment. Consider the following two quotations that come from students in Singapore about what they have learnt in the geography classroom, and how it has shaped their environmental behaviour:

> "I don't think most people would bring home what they actually discussed about. And some people would forget about it. Some people actually take down notes to study for the exams. I think after the exams, everybody would just (pause) yeah, forget about it."

> "Actually, I think exams are very effective of making us remember things. But erm . . . but (if) you remember, do you do it? I don't, you know. I remember, I

know everything. I know things that I'm supposed to remember, but I don't . . . (long pause)."
(Chang, 2014)

While one can argue that teachers should be encouraging independent and critical thinking in their classrooms (Jickling, 1992; Aldrich-Moodie & Kwang, 1997), and that advocating for values education and social change for the environment (as suggested by Fien, 1993; Huckle, 1985; Morgan, 2012) is anti-educational (Williams, 2008), it is our contention that not providing any opportunity to examine the behavioural and attitudinal learning outcomes would be worse. For instance, some studies have found that teachers are uncomfortable and reluctant to advocate for the environment in their lessons (Tomlins & Froud, 1994; Cross, 1998), but are more comfortable in presenting a neutral position while discussing a range of different viewpoints about environmental topics (Cotton, 2006). In contrast, some teachers feel responsible for promoting environmental attitudes and behaviours (Ballantyne, 1999; Grace & Sharp, 2000). In fact, Ho and Seow (2015) have found that the same geography curriculum in Singapore is interpreted and enacted differently by teachers based on their beliefs about the purpose of geographical education.

Further, teachers will select different assessment based on where they stand on the issues. Teachers who want to focus on geographical knowledge will choose to test students' ability to apply geographical theories to make sense of the dynamic processes they observe in the field. Those who prefer to emphasise geographical skills may design assessment around students' field-based procedural knowledge. On the other hand, teachers who want to focus on behavioural or attitudinal dimensions may seek to evaluate the types of actions that students choose to take to tackle problems in the field, and pay close attention to the reasons guiding these actions.

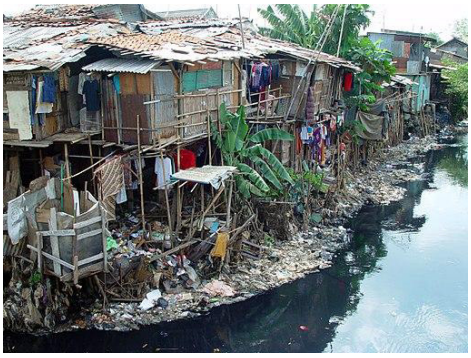
Regardless of the ethical stances adopted by the teacher (to just present options versus promoting action), assessment has consequential validity if it encourages students to think about their own behaviours and attitudes. This could be through the national level curriculum and assessment design or the deliberate inclusion of behavioural and attitudinal aspects of learning outcomes. Although the Singapore example will be different from geographical education contexts in other regions and states, these innovations in assessment align with the vision of the 2016 Charter, where school geography plays a critical role in preparing young people to engage in the global issues of their time.

What do assessment items that have consequential validity look like?

To take the example of assessment in school geography in Singapore further, two examples of authentic assessment items are taken from grade 8 classrooms for discussion on how the items may or may not have consequential validity.

A question on the topic of human-environment interaction is shown in Example 1.

Study the photograph, which shows water pollution along the river, one of the negative consequences of slums and squatter settlements.



(By Jonathan McIntosh [CC BY 2.0 (https://creativecommons.org/licenses/by/2.0)], from Wikimedia Commons)

a. Define 'pollution'.
b. Explain how slum and squatter settlements lead to water pollution such as the one shown in the photograph.
c. Other than the pollution shown in the photograph, list and explain another form of pollution resulted by slum and squatter settlements.

Example 1: Sample Geography Content Domain Question

Example 1 shows how a question on human-environment interaction appears. The answers to Part (a) and Part (b) can be learned/memorised from the textbook. It is a retrieval of information (recall) and there is not much thinking or reasoning involved in the process. However, Part (c) requires the student to infer another possible form of pollution. For this question on photograph interpretation, students are required to know (e.g., recall or describe), apply (e.g., compare, interpret and relate) or reason (e.g., analyse, evaluate and draw conclusions).

What seems to be lacking in this example is consequential validity. A student who is able to define pollution, explain the contribution of

waste production through domestic activities in slums, and even extend the knowledge to noise pollution may or may not be someone who has attitudinal or behaviour learning outcomes associated with the empathy for people living in these adverse urban conditions. Indeed, evidence of the students' learning to live together aspect of Delors' four pillars of education may not be easily obtained from this assessment item.

In the next example, students are asked four questions based on two information sources. One is a photograph of traffic congestion and the other is a description of the negative impact of traffic congestion.

Study Figs. 2A and 2B which show traffic congestion in Delhi.

(By NOMAD
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Fig 2A: Stress, pollution, fatigue: How traffic jams affect your health.

Late Tuesday night, thousands of commuters and motorists were caught in a gridlock* on the roads during rush hour. The traffic jam was so bad that many commuters spent hours on the road just to get home. Some managed to reach their destination past midnight. Gridlocks are part of the daily grind here in Delhi.

Fig. 2B

* Gridlock – a type of traffic jam where continuous queues of vehicles block an entire network of intersecting streets, bringing traffic in all directions to a complete standstill.

1. With the help of Fig. 2A and what you have learnt, describe the characteristics of traffic congestion.
2. Explain how inadequate transport infrastructure and poor provision of public transport services can lead to traffic congestion.
3. With reference to Fig. 2B and what you have learnt, explain how traffic congestion can affect people psychologically.
4. "Imposing road pricing is the best way to reduce traffic congestion." How far do you agree with this statement? Explain your answer using relevant examples.

Example 2: Sample Geography Cognitive Domain Question

Example 2 shows how students are required to demonstrate that they apply and provide reasons for their answers. Part 1 is a knowing question which requires students to recall what they have learnt from textbooks and describe the characteristics of traffic congestion. Students rely on recall of facts and information obtained from the textbook. However, Part 2 requires students to apply what they have learnt and explain how inadequate transport infrastructure contributes to traffic congestion. Part 3 requires more thinking from students as they are required to use their own experience or information gathered from other resources, including the internet and newspapers, to explain the connection between traffic congestion and human psychology in the

transport context. Part 4 is a high-level thinking question which requires the student to analyse, relate and provide a reason for their conclusion. In essence, students who can answer this part will provide evidence that they have formed an opinion about the issue and furnish justification for their opinion. While we do not need students to develop any emotional response to the situation, we would like them to be able to critically analyse, and form an opinion based on sound reasoning. In particular, students will have to use examples to explain how having a road pricing system may or may not alleviate the traffic problem posed in this question. In this way, the item connects more with the social consequences of the traffic problem by engaging the student with the task of evaluating a possible mitigation strategy set against the issues that affect others' lives. In some sense, the student has to go beyond learning to know, do and be to also learn what it means to live together.

These two examples provided in this discussion are clearly not exhaustive but they do indicate that with the framework of considering consequential validity beyond cognitive, construct and criterion-related validity, assessment can help teachers collect evidence on what students have learnt in school geography.

Conclusion

At the core of the discussion in this paper, the authors are interested to find out if students have learnt what we have intended for them to learn. We have also sought to provide clarity on what we think students should be learning in geographical education, by drawing on the International Charter on Geographical Education (IGU-CGE 1992, 2016), as well as such major developments in geographical education research as Powerful Knowledge. Geographical education matters, as the documents, eloquently argue. As such, it is important that the ways in which we assess geographical learning also matter. We advocate for the use of the concept of consequential validity to move the discussion on assessment beyond content, criterion-related or construct validity, towards considerations of the social significance of a geographical education. This is critical in helping geographical educators design assessment that will help improve student learning in geography beyond learning to know to learning to do, be and live with each other.

Pen and paper examinations remain popular in many places, and we have suggested, in this paper, that there is room for innovation in summative assessment modes for geography by providing examples from the Singapore context. However, alternative, but not mutually exclusive methods of gathering evidence to measure students' geographical learning, need to be considered, and researched.

"Assessment is today's means of understanding how to modify tomorrow's instruction" (Tomlinson, 2014, p. 17). Indeed, assessment should be considered as an integral part of the curriculum process, for while it helps us gather evidence to find out what students have learnt or how well we have taught them, it also helps us design instruction that is aligned to the intended outcomes, of learning to know, do, be and live together, through the school geography curriculum.

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The Impact of National Examinations on Geography Teachers' Assessment practices in the Netherlands

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Abstract

Geography teachers' school-based (internal) examinations in pre-vocational geography education in the Netherlands appear to be in line with the findings in the literature, namely that teachers' assessment practices tend to focus on the recall of knowledge. These practices are strongly influenced by national (external) examinations. This paper provides empirical evidence about the impact of the national examinations on internal assessment practices. An analysis of test items in national examinations from 2015, 2016 and 2017 shows that the majority of these items focus on remembering and are in a format that can be marked reliably. Teachers' tendency to copy these formats in their school-based assessment raises questions regarding validity. This paper explores these concerns and contributes to the discussion on effective assessment in secondary school contexts.

Introduction

Emphasis is often placed on the negative impact of teachers' summative assessment practices on students' learning (Harlen, 2004). In geographical education, the tendency to focus on the recall of knowledge has been identified. For example, The Road Map Project (2013) revealed that the majority of large-scale assessments in the United States tested students' recall of geographical facts (Wertheim, Edelson, & The Road Map Project Assessment Committee, 2013). This tendency could be a result of the demand to produce reliable test items "that are relatively closed in nature and require minimal or no subjective judgement. In short, they are safe" (Stimpson, 2006, p. 79).

The pressure to produce reliable results is stronger when systems are based on high-stakes tests. The results of these tests are often used for purposes of accountability which can lead to a teaching to the test strategy. Klenowski and Wyatt-Smith (2011) in their analysis of the impact of high-stakes testing in Australia found that many schools used the teaching to the test strategy to improve literacy and numeracy. Equally, Kuiper, Van Silfhout, and Trimbos (2017) in the Netherlands, in their reflections on the relationship between curriculum and assessment, emphasised the *pre-shadowing* effect of national examinations on teachers' classroom assessment practices and the enacted curriculum.

The Dutch national examinations impact on the enacted curriculum and internal assessment practices and this can cause problems with regard to validity. As Kuiper et al. (2017, p. 86) stated, "what is tested makes beloved and what stays untested makes unbeloved". The enacted curriculum often reflects the content and structure of the national examination rather than the aims and objectives of the intended curriculum. This situation is not typically Dutch, as it can also be found in other countries. Spielman (2017), Ofsted's chief inspector in England, recently reported on this issue:

> There need be no tension between success on these exams and tests and a good curriculum. Quite the opposite. A good curriculum should lead to good results. However, good examination results in and of themselves don't always mean that the pupil received rich and full knowledge from the curriculum. In the worst cases, teaching to the test, rather than teaching the full curriculum, leaves a pupil with a hollowed out and flimsy understanding.

To prevent summative classroom assessment practices being too focused on national examinations, teachers should consider the validity of assessment items. Assessment programs should reflect the full content and objectives of the intended curriculum. A dependability approach, as suggested by Harlen (2005), could contribute to this outcome. Harlen (2005, p. 213) defined dependability as the sum of reliability and validity:

> The interdependence between the concepts of reliability and validity means that increasing one tends to decrease the other. Dependability is a combination of the two, defined in this instance as the extent to which reliability is optimized while ensuring validity. This definition prioritizes validity, since a main reason for

using teachers' assessment rather than depending entirely on tests for external summative assessment is to increase the construct validity of the assessment.

Up to now, far too little attention has been paid to geography teachers' summative assessment practices in the Netherlands. Although data on students' results in national examinations are collected each year, there have only been a few investigations into geography teachers' assessment practices and how such practices are influenced by the national examinations. This paucity of evidence is in line with the lack of published research pertaining to geographical education and assessment in general (Lane & Bourke, 2017).

This paper contributes to the discussion of the impact of high-stakes tests on geography teachers' classroom assessment practices. An analysis of test items in Dutch national examinations will be compared with results from prior studies of teachers' assessment practices. The consequences of these results and their implications for assessment in schools will then be discussed.

Background

Structure of geography and examinations in the Netherlands

Pre-vocational education in the Netherlands is a four-year course and is one of the possible tracks in secondary education. The other two tracks are a five-year general education track and a six-year pre-university education track. Students enter secondary education at the age of twelve. Geography is only compulsory in the first two years of secondary education. In the final two years, students choose six or seven subjects as part of their examination program. For those who choose geography the program consists of two parts: a national examination and an internal school-based examination. Both contribute 50% to the overall result at the end of secondary education.

Since 2013, the examination program in pre-vocational geographical education has contained six content domains: (1) Sources of energy, (2) Poverty and wealth, and (3) Boundaries and identity (internal school-based examinations) (4) Weather and climate, (5) Water, and (6) Population and place (domains of the national examination). A separate domain with specifications for geographical skills and methods is also included.

Prior research has highlighted two problems with regards to the alignment of internal (school-based) and external examinations. First, school-based examinations are dominated by the content of the national examination program. Results of a questionnaire conducted by Noordink, Oorschot, and Folmer (2017) showed that three-quarters of teachers in pre-vocational geographical education assessed the content domains of the national examination program in their school-based examinations (Noordink et al., 2017). These results were confirmed by Bijsterbosch, Van de Schee, Kuiper, and Béneker (2016) who found an even higher proportion of teachers structuring their assessment in this way. The second problem relates to the format of the internal school-based examinations. In a questionnaire by Bijsterbosch et al. (2016) geography teachers (n=74) responded that the purpose of internal examinations was preparation for the external assessment. The majority of these teachers believed that using a similar test format (multiple-choice questions or short, constructed responses) benefited students in this preparation. They also believed that these formats supported greater reliability in marking. Open test items demanding longer answers from students were less common. This suggests that teachers were more concerned with reliable test results than they were with the validity of their school-based examinations. These results are consistent with the findings of Harlen (2005), Black, Harrison, Hodgen, Marshall, & Serret, (2010) and Bijsterbosch, Van der Schee, and Kuiper (2017) regarding the reliability and validity of internal assessment practices. One of the consequences of these practices is that geography teachers' summative assessments in pre-vocational geographical education in the Netherlands do not always initiate meaningful ways of learning. More than 60% of these test items focus on recall of knowledge only (Bijsterbosch et al., 2017). Test items focusing on higher-order cognitive skills, such as evaluating or creating, are rarely included in these examinations.

These findings deviate from teachers' stated goals for geographical education. During the panel interviews, teachers confirmed that their goals went beyond the recall of knowledge (Bijsterbosch et al., 2017). Most teachers felt that geographical education should aim to support deep understanding and should scaffold students to become citizens who can make informed decisions about their world in the future. This raises serious questions about the impact of the national examinations on the design of school-based assessment and the accuracy of teachers' perceptions of the content domains of the national assessment.

Content analysis of national examinations

To identify the extent to which the national examinations reflect teachers' perceptions, the national examinations from 2015, 2016 and 2017 were analysed with regard to geographical knowledge and cognitive dimensions. Both dimensions were scored using the revised taxonomy by Bloom (Anderson, Krathwohl et al., 2001). In this table, the knowledge dimension consists of four categories. The first category is factual knowledge containing knowledge of specific details and elements, and knowledge of simple concepts. The second category is conceptual knowledge, which comprises knowledge of geographical principles or relationships between concepts. The third category, procedural knowledge, focuses on geographical skills and methods. The final category, metacognitive knowledge, includes knowledge of learning strategies.

The second dimension of the taxonomy consists of five cognitive processes: remembering, understanding, applying, evaluating and creating. Remembering refers to students' abilities to recall knowledge. Understanding is a more comprehensive category, containing cognitive processes such as explaining or inferring. The third cognitive process, applying, refers to students' abilities to choose and apply geographical skills. Evaluation requires students to attribute or critique the opinions of others, or give an opinion themselves. Finally, creating refers to the processes of developing a new idea or solution. In the analysis of test items, an important distinction was made between remembering and the other cognitive processes. Test items focusing on understanding, applying, evaluating and creating must contain new information. Otherwise, it is assumed that students will be able to answer the task correctly solely based on what they have already learned.

All test items in the national examinations (N=133) were scored by the author. A random selection of twenty-six test items were scored by another geography teacher educator in order to achieve inter-coder agreement. An interrater reliability test showed that Cohen's Kappa was 0.77 ($p<0.001$) for the scores of the test items in the distinct cells of the taxonomy table, which indicates a substantial agreement. The results of the analysis (Table 1) show that the majority of test items focus on remembering. Sixty per cent of items analysed assessed the recall of conceptual knowledge (see Appendix A, Examples 1, 2 and 4). The second most important category is 'understanding conceptual knowledge' (Appendix A, Example 3). Only seven per cent of the test items focused on applying (Appendix A, Example 5) and there were no examples of items assessing evaluation or creation of knowledge.

The examinations were also analysed by the assessment developers, the National Institute for Educational Measurement (Cito). These analyses are published on-line (Cito, 2015, 2016, 2017) and include psychometric indicators, such as the P-value or Rit/Rir-value of the test items. In their analysis Cito assigned each item to a category. An overview of the number and percentages of test items assigned to each category is provided in Table 2. The first three categories refer to the types of test item – open, multiple choice and pre-structured – while the remaining categories denote the targeted cognitive process: items with *statements*, *mention/cite* items, and *explanation* items. The definitions of these distinct categories come from Cito, but have been translated by the author. Note that the categories can overlap – a test item can be pre-structured and also include statements. Appendix A contains examples of test items in each category.

Table 1: Cumulative percentages of test items (2015, 2016 and 2017) in the taxonomy table.

Knowledge Dimension	Cognitive Process Dimension					
	Remember	Understand	Apply	Evaluate	Create	Total
Factual Knowledge	11					11
Conceptual Knowledge	49	33				82
Procedural Knowledge			7			7
Metacognitive Knowledge						
Total	60	33	7			100

Table 2: Numbers and percentages of test items in national examinations according to Cito in 2015, 2016 and 2017.

	2015 (n=43)	2016 (n=45)	2017 (n=45)
Open tasks	21/49	30/67	24/53
Multiple choice	14/33	15/33	15/33
Pre-structured	8/19		6/13
Statements	6/14	6/13	4/9
Mention/cite	12/28	16/36	11/24
Explanation	11/26	11/24	16/36

Conclusions/discussion

The outcomes of the content analysis of national examinations by the author is in line with the outcomes of the previous analysis of school-based examinations (Bijsterbosch et al., 2017). The majority of test items focus on the recall of knowledge. Higher-order cognitive processes, such as evaluating and creating, are completely absent.

A comparison with the analysis by the test developer was more complicated because Cito used distinct categories for the cognitive dimension. These categories do not match the categories of the revised taxonomy (Anderson et al., 2002), nor do they reflect the categories that are prescribed in the examination program (describe, explain, evaluate, problem solve, predict). The key question is whether the national examinations reflect the requirement of the syllabus for students to demonstrate higher-order cognitive processes. The content analysis of the external examination outlined above suggests that this is not the case. This raises questions regarding the construct validity of the test items in the examination. In this regard, some critical comments can be made about the format of test items. Cito distinguished three categories of test items – open, multiple choice and pre-structured. Most of the items in the external examinations adopted an open format. These tasks could best be defined as constructed response tasks that require a short answer (see Appendix A Example 2). Multiple-choice and pre-structured tasks were also common. These item formats are preferred because they provide reliable results. While there is nothing wrong with striving for reliability, this focus should not be at the expense of content and construct validity.

Greater attention to the validity of the examinations, both national and school-based, is needed. This problem has been previously highlighted in the literature. Kuiper et al. (2017) identified the need to ensure a balance between assessment reliability, validity and transparency. Kuiper et al. (2017) also drew a distinction between broad curriculum goals and specific achievement standards. The curriculum goals are expressed in generic terms and provide schools and teachers with choice regarding the selection of topics and learning objectives. The achievement standards are a set of attainment targets that students are supposed to demonstrate and, as such, are fundamental for both the internal and external examination program.

Ideally, the exam content and structure should align with the curriculum goals and the achievement standards. This does not mean that the exams fully reflect the content and objectives of the entire curriculum; rather, the knowledge and cognitive processes students are supposed to demonstrate in the exams are in line with the broader educational goals of the subject – in the context of this paper, the educational goals for geographical education. The exams are supposed to follow the content and objectives of the curriculum, not vice versa (Kuiper, 2017). This sequence becomes problematic when teachers *teach to the test* and exams dictate the enacted curriculum. This has the effect of widening the gap between the intended and enacted curricula.

To bridge this gap, greater focus on constructive alignment is necessary. Constructive alignment focuses on the relationship between educational goals, instruction, pedagogy, assessment and achievement standards. These five aspects should be in line with each other. An approach based on powerful knowledge, as suggested by Lambert (2011) and others, might be helpful in achieving this. According to Lambert, three domains are essential for powerful knowledge:

1. deep descriptive and explanatory world knowledge;
2. development of relational thinking in geography; and
3. an enhanced propensity to think about how places, societies and environments are made.

Powerful knowledge, in this sense, is strongly connected to a capabilities approach. A

capabilities approach invites teachers and curriculum leaders to reflect on how education contributes to human autonomy and potential (GeoCapabilities, 2016). This approach also allows teachers to connect the subject-specific knowledge to the goals for which to strive. As Lambert (p. 258) states:

> A 'capabilities' geography expresses geography in terms of educational goals. The curriculum content, beyond the statutory knowledge requirements (including possibly a core knowledge sequence), still has to be selected. But the goals articulate what we are trying to achieve with young people: an improved knowledge and understanding of the world and their relationship with it.

In geographical education, this approach is helpful in determining what the content and objectives should be and which pedagogies should be applied to meet these goals. This approach would also be helpful in order to align the ultimate goals in geographical education with geography examinations, both national and internal.

A dependability approach, with a strong focus on constructive alignment that rebalances the focus on reliability with validity in the construction of examinations, is required to create meaningful examinations in the Netherlands. A rethinking of the examination program, and the relationship between content and purpose of school-based and national examinations, is also necessary. The distinction between a school-based examination programme and a national examination programme has led to undesirable effects, as described above. Reconsidering this distinction therefore seems to be necessary.

Another issue worth reconsidering is whether the current content of the examination program is appropriate. Noordink et al. (2017, p. 13) note that many teachers of pre-vocational geography believe that the examination program is "overloaded" and that the range of topics and regions should be reduced. Progression in geographical understanding is often considered to reflect increasing breadth, increasing depth, a move from the concrete to the abstract, and the use of a wider range of techniques (Taylor, 2013). The current focus on breadth in the examination program might be at the expense of increasing depth. This may also promote a focus on the recall of knowledge. A less overloaded examination program, therefore, might be required. There is an urgency to rethink the design of the examination program, to ensure that both school-based and national examinations contribute in meaningful ways of learning in geography. The promotion of more meaningful ways of teaching, learning and assessing geography is a responsibility of the entire geography community in the Netherlands.

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Appendix A

1. Example of a test item that has been classified as testing 'remembering conceptual knowledge' by the author and as a 'mention/cite' item by Cito:

   The construction of the Aswan Dam in South Egypt has advantages and disadvantages for the people living in the area of the lower reaches of the Nile.

   Describe an advantage for the people living in the area of the lower reaches of the Nile.

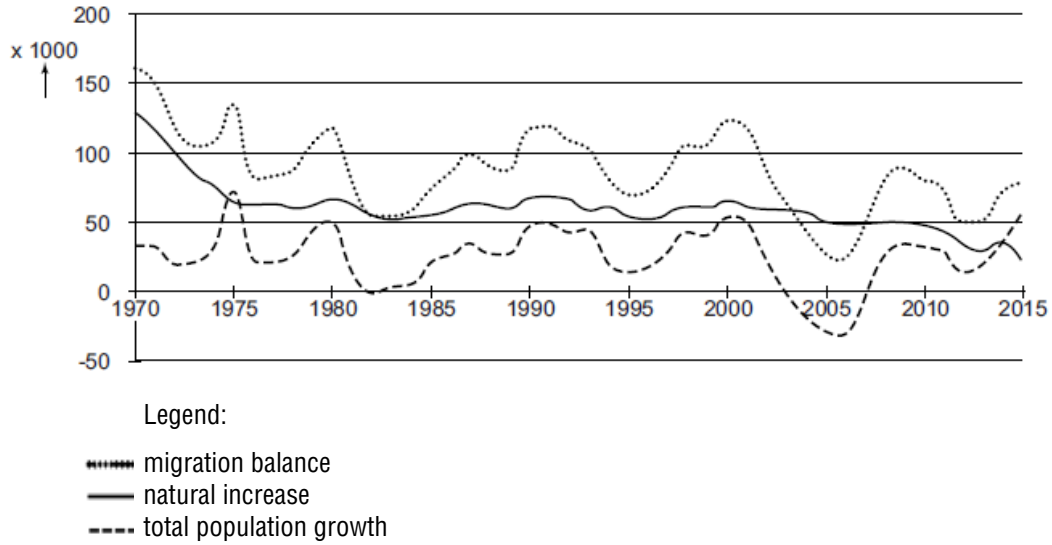
2. Example of a test item that has been classified as testing 'remembering conceptual knowledge' by the author and as an 'open task and explanation' item by Cito:

   Tornados and hurricanes are both manifestations of extreme weather conditions. In general, hurricanes lead to more victims than do tornados. Despite this, hazard management for tornados is more difficult than it is for hurricanes.

   Mention a reason why this is the case.

3. Example of a test item that has been classified as testing 'understanding conceptual knowledge' by the author and as a 'pre-structured and statement' item by Cito:

   Figure 32 Population development in the Netherlands, 1970–2015



Study Figure 32.

*Below are thr*ee statements, based on Figure 32.

Statement 1: In 2015, more people died than were born.

Statement 2: In 2006, the total population growth was less than was the natural increase.

Statement 3: Between 1970 and 2015, the Dutch population mainly grew because of natural increase.

Write the number*s 1, 2 and 3 on your paper and write whether the statement is correct or incorrect*

4. Example of a test item that has been classified as testing 'remembering conceptual knowledge' by the author and as a 'multiple-choice and statement' item by Cito:

   Two students make a statement about air pressure.

   Statement 1: The tighter the packing of the isobars, the weaker the wind blows.

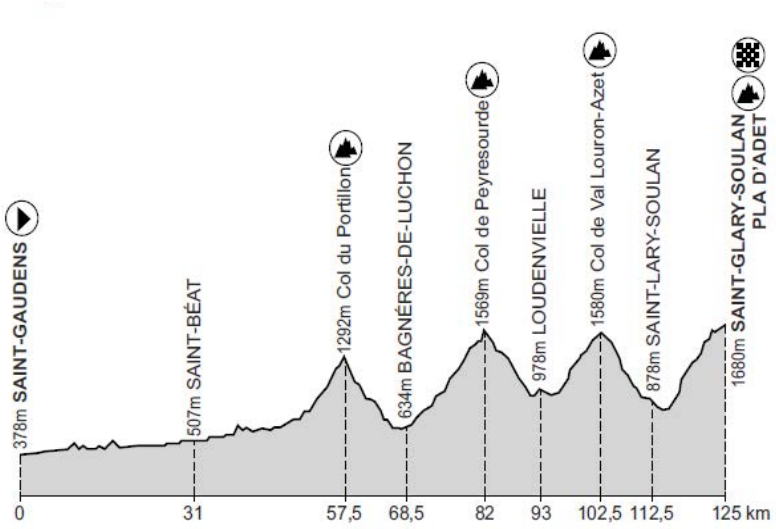
   Statement 2: In high-pressure areas, the air rises, thus creating a greater chance of precipitation.

   Which is correct?

a. *Only statement 1 is correct*
b. *Only statement 2 is correct*
c. *Both statements are correct*
d. *Both statements are incorrect.*

5. Example of a test item that has been classified as testing 'applying procedural knowledge' by the author and as a 'multiple-choice' item by Cito:

Figure 4. Stage 17 in the Tour de France 2014

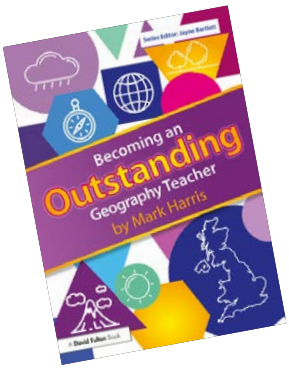


In stage 17, the cyclists had to climb. That day, the weather was calm. The temperature in Saint-Béat was 24 degrees Celsius. How many degrees Celsius lower was the temperature at the top of the Col de Peyresourde?

a. *Approximately 0,6 degrees Celsius*
b. *Approximately 1,0 degrees Celsius*
c. *Approximately 6,0 degrees Celsius*
d. *Approximately 10,0 degrees Celsius.*

Book Reviews

Reviews Editor: Geoffrey Paterson



Becoming an outstanding geography teacher.

By Mark Harris. Abingdon: Routledge, 2018

215 pages, paperback, ISBN 9781138697218. http://routledge.com

It is not uncommon for a pre-service geography teacher, or in fact an experienced teacher, to ask the question: *what makes an outstanding geography teacher?*

In 2006, an earnest attempt was made by the University of Melbourne, Geography Teachers Association of Victoria and Australian Geography Teachers Association via the Geogstandards project to identify 'exemplary geography teaching through the development of Professional Standards for Accomplished Teaching of School Geography' (www.geogstandards.edu.au/).

In his book, Mark Harris also explores the *ingredients* involved to be an outstanding geography teacher. Whilst it can be argued that there should not be a formula for the accomplished geography teacher, the Geogstandards project and now Harris's book, does go some way towards identifying strategies, approaches and techniques that are generally agreed on as good practice for the geography teacher aspiring to be outstanding. There are commonalities between the pedagogical content knowledge of geography, advocated by Harris and Geogstandards, that make for some interesting reading and affirmation of what many geography teachers aspire to – to motivate and enthuse their students about geography, whilst being rigorous and authentic with the learning.

Although the book often refers to the General Certificate of Secondary Education course in England, it is highly applicable to the approaches advocated in the Australian Curriculum: Geography. This is particularly true in the frequent references in the book to geographical thinking, skills, questioning and creating curiosity through inquiry.

The book is very practical in its approach, providing numerous classroom ideas for lesson starters, using current events, and lesson planning in general. The chapters on literacy and numeracy are particularly useful as they articulate the nature and importance of these areas in the teaching of geography.

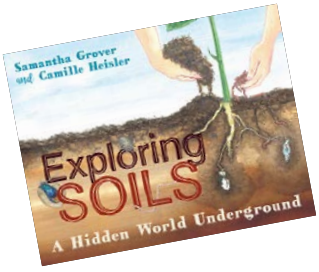
In the current education scene with an emphasis on literacy and numeracy in schools, such articulation is incredibly useful for the geography teacher to argue the value of their subject in these areas – that geography is much more than just about maps!

I suggest the focus on the English curriculum in the chapters on *Marking for progress* and *Teaching A Level* does not distract from the usefulness of this book for the aspiring geography teacher in Australia.

The final chapter on promoting geography is particularly useful because I have found one of the most common identifiers of the outstanding geography teacher is a geographer who goes out of his or her way to promote the subject in the school and broader community, and most importantly with students. It is clear from this book that such promotion is an imperative for any geography teacher – without such marketing of our subject, the outstanding geography teacher will not have the opportunity to practise his or her skills!

This is a useful and thought-provoking book on an important topic to support outstanding geography teaching.

Malcolm McInerney
University of South Australia.



Exploring soils: A hidden world underground.

By Samantha Grover and Camille Heisler. Clayton South: CSIRO Publishing, 2017

32 pages, hardback, ISBN 9781486305001. http://publish.csiro.au/

Exploring soils: A hidden world underground is an illustrated reminder of how many geographers begin – as young children exploring the world around them. Written by Dr Samantha Grover, a soil scientist and parent, this well-informed picture book is intended for primary school-aged children, their parents, and teachers.

The author and illustrator have done very well to take a complex and at times overlooked scientific field and convert it into a comprehensive picture book. Information is written

and presented in ways that are easy to understand and relatable for primary school-aged children, with diagrams integrated into the illustrations.

The book begins by identifying soil as a habitat for insects and as an ecosystem where compost is decomposed to support plant life: 'I don't think I'd like compost in my bed, but the insects and microbes love it'.

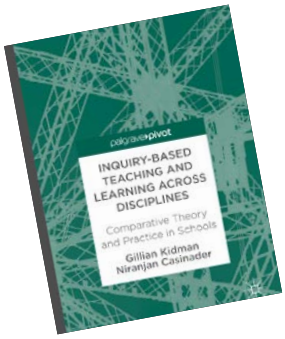
The book then shows how soil is found in layers with rock, comparing those layers to 'Nan's sponge cake', before briefly introducing Hans Jenny's theory of soil development: "'Clorpt?" says Dad from the front. 'That's a new word to me'".

The book next identifies three types of soils (sand, silt, and clay) and some of the properties and uses of each: to make sandcastles, for growing vegetables, and to make clay bowls and Aboriginal paints.

Although the narrative lacks the appealing subtle predictability which many picture books share, as an educational resource for Years 3 to 6 primary school teachers the book delivers appropriate depth and breadth of knowledge and makes a useful and unique contribution to the scientific classroom community.

Given that this book is intended for primary school-aged children, I leave the final remark to my nine-year-old daughter, Dakota: 'This is an interesting book. It's about children learning about the different soils in the ground. I like the part where it says "I just add chicken poo and ta-da – strawberries for everyone!"'

Dr Kevin F. McGrath
New South Wales. Service for the Treatment and Rehabilitation of Torture and Trauma Survivors,
Sydney, New South Wales



Inquiry-based teaching and learning across disciplines: Comparative theory and practice in schools.

By Gillian Kidman and Niranjan Casinader. London: Palgrave Macmillan, 2017

181 pages, hardback, ISBN 9781137534620. http://palgrave.com

This valuable book by two education academics from Monash University, with wide experience in Science, History and Geography, examines the nature of inquiry teaching and learning across the three disciplines.

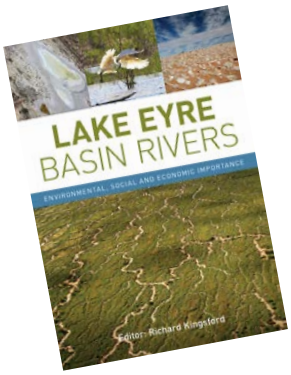
Their discussion begins with an account of the history of inquiry in schools providing a valuable background to their analysis of the use of inquiry in classrooms and in curriculum as seen in the three disciplines. In doing so, the authors draw attention to what can only be described as a patchy and inconsistent use of the concept, both in the classroom and in curriculum documents, and the way inquiry varies significantly from one discipline to the other, a valuable research finding that needs to be emphasised. Inquiry in Science is different from inquiry in History, and Geography sits somewhere in between.

Their comparison of classroom goals in inquiry, focusing on students learning how to think for themselves, with classroom practice is a most useful discussion of the possibilities and difficulties of this area. For all sorts of good reasons, teachers feel they need to be in control and yet inquiry learning, with its focus on students controlling what happens, challenges such thinking. As one teacher said to me, 'How can I make sure the students know what they need to know for the exam?'

The authors' analysis of the Australian Curriculum documents is an intriguing comparison of the differences between the three disciplines, and the difficulties curriculum writers have in producing documents that will be useful to schools and teachers while satisfying other social/political imperatives.

However, it is the last chapter on fieldwork that is probably the most valuable for the geography teacher. The chapter's focus on 'intelligence in the wild', a lovely encapsulation of the importance of fieldwork to geography learning, and the issues, both practical and theoretical, that teachers and schools need to face up to in ensuring that fieldwork is part of all students' learning, is an important conclusion to the book. This book is a valuable addition to the literature on inquiry learning and geography education while probably being too technical for most teachers.

Bill Stringer
Balwyn North, Victoria.



Lake Eyre Basin rivers: Environmental, social and economic importance.

Edited by Richard Kingsford. Clayton South: CSIRO Publishing, 2017

272 pages, paperback, ISBN 9781486300785. http://publish.csiro.au

Drought is once again on the national agenda. With water use and management hot button issues, and so much focus on the Murray-Darling Basin, it was refreshing to learn more about the Lake Eyre Basin in the heart of the nation. This book serves as a reminder of the diversity, complexity and importance of our central Australian river systems.

The book is composed of twenty-two articles written by a diverse mix of authors ranging from scholars and ecologists to Traditional Owners and pastoralists. This breadth of voices is one of the publication's greatest strengths. Entries cover topics

such as fish and turtle species, indigenous significance, mining, beef production, and government policy.

The publication is bookended by contributions from its editor, Richard Kingsford. These two are the real gems for those less familiar with this river basin. As the cover states, this book is most valuable as a reference for 'environment and government agencies, industries and policy-makers'. That said, the opening piece, *The Lake Eyre Basin – one of the world's great desert river systems*, is a fascinating and accessible examination of the geomorphology of the basin and its boom and bust flows which could be used to examine the complexity of Australia's inland water systems with students in Years 11 or 12.

Anna Hind
Vice President
Geography and History Teachers' Association Northern Territory.

Modern India: A very short introduction.

By Craig Jeffrey. Oxford: Oxford University Press, 2018

140 pages, paperback,
ISBN 9780198769347.
https://global.oup.com

India is the seventh largest country by area (3,287,263 km^2) in the world but with 1,354,051,854 people it is second by population behind China's 1,415,045,928.

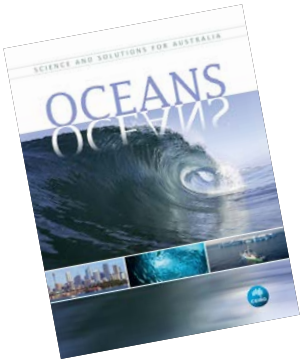
The complexity and contradictions that make up current day India are succinctly and clearly outlined in this short book by Craig Jeffrey, Director and CEO of the Australia India Institute and a Professor of Human Geography at the University of Melbourne.

Modern India outlines in seven chapters the energy of the people to overcome the economic, environmental and social destruction caused by British rule through crippling taxes, land degradation and solidification of the differences between religions and castes. It outlines the political changes since independence from Nehru's strong leadership and the autocratic rule of his daughter, Indira, and grandson Rajiv, to the rise of Hindu nationalism. It describes how economic reform has not benefitted all and how social inequity continues to impact on women, lower classes and castes as well as Muslims and Christians. Many groups are active in campaigning to improve education, health and employment and address corruption.

Readers gain insight into the various cultures through quotes, sayings and Hindi words throughout the text. Unfortunately, there is only one, difficult to read, map, The British Territories in 1856. The 14 photographs appear to break up the text where statistics supporting the text would have added depth of understanding. Annotated maps could have been useful to gain greater insight into the diversity throughout the country.

There is a short useful list of references but each chapter refers to significant people so a glossary would have been helpful. Overall this concise introduction to current day India would inform any teachers engaging students with incredible India.

Catherine McNicol
Hampton, Victoria.



Oceans.

Edited by Bruce Mapstone. Clayton South: CSIRO Publishing, 2017

211 pages, paperback,
ISBN 9781486307937.
https://publish.csiro.au/

Oceans contains a collection of short chapters, each presenting different scientific research covering the characteristics, management challenges and future prospects for Australia's oceans. The research links closely with Geography curricula from Years 7 to 12 using studies from a variety of places. The introductory chapter discusses the interconnection between oceans and liveability, food production, tourism and climate. The rest of the book is divided into three sections: Australia's Marine Estate, Science and Ocean Use, and Future Oceans Science.

The first section contains a detailed look at Australia's oceanography including ocean currents and seasonal circulation patterns. A variety of maps shows the location and direction of these features while schematic diagrams demonstrate their related processes. The bioregions of Australia's marine estate are explored in detail, highlighting the broad range of habitat types from coast to deep ocean. Additional chapters cover the geology of the Australasian tectonic plate and Australia's continental shelf, the links between the ocean and climate change, and the uses and management of the ocean by people.

Topics covered throughout the second section of the book include the management of fisheries and aquaculture, oil and gas exploration, the impacts of development within the coastal zone and the costs and consequences of ocean pollution. The final section explores methods used to observe and model changes to oceans including biological and climate systems and conservation outcomes.

One of the strengths of this book is the use of a variety of photographs, maps, graphs and diagrams from a wide range of case studies. The language used is at an appropriate level for teachers and senior students, even if they do not have any background knowledge in this area. Given the wide range of relevant topics covered throughout this book, I highly recommend it as an asset to a school library as a resource for both teachers and senior students.

Adrian De Fanti
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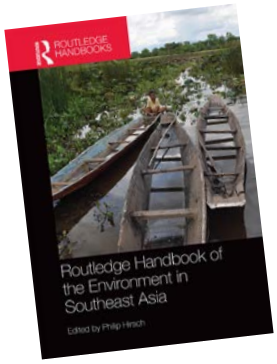


Routledge handbook of the environment in Southeast Asia.

Edited by Philip Hirsch. Abingdon: Routledge, 2017

521 pages, hardback, ISBN 9780415625210. https://routledge.com

This handbook is a collection of 30 chapters dealing with significant environmental issues. It is structured into four main parts, providing a comprehensive overview of the environments of South East Asia, the problems experienced within these environments, and the challenges faced overall within this region.

The term *environment* is a significant issue today in geographical studies and students at all levels are familiar with dilemmas regarding economic development. South East Asia has been selected because it is an economically diverse region with many environmental issues.

The study of Geography, in Victoria, involves an understanding of the characteristics of the places that make up our world, using concepts such as place, space, environment, interconnection, sustainability, scale and change. The handbook, through its chapters, refers to these concepts, allowing students to question their world, reflect on their relationships with their environment, take responsibility and propose action to enable a socially just and sustainable future.

The handbook discusses a variety of environmental issues, how these have changed over time and how these vary through regions in South East Asia. The issues are taken from a global perspective but discussed at a local level, focusing on peoples' interaction with their surroundings.

South East Asia is an appropriate region for environmental debate as it is an economically, demographically and ecologically dynamic region. The issues have arisen due to human induced biophysical changes, largely due to economic development and population growth and movement. Studying this region, students will be aware of the pristine landscapes, but also congestion, pollution, resource depletion and conflict. Whilst many environments within this region have been protected and managed, many have been used by people for their livelihoods.

The term *environment*, therefore, means different things to people here. For example, many environmental concerns have opposed dams, protected forests and wildlife and improved the quality of life for people. There have, however, also been conflicts over sustainable development, such as conflicts over water resources in the Mekong and haze impacts from fires in Indonesia affecting Singapore.

This is not a book for school students. The book is an academic study from which teachers could extract interesting case study material. The data are topical and relevant; however, teachers will need to be prepared for some heavy reading. Its outstanding features are the detailed aspects on a wide range of environmental issues within the South East Asian region, past, present and thinking of the future.

Specific examples include the following. The concept of *change* is included in Chapter 11, which deals with the conversion of forested lands to cultivated and urbanised landscapes, that is, forest use and management as a commercial resource and biodiversity exploitation, and the agricultural expansion due to population growth, linked with environmental degradation and deforestation in Chapter 4.

Chapter 3 suggests that population growth and economic change (trade) are the prime drivers of environmental change.

Chapter 2 states that development is not necessarily in conflict with the environment and that economic development will occur with improved environmental management if environmental degradation is kept low.

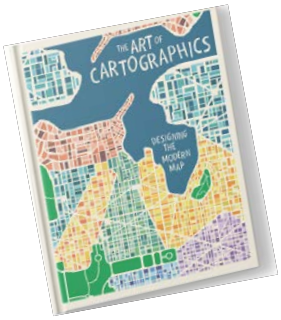
Shifting cultivation and human interaction with forests is a focus in Chapter 12. Interaction with the hill forest in the past 50 to 100 years is emphasised as this practice is central to debates about the environment and development in the South East Asian region.

The importance of water, rivers and dams is tied to ecosystems, societies, economies and cultures in this region. Chapter 13 discusses the rapid economic and societal change which is transforming the relationships between rivers and people. Chapter 14 describes how coastal ecosystems are under pressure from, for example, overfishing, offshore oil and gas, coastal tourist resorts and sand mining, which all impact on, and contribute to, the region's economic transition.

The book also includes regional and country studies, good if a specific locational focus is needed. For example, the Mekong and hydropower, environmental management in Cambodia and the evolving environmental governance in Myanmar.

Overall, if a teacher wants to focus on specific environmental issues in South East Asia, and is willing to undertake some reading, then the case studies and detailed information will be of use. Maps, diagrams and statistics are used by some authors. This is a handbook which could provide some interesting and valuable data for teachers developing investigations into the Victorian Certificate of Education Unit 3: Changing the land, focusing on geographical change, especially land cover and land use, with an emphasis on deforestation.

Marilyn Wiber
Melbourne, Victoria.



The art of cartographics: Designing the modern map.

Preface by Jasmine Desclaux-Salachas. Ultimo: Hardie Grant, 2017

255 pages, hardback,
ISBN 9781741175615.
http://hardiegrant.com/au/books

Despite the ubiquity and ease of use of GoogleMaps, OpenStreetMap, GPS, and GIS software, good map design is surprisingly rare. This book presents a selection of about 100 maps-as-art, and artworks involving maps (as either raw material or thematic inspiration), in two- to four-page spreads, all divided into two highly-overlapping (so rather pointless) *chapters*: the physical environment, and human activity.

Each work is given a brief paragraph of textual description, but is otherwise left to visually explain itself. The works included range from real maps produced as posters, or for tourist brochures or bus-stop billboards, to infographics for magazine articles and corporate presentations, online geographic data-mashup apps, and ephemeral 3D art installations.

They utilise a variety of media from the digital to the arboreal (a subway map of Moscow made from painted birch sticks)[1], the oleous (a map of oil spills made with ink blots)[2], and even the lithic (a world map 'created' by smashing the plaster off a gallery wall with a sledgehammer!)[3].

This is not a book about how to design a map, but rather an ideas book for the designer, artist or cartographer seeking inspiration for his or her next publication or commission. Each spread identifies the designer/artist by name and nationality, and a two-page index (annoyingly sorted by Christian name not surname!) lists a website for each, which is particularly necessary for the works intended for online interaction (for example, a colour-coded dot-map of New York City's municipally-managed trees, filterable by species)[4].

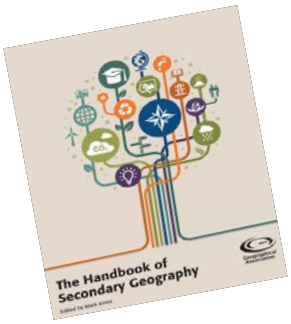
With only two works *by* Australians, and only one work *of* Australia[5], the geographies depicted will likely be of little interest to most students (the pretty Middle Earth maps excepted)[6]. Nevertheless, it does constitute an interesting catalogue of examples of both good and bad design (cartographic or otherwise): students could be asked to identify and comment on the positive and negative design features of the featured maps (colours, fonts, layout). After all, maps are a combination of visual and textual communication, and a map that fails to communicate its message clearly and quickly is next to useless. While all the included works are visually interesting, some certainly trade off legibility and informativeness for a purely trendy use of colours or styles (San Francisco rent prices versus private shuttlebus stops)[7]; while others elegantly transcend even language barriers (an Italian-language map of the Beatles' foreign tours)[8].

More a coffee-table book suitable for a design studio's lobby, it appears of little relevance to the school geography curricula, but may be of interest for art/design teachers.

Dr Brendan Whyte
Assistant Curator of Maps
National Library of Australia, Canberra, ACT.

Websites:

1. www.behance.net/gallery/13358921/muravejnik-(shema-moskovskogo-metro)
2. www.ceciliadellalonga.com/projects/drops.html
3. http://jeandenant.fr/site/Mes_operation_tonnerre/Pages/operation_tonnerre.html
4. http://jillhubley.com/project/nyctrees/
5. www.saradrake.com/
6. http://tomaszkowal.pl/index.php?option=com_content&view=category&layout=blog&id=29&Itemid=69&lang=pl
7. http://byysr.com/work#/sfmap/
8. https://www.behance.net/gallery/10984881/IL-Gran-Tour



The handbook of secondary geography.

Edited by Mark Jones. Sheffield: Geographical Association, 2017

351 pages, softback,
ISBN 9781843773771.
http://geography.org.uk

What is geography?

This is certainly the right place to start with a comprehensive textbook resource for teachers of the subject. The first chapter helps to focus in on the purpose of geographical education and is a launching point for the rest of the resource.

As the title suggests, this is a resource for secondary geography teachers. It is divided into three sections with 24 chapters in total. Each chapter has a list of recommended key readings and a short description of each of these.

Section 1 explores the *big picture* topics around thinking geographically, planning for enquiry, progression, and curriculum.

Section 2 forms the bulk of this resource and provides practical advice on many aspects of geographical education around the wide range of styles and strategies we can use in teaching geography. There are chapters in this section that look at what makes a *good* geography lesson, the range of resources available for a geography classroom, strategies to differentiate work tasks, assessment, approaches to incorporating literacy and numeracy into your geographical teaching, approaches to

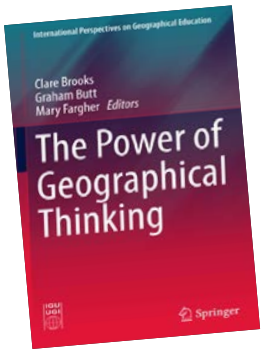
fieldwork, and the benefits and challenges of using a range of spatial technologies.

Section 3 looks to the future of a teacher's career and encompasses professional development, researching geographical education, mentoring, leading the geography department and the importance of belonging to a subject community.

Whilst the text is targeted at teachers of Geography in the United Kingdom, and there are regular references to the UK curriculum and political situation, with some chapters and sub-parts focusing on these, the resource is universal in its underpinning principles and practical advice.

Due to the range of content covered by this resource, it is certainly suitable for beginning teachers with little or no experience teaching geography, right through to experienced and aspiring leaders in the field. I highly recommend this for teachers at any stage of their career, as there is something for all of us in here.

Rowan Harris
Hobart College, Tasmania.



The power of geographical thinking.

Edited by Clare Brooks, Graham Butt and Mary Fargher. Cham, Switzerland: Springer International, 2017,

238 pages, hardback, ISBN 9783319499857. http://springer.com/

Every once and a while you get a textbook and go *Wow! That really is valuable to me and my students!* Well, it is 'double wow!' for *The power of geographical thinking.*

It became one of those rare books that I did not want to put down as it led me through those various areas of contemporary geographical education that really matter in both practice and research. It begins with a solid look at 'Theorising Geographical Thinking', thus setting a rigorous theoretical underpinning for what is to follow. It then goes on to what I regard as the heart of good geographical education with a section on 'Pedagogy and Geographical Thinking'. Early on in my career I maintained to my high school students studying Geography that a key outcome by Year 12 was to be able to think like a Geographer. As an example, to *see* the actual terrain in detail on a topographic map – rather than just brown and green lines.

The various authors who contributed chapters to the book provide, amongst other things, useful case studies from around the world about thinking and teaching in geographical education. This provides a rich international perspective that gives the reader a range of insights into the teaching and learning of Geography in a wide variety of settings. This is a very valuable approach that makes the book particularly interesting as all address that key concept of 'The power of Geographical thinking'.

The book covers key topics and concepts in geographical education as well as a number of contemporary issues. With my keen interest in educational neuroscience, I found the various ideas, shared by the authors, contributing to developing significant expertise in teaching and learning of Geography. Indeed, I would see this book as not only a very valuable contemporary contribution to the field of geographical education – particularly in practice and research – but as one that will continue to be on the 'must have and use extensively' book list at universities. This is a terrific text for both university students and teachers of Geography.

In their Conclusion (p. 235) the Editors cite Jackson (2006) who so eloquently noted:

> Thinking geographically does provide a language – a set of concepts and ideas – that can help us see the connections between places and scales that others frequently miss. That is why we should focus on geography's grammar as well as on its endless vocabulary. That is the power of thinking geographically (page 9).[1]

So, recommendation overall?

The currency of this book alone makes it a valuable resource for all involved in geographical education. It is not only a most valuable addition to the library of in service and preservice teachers, and academics, but a book really worth the investment of time to engage with as a valuable resource and use to further enhance our practices – both in teaching and researching in geographical education.

If you have the chance, have a read of Chapter 16 'Reflecting on what makes geographical thinking powerful'– the final chapter of the book written by the Editors. That succinct summary, provided by the Editors at the conclusion of the work, will very likely motivate you to have access to your own copy of the book!

Professor Ken Purnell
CQUniversity Australia.

1 P Jackson (2006). Thinking geographically. *Geography*, *91*, 199–203. The quote is on page 203.

The weather obsession.

By Lawrie Zion. Carlton: Melbourne University Press, 2017,

208 pages, paperback, ISBN 9780522868418. http://mup.com.au/

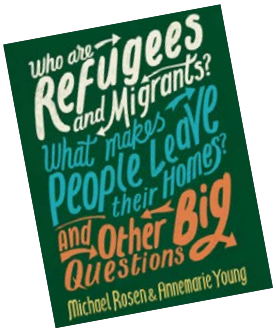
Lawrie Zion has produced a very readable and accessible account of his life as a self-confessed *weather tragic*. This fascination, he claims, is shared by most Australians as the weather is a shared common experience and 'weather remains a part of our social lubrication, our identity, and it is central to how we live' (page 2). Information about the weather is pervasive in our everyday lives through digital technology in our cars, mobile phones, weather apps and shared images on social media. There are also many fascinating statistics and historical asides.

The book traces the gradual development of Australians' understanding of the climate and weather after 1788 as more data is collected, analysed and distributed, and the relatively new science of meteorology develops. This distribution of weather information has been enabled by technological developments from the telegraph to the internet. A particular focus is how the presentation and distribution of weather information through the press, radio, TV and the internet has changed over time and improved our understanding.

The author states that his earliest interest in the weather as a young man was sparked by forecasts, statistics and maps contained in daily newspapers. Unfortunately, these features do not appear in the book. As a result, it is very text heavy and I think that this detracts from its overall appeal. The gradual development of weather maps in the press and their importance are covered in some detail. An inclusion of one or more would have been useful.

This book is a teacher resource. The most useful chapters for geographers would be Chapter 4 *Catastrophic*, which examines developments in the way in which the Bureau of Meteorology and other agencies deal with preparing Australians for extreme weather events and contrasts the 1999 hailstorm in Sydney with the 2009 Black Saturday bushfires and the preceding heat wave. Chapter 9 examines the issue of climate change in some detail.

John Ramsdale
Montmorency, Victoria.



Who are refugees and migrants? What makes people leave their homes? And other big questions.

By Michael Rosen and Annemarie Young. London: Wayland, Hachette Children's Group, 2016

48 pages, hardback, ISBN 9780750299855. http:// hachette.com.au

This book is aimed at young people, probably upper primary to lower secondary, to help them understand migration and all forms of people movement. The opening pages are entitled *Why we need this book* and state

> the aim of this book is to get you to think for yourself about the questions we raise. Questions like, 'What makes people leave their homes?' and 'What happens to them/how are they treated when they arrive in a new country?'

The layout of the book is clear and easy to read with limited text, good use of colour and images. The book begins with some key definitions and links to the United Nations. It then moves through topics dealing with themes such as the reasons for migration, migration over time, the rights that migrants and refugees have, prejudicial vocabulary and sharing of cultures.

None of these topics is covered in detail as is appropriate for the target audience. Each section is either a double-page spread or across four pages. There are questions to challenge students on each spread which are clearly identified with a *Think about* sign. These would form an excellent basis for class discussions.

Interspersed between these topic pages are six double-page spreads covering personal migration stories of individuals, including those of the two authors. There are also quotes from a wide range of other migrants which link to the issues raised. These first-person narratives help the reader make connections on an individual level and are excellent primary sources.

The book concludes with two sections: *What would you do?* which asks the readers to imagine they are forced to flee; and *What do you think?* which asks the readers to write their own list of human rights that everyone should share.

There is also a glossary covering a good range of key terminology, some suggested additional reading, and a list of websites and organisations for gathering further information.

This book is not a Geography text as such although it addresses a vital geographic issue: population movement. It would make a valuable addition to a school library or as a teacher resource for units such as Year 8: Changing Nations.

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Australian Geography Teachers Association Limited and its affiliated associations 2018

Australian Geography Teachers Association Limited

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“There is an eternal landscape, a geography of the soul; we search for its outlines all our lives.

—Josephine Hart

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