ŌTAUTAHI CHRISTCHURCH AOTEAROA NEW ZEALAND
35TH AUSTRALASIAN ASSOCIATION FOR ENGINEERING EDUCATION ANNUAL CONFERENCE
8-11 DEC 2024
THE ENGINEER AND THE WORLD

Increasing Enrolments in Geotechnical Engineering Education – A Plan for Industry Advocacy in Australasia

Golnaz Alipour Esgandani[a]; Eleni Gkeli[b]; Sukumar Pathmanandavel[c]
Macquarie University[a], Stantec[b] Geoexec Pty Ltd.[c]
Corresponding Author Email: golnaz.alipour@mq.edu.au

ABSTRACT

CONTEXT

Engineering programs in Australasia are facing cutbacks despite high demand for engineers. There's a need for a turnaround to meet both local and international demand for engineers and engineering.

PURPOSE OR GOAL

This paper addresses an initiative being designed, focussed on end clients, to help increase student interest in undertaking geotechnical engineering and engineering geology courses at academic institutions in Australasia. In our view, this is a novel approach to an issue that has been much discussed and debated in Australasia in the past years and possibly decades.

APPROACH OR METHODOLOGY/METHODS

In 2023 and 2024 there have been various sessions held in Australia and New Zealand about Geo-Education. With a certain level of consensus on major issues reached, the study team aims to engage end clients (provisionally termed Geo-Owners) across industries like Defence, Construction, Academia, Transportation, Earthquake Response, Resources, and Offshore to understand their technological needs and modern practices. The goal is to promote geotechnical engineering and engineering geology, through advocacy of the profession by end clients, who possibly can benefit from a strengthened academic platform in Australasia.

ACTUAL OR ANTICIPATED OUTCOMES

We want to portray to the present and future generations of geotechnical engineers and engineering geologists, collectively called geo-professionals, what is the current reality and excitement of the profession, as it takes on the increasingly complex and large projects that the nations in this region and elsewhere undertake, and the highly interdependent nature of geotechnical profession in a rapidly changing engineering world. We hope, through a series of interviews with key, influential leaders in the end client world, to discover, develop and promote a revitalised view of geotechnical profession, seen through the client's eyes, and promoted through the client and others in the industry and academia.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

We believe the need to increase student enrolments in engineering courses is not isolated to geotechnical engineering, and the purpose of this paper is to inform others who might wish to consider similar actions, and also to seek feedback, input and interest from others on our work.

KEYWORDS

Leadership, Education, Geotechnical Engineering, End Clients, Industry, Advocacy

Introduction

Universities, as key institutions for the creation and dissemination of knowledge, occupy a unique position within society and have an important role in advancing the Sustainable Development Goals (SDGs). Aligning higher education, particularly in engineering, with the SDGs is crucial for addressing global challenges and promoting a sustainable future. Engineering, as a discipline, plays a fundamental role in the planning, design, and development of infrastructure necessary to support the continued prosperity of the Australasian region while also contributing to the global achievement of the SDGs (Buckler & Creech, 2014).

However, engineering programs at universities across Australasia are under increasing pressure, with some disciplines, such as engineering geology, facing potential reductions or discontinuation (De Paor et al., 2009). To meet the growing local and international demand for engineers, it is imperative to reverse the declining trend in the perception and viability of engineering programs in the region.

Several factors can contribute to the declining appeal of geotechnical engineering, including a preference among students for office-based roles over fieldwork and the perception of geotechnical engineering as a less technologically advanced and less attractive option within civil engineering curricula. This paper introduces a novel, industry-focused initiative to engage with end clients designed by a collaborative team from both industry and academia in Australia and New Zealand. Led by academia, the initiative aims to increase student interest in geotechnical engineering and engineering geology courses across Australasia.

The paper outlines the background context, the steps taken thus far, and the intended approach for future actions, along with the expected outcomes. While the initiative focuses on geotechnical engineering, we believe the need to boost student enrolment extends to other engineering disciplines. The paper also seeks to share insights and engage with others interested in implementing similar strategies and gathering feedback for further refinement.

Background and discussions sessions held in Australasia, 2023 & 2024

An Australia and New Zealand collaborative team, working as part of International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE) Heritage Time Capsule (HTC) Project has focussed on Geo-Education issues in Australasia (ISSMGE, 2024). Regular accounts of the outcomes of discussions session held in both Australia and New Zealand have been published in several publications ("Education of the next generation of geotechnical and engineering geology professionals in Australia and NZ," ; "Geo-Education in ANZ, “Education and Training of graduates – Challenges and opportunities”," ; Gkeli). A road map of the sessions held and planned can be seen in Figure 1.

In one of the latest sessions that was held in 2024 in Sydney, Australia, several key questions were asked from the panel and the audience about whether they think there is any problem with the number of graduates in Geo-profession, whether there are any skill gaps in the recent graduates, how they think the appeal of the profession is and what they think can be done to increase the attractiveness of this profession.

In responses to the question of “what can be done to attract the attractiveness of the profession?”, the need to make the profession and its work more visible to schools and younger generation is noted. This includes suggestions about sharing stories with younger generation about our profession, promotion to school children through excursions and presentations, encouraging young professionals to attend institution events, young people to get involved and see what exciting and varied work our profession does, and industry providing guest lectures at universities. There was also one question about how they think the universities, industry and technical societies can contribute to improving the current situation. A summary of the key points

discussed in the later sessions can be found in ("Geo-Education in ANZ (an ISSMGE HTC project) - The key points discussed at various events up to May 2024," 2024).

A special project of the ISSMGE, the Heritage Time Capsule (HTC), 2020 - 2026, has provided a sound platform for the academia in Australasia, in collaboration with the industry in both countries, to make a powerful and positive impact on a situation that seems to be generally agreed to be poor and not getting better. The two industry professional bodies, which are Member Societies of the ISSMGE in the Australasia region, the Australian Geomechanics Society (AGS) and New Zealand Geotechnical Society (NZGS), both quite significant in size, active and vibrant, are in full support of the overall theme of Geo-Education that is being explored by the HTC team, including facilitating holding of HTC sessions at their scheduled local and regional events. The HTC team will continue to liaise with and seek support and formal approval from the two member societies at appropriate stages of the project. Figure 2 provides an illustrative overview of the HTC sessions carried out in Australasia to raise awareness, hold discussions and seek for solutions. So far, several topics have been discussed in Geo-Education sessions. The main focus was on the skills that the geo-profession graduates are lacking or need improvement. One of the key concerns was whether geotechnical engineering / engineering geology education and training is meeting the needs of graduates and the industry.

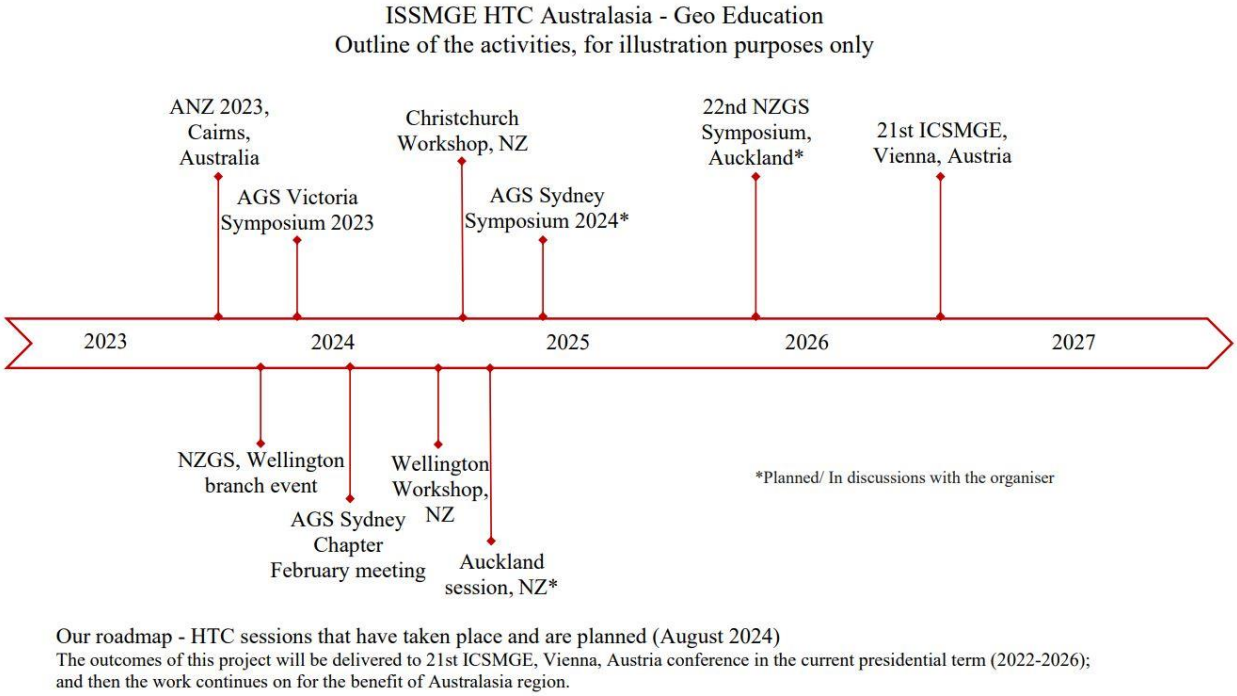

Figure 1: Road map of the HTC sessions held in Australasia region

Methodology

Having come to a point where it appears there is a reasonable agreement on the main issues, and problems, the Australasian HTC team is now embarking on directly approaching end clients (provisionally termed Geo-Owners) in various sectors of the industry, such as Defence, the Construction Sector, Academia, Transportation, Earthquake and Natural Hazards response, Resources, and Offshore industries to understand the technologies they use in their projects and modern methodologies and day to day application of geotechnical profession and the work of geotechnical engineering in the modern era. What is hoped to be achieved is promotion of geotechnical engineering with and through the help of, end clients, being those who possibly stand to benefit from a resurgent academic platform for geotechnical engineering studies in Australasia.

To help clarify who we mean as end clients, we refer to the work of Porter (1979, and 2008), in which five forces are identified that shape industry competition (Figure 2). For the purpose of this exercise, and to help identify the relevant player cohorts, we can consider the industry to be the providers of geo professional services in Australasia. The five forces in Porter's framework are bargaining power of buyers, bargaining power of suppliers, threat of new entrants, threat of substitute products or services, and rivalry amongst existing competitors.

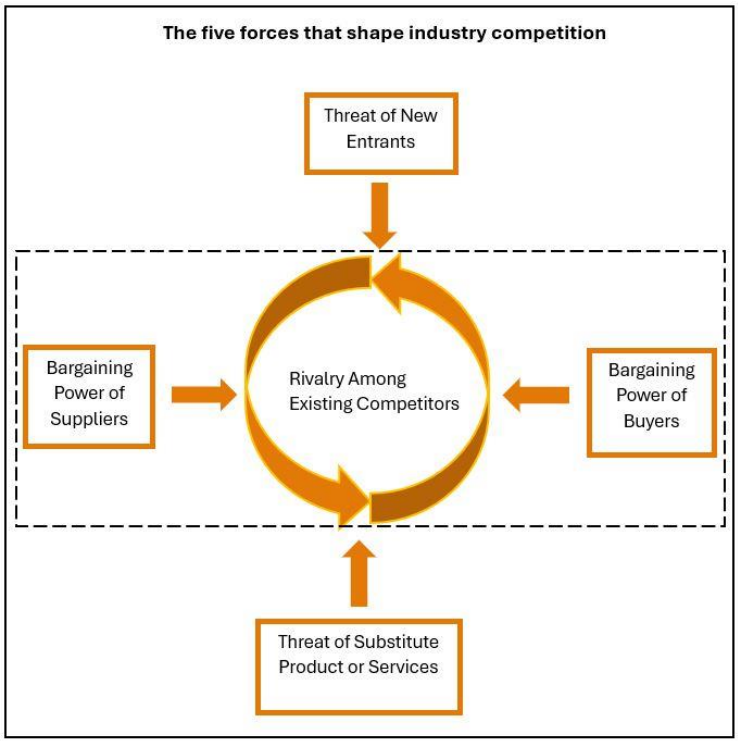

Figure 2: The five forces that shape industry competition after (Porter, 2008); the dashed horizontal box covers the three forces that are discussed below.

The threat of new entrants, i.e. new players in the market, and threat of substitutes such as Artificial Intelligence (AI) and automation are relevant to the overall industry competitiveness, but considered outside the remit of this paper. If we therefore focus only on the three forces that are horizontally aligned (within the dashed box superimposed on Figure 2), then Table 1 below shows what the buyers (who we have called end clients), and, universities and institutions (i.e., suppliers and shapers of resources, graduates) may "see" when they look at the issue of enrolments for geotechnical engineering within the industry. This perspective could be important, as people are possibly more motivated to act on what they can see and or perceive, and less on matters that appear to them to be either opaque or unclear. On the buyer side, the end clients may see or assess what is available in the industry, at any particular point in time. They may not see to the same extent what is happening on the supplier side, as the involvement of the supply side with end clients could generally be through the industry players.

The universities (and institutions) may not get clear enough overarching signals from the industry, in a form that is actionable, about current and future demand for geo professional work, or be able to get a firsthand understanding of the requirements of the end clients.

Engagement with the Buyers (end clients) in planned and structured interviews led by academia and institutions (the suppliers) therefore seems to have a number of positive features:

1. The suppliers can get to hear from the end clients directly on their experience on geo professional work on their projects, both positive and requiring further work,

2. Through the framing of our preset interview questions, most likely made available to the end clients ahead of the interviews, the suppliers can help direct end clients to think and reflect on issues that may have occurred to them in the past or are experiencing now, and which can be collated for the benefit of both end clients, industry, and supply side
3. Through the process of interviews, there may emerge a cohort of end clients, for whom availability of adequate quantity and quality of geo professionals is a present and on-going concern, and who might be willing to act as advocates to promote a career in geo profession, and in particular, share what actually happens in projects from a geo profession perspective, that can act to excite and motivate potential entrants to the profession.

Table 1: How perceptions of suppliers and buyers may be shaped by industry structure

Suppliers **(and shapers of resources)**	**Industry Rivalry** **(possible player cohorts)**	**Buyer** **(End client criteria)**
• Universities (providing graduates + research +specialist advise/ testing facilities) • Institutions/ societies (providing broad based discussion forums, training facilities, codes of practice)	• Contractors • Consultants • Manufacturers • Geo professional specialists • Testing facilities • "In house" team of geo professionals of end clients (undertake work, review, advise)	• Organisations that directly provide services and products to communities, and whose (organisations') capital and maintenance expenditure are directed towards infrastructure, resources and building projects that are intended to providing services and products to communities, and / or, • Organisations that are significant end users of geotechnical engineering services, who may not in general own the assets they construct, but during construction phase have a high level of control of the works, nature of construction and its outcomes

The end clients can range in size from small, medium and large organisations that require the services of a small or significant cohort of geotechnical engineering persons for their projects. Our focus will be generally at the larger organisations whose projects might require more than occasional geo professional services. We have provisionally thought of interviewing a cohort of clients numbering at least 10 in each of the two countries (Australia and New Zealand) represented by the ISSMGE Member Societies, AGS and NZGS.

Our assessment is, given the relative newness of this approach, better quality of information can be obtained by one-to-one interviews. Additionally, one to one interview provides us the opportunity to identify potential advocates within the end client cohorts, as well as identify areas where further research can be usefully carried out by others in this field.

A further advantage of the interviews might be to leverage the interview to create opportunities and a platform to think about future possibilities. The integration of modern technologies in geotechnical engineering has the potential to revolutionise how industries and end clients manage their projects, ensuring enhanced efficiency, safety, and sustainability. Technologies such as Artificial Intelligence (AI) and Machine Learning enable predictive analytics for soil behaviour and risk assessment, that can help optimise construction processes and resource allocation. Building Information Modelling (BIM) and Geographic Information Systems (GIS) facilitate the integration of geotechnical data with design models, improving project planning and visualization. Remote sensing and drones offer high-resolution site assessments and real-time monitoring, while the Internet of Things (IoT) provides continuous data from sensors to manage soil conditions effectively. Robotics and automation have the potential to streamline site investigations and maintenance, reducing human risk in hazardous environments. Ground

Penetrating Radar (GPR), geophysical techniques, laser scanning and advanced geotechnical software enhance subsurface imaging and structural analysis. Additionally, Augmented Reality (AR) and Virtual Reality (VR) enable immersive visualization and training, improving stakeholder engagement. Hydraulic and hydrogeological modelling tools support effective groundwater management and stability assessment. By leveraging these technologies, geotechnical engineering projects can aim to achieve higher confidence in outcomes, resilience, and alignment with sustainable development goals.

In order to establish proper partnerships, a common definition of the end clients needs to be set. While geotechnical engineering services is/ can be important to the 'end client' organisations, their revenue is not directly or indirectly a function of the geotechnical / engineering services, but rather products and services arising from the engineering services, like buildings, roads, railways, ports, mines, oil & gas operational facilities, defence facilities etc. In other words, they are at the end of the supply chain in the use of geotechnical engineering services. The Buyer column in Table 1 sets out our thinking about the criteria we might apply to select 'end clients'.

Limited exploratory discussions have been had, to understand what end client's perspective is and how they think geotechnical engineering and engineering geology benefit them. We have tried to understand what the consequences are for them of potential shortage of graduates in the future. We believe that end clients can have a significant impact on the perception of geotechnical engineering in the community and help academia to attract more students to geo-engineering fields. By interviewing end clients and sharing the stories with the community, we also believe that we can inform the young and emerging generation about exciting technologies that are being used in geo-engineering fields and improve the appeal of this profession.

The approach for conducting interviews:

The interview questions are designed after extensive review of existing literature to identify key themes and gaps. Structured communications are conducted based on Delphi method to gather the opinion of several experts from Australia and New Zealand (Okoli & Pawlowski, 2004). It is decided by the team to take a semi-structured approach in our interviews. This allows for a blend of fixed and open-ended questions where the conversation can be guided by the interviewee's response to the pre-determined questions. Pilot studies will be run to check the clarity and effectiveness of the questions (Van Teijlingen & Hundley, 2001). The questions may be revised according to the feedback from the pilot study stage. The ethics approvals will be obtained prior to running the interviews. Interviews will be conducted remotely via video conferencing platforms since the end clients are at different geographical locations. With the consent of the interviewees, the interview will be recorded for further analysis. Thematic analysis will be applied to qualitatively analyse end clients responses and identify the key common themes (Braun & Clarke, 2012). The interview questions are designed in four different categories: benefit to end clients, perceptions of geo professions, contribution from end clients, and expected contribution from others.

This is still early days in the planning and execution, with our overall timeline extending to mid-2026, where the findings are planned to be presented at a prestigious international geotechnical conference. It is therefore timely for us to seek, and a key reason for presenting this paper at this conference, constructive feedback and helpful directions amongst the assembled academic audience, who may have encountered similar issues, have an interest or have views on proposed methodology, and as well as ideas on measures to address them.

We are therefore inviting those attending the conference to "have your say" on our proposed work in one or more of the ways as follows. Please address all communications to (golnaz.alipour@mq.edu.au).

1. Make a request to join the work of the HTC Australasia, both to better understand what we are doing, and in turn help us with your insights and experience.
2. Help us list out potential / possible hurdles that end clients may have in acceding to our request for interviews, and potential ways of addressing the hurdles.

3. Provide us with your suggestions on conducting the interviews to bring about successful outcomes.
4. Help us identify critical factors that we should include in working through our proposed approach.
5. Help us by pointing out high yielding pathways that you feel we could best utilise at this or later stages, including as an experiment (i.e., it is not already tried and tested).

Anticipated outcomes

The project will present both current and future generations of geotechnical professionals a comprehensive understanding of the contemporary landscape of the profession, emphasizing the growing complexity and scale of projects undertaken by nations in this region and globally. Geotechnical engineering is becoming increasingly interdependent with other engineering disciplines in a rapidly evolving technological and industrial environment. It is evident that individual perceptions of the profession are significantly shaped by those in their professional networks. However, there exists a disconnect between the understanding of the current engineering landscape among influential stakeholders and the actual practices being implemented across various industry sectors, departments, projects, and organizations.

Through a series of video-recorded interviews with key leaders and decision-makers in the end client sector, this study seeks to explore and promote a refreshed perspective on geotechnical engineering. This perspective will be grounded in the insights of end clients and will be shared across both industry and academic institutions. Furthermore, it is anticipated that this initiative will not only elevate the perception of geotechnical engineering among end clients but also increase their awareness of opportunities to leverage both recent advancements and well-established practices in the field.

The primary outcome of the project will be to ensure that universities are equipped to produce a sufficient number of highly skilled geotechnical graduates to meet the demands of the industry, both now and in the future. Additionally, the following key insights are expected to emerge from the project:

1. **Attractiveness of the Profession**: An assessment of the appeal of geotechnical engineering and geosciences to school students, alongside an identification of barriers that may deter entry into these fields.
2. **Status of University Programs**: An evaluation of current geotechnical engineering and geoscience programs in universities, identifying gaps in education and their alignment with industry requirements.
3. **Ideal Graduate Profile**: A characterization of the ideal skill set and competencies that industry requires from university graduates entering the geotechnical profession.
4. **Early Career Skill Development**: An analysis of how the skills acquired during academic studies evolve in the early stages of a professional career.
5. **Client Perception of Geotechnical Expertise**: Insights into how "geo-owners" (end users and beneficiaries of geotechnical services) perceive the quality and capabilities of geotechnical professionals

Conclusion

The Heritage Time Capsule (HTC) project, an initiative of the International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE), has established a robust platform for the academic community in Australasia to address pressing issues related to the education of the next generation in geotechnical engineering and engineering geology. Since 2023, a series of sessions held at various conferences and events have aimed to raise awareness of the current challenges in geotechnical education, gathering feedback from academics, senior industry

professionals, and young engineers on the skills that contemporary graduates require, as well as the types of training necessary to meet industry demands.

These discussions have highlighted deeper, more fundamental concerns, such as the discrepancy between the number of students pursuing careers in geo-engineering and the increasing demand for skilled professionals in the field. One of the key outcomes of the project is to explore strategies to enhance the appeal and visibility of geo-engineering as a career path, thereby attracting more young people to pursue undergraduate and postgraduate studies in this area. An important aspect of this initiative is engaging with end clients—those who directly benefit from geotechnical services—to understand how the shortage of graduates and other identified challenges impact their operations. Additionally, the project seeks to investigate the technologies currently aiding clients in completing their projects and their outlook on the future of geo-engineering.

By showcasing these exciting technological developments and their societal benefits, the HTC project aims to inspire the next generation of engineers. The expected outcomes of this project from a broader perspective include:

1. **Challenging Academia**: Encouraging academic leaders in the Australasian region to take an active role in community leadership, particularly in fostering relationships with end clients, as part of their responsibility.
2. **Empowering End Clients**: Equipping end clients to effectively describe and promote the value of geotechnical engineering, in collaboration with academia and industry, to engage and motivate prospective geotechnical engineers.
3. **Collaborative Academic Planning**: Developing a collaborative strategy within the academic community to address the critical need for increasing enrollment in geotechnical engineering programs across the Australasian region.

References

Braun, V., & Clarke, V. (2012). *Thematic analysis*. American Psychological Association.

Buckler, C., & Creech, H. (2014). *Shaping the future we want: UN Decade of Education for Sustainable Development; final report*. Unesco.

De Paor, D. G., Whitmeyer, S. J., & Education, F. G. (2009). Innovation and obsolescence in geoscience field courses: Past experiences and proposals for the future. *Geological Society of America Special Papers, 461*, 45-56.

Education of the next generation of geotechnical and engineering geology professionals in Australia and NZ. (December 2023). *NZ Geomechanics News*, (106).

Geo-Education in ANZ (an ISSMGE HTC project) - The key points discussed at various events up to May 2024. (2024, June 2024). *Australian Geomechanics*, *59*(2).

Geo-Education in ANZ, “Education and Training of graduates – Challenges and opportunities”. (December 2023). *Australian Geomechanics*, *59*, 7.

Gkeli, E. (December 2023). From the ground up. *Engineering New Zealand Journal*, 1.

International Society for Soil Mechanics and Geotechnical Engineering. (2024). ISSMGE. https://www.issmge.org/

ISSMGE. (2024). *Heritage Time Capsule (HTC) Project*. https://htc.issmge.org/

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: an example, design considerations and applications. *Information & management, 42*(1), 15-29.

Porter, M. E. (2008). The five competitive forces that shape strategy. *Harvard business review, 86*(1), 78.

Van Teijlingen, E., & Hundley, V. (2001). The importance of pilot studies. *Social research update*(35), 1-4.

Acknowledgements

We acknowledge the HTC team members in Australasia region who made great contributions to the Geo-Education project. We also acknowledge the HTC team members from all around the world who provided constructive feedback to us at different stages of the project. We also acknowledge the support we have received so far from ISSMGE, AGS, NZGS.

Copyright statement