



**Title of Issue/Section Teachers and Curriculum, Volume 17, Issue 2, 2017. Special Issue: Mobile Technologies and Learning**

**Editor/s Nigel Calder and Carol Murphy**

---

To cite this article: Aguayo, C., & Eames, C. (2017). Using mobile learning in free-choice educational settings to enhance ecological literacy. *Teachers and Curriculum*, 17(2), 7–14.  
<http://dx.doi.org/10.15663/tandc.v17i2.159>

To link to this article: <http://dx.doi.org/10.15663/tandc.v17i2.159>

To link to this volume <http://dx.doi.org/10.15663/tandc.v17i2>

---

**Copyright of articles**

Creative commons license: <https://creativecommons.org/licenses/by-nc-sa/3.0/>

Authors retain copyright of their publications.

Author and users are free to:

- **Share**—copy and redistribute the material in any medium or format
- **Adapt**—remix, transform, and build upon the material  
The licensor cannot revoke these freedoms as long as you follow the license terms.
- **Attribution**—You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use
- **NonCommercial**—You may not use the material for commercial purposes.
- **ShareAlike**—If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.

**Terms and conditions of use**

For full terms and conditions of use: <http://tandc.ac.nz/tandc/about/editorialPolicies#openAccessPolicy>

# USING MOBILE LEARNING IN FREE-CHOICE EDUCATIONAL SETTINGS TO ENHANCE ECOLOGICAL LITERACY

**Claudio Aguayo**

*Auckland University of Technology  
New Zealand*

**CHRIS EAMES**

*The University of Waikato  
New Zealand*

## Abstract

*This article presents the case for using mobile technologies to facilitate the integration of classroom and outside-of-classroom learning experiences designed to enhance the ecological literacy of primary school students and their parents. There is growing evidence supporting the transformative potential of mobile learning technologies and tools within education settings to deliver meaningful learning experiences. We argue here that this potential could extend to integrating learning between the classroom and education outside the classroom (EOTC). We further argue that this mobile learning potential can mediate learning between students and their parents, visitors and educators at free-choice learning settings. We situate our argument within learning to enhance ecological literacy and call for studies that can consider the possibilities offered by mobile technology and related pedagogical frameworks, the reinforcement of learning experiences post a visit to a free-choice setting, and the integration with hands-on and non-technology mediated learning instances. Here we present some key theoretical considerations as a prelude to a study being funded by the Teaching and Learning Research Initiative to examine these possibilities.*

## Keywords

Mobile learning; marine conservation; free-choice learning; EOTC; ecological literacy; environmental education; sustainability education; technology-enhanced learning

## Introduction

Mobile learning tools have great potential to enhance educational experiences in a variety of settings. In this article we argue the case for how this potential could be realised in free-choice educational settings (settings where learners are free to choose what they learn from educational opportunities based on their own motivations and needs, e.g., museums, zoos). In particular, we focus on how learning experiences that integrate classroom and free-choice settings could be designed to incorporate mobile learning tools and affordances (range of possibilities offered by mobile technology). We situate this argument in the context of enhancing the ecological literacy (the knowledge and attitudes that support environmentally-friendly behaviour) of all learners (e.g., students, parents and the wider community) to promote sustainable communities.

There is growing evidence indicating that Information and Communication Technology (ICT) has the potential to enhance learning, increase knowledge and promote transformative changes in the attitudes and behaviour of both individuals and the broader community (Aguayo, 2014; Becta, 2009). Within ICT, today's mobile learning technologies (e.g., smartphones, tablets) have multiple potential positive impacts for teaching and learning. Most importantly, they allow for learning processes to occur practically anywhere in collaboration with anyone (Cochrane et al., 2013; Pachler, Bachmair, & Cook, 2010). They also promote innovative (Parsons, 2013), inclusive (Traxler, 2010) and transformative (Lindsay, 2015) types of learning that challenge traditional pedagogical approaches (Cochrane, 2014; Merchant, 2012). The content can be shaped to fit individual characteristics and needs (Aguayo, 2016) through self-determined and real-life learning, and within user/learner-generated content and contexts (i.e. *heutagogy*) (Hase & Kenyon, 2013; Luckin et al., 2010; Narayan & Herrington, 2014).

Corresponding author

Email address: Claudio Aguayo: [claudio.aguayo@aut.ac.nz](mailto:claudio.aguayo@aut.ac.nz)

ISSN: 2382-0349

Pages 7–14

This wide-ranging flexibility can then be applied to (re)-connect people to places through culturally-responsive experiences (O’Carroll, 2013) and promote locally meaningful transformative learning, ecological understanding and action taking for sustainability (Aguayo, 2014). These approaches can also act to create continuity between classroom and outside-classroom experiences, and provide a record of learning experiences for later reflection or analysis.

Our aim here is then to theorise how the use of mobile learning could be incorporated to enhance learning experiences within free-choice educational settings, and how these experiences can be reinforced over time through digital mobile platforms. We draw on relevant existing theories to examine this potential.

### **Evidence-based literature on mobile learning**

In the context of Aotearoa New Zealand, there is an accumulating body of evidence-based literature on mobile learning. One example is the recent Ako Aotearoa National Project ‘Learners and mobile devices’ (#npf14lmd project) that studied innovation and institutional transformation on mobile learning across six tertiary institutions and within more than 30 cross-discipline case studies (Frielick & Sciascia, 2016). Outcomes from that project provide useful examples and guidelines for enhanced learning using mobile devices, and for successful online collaboration between mobile learning practitioners within tertiary environments. In addition, the ‘He Whare Ako, He Whare Hangarau’ framework (Sciascia & Aguayo, 2016), developed as part of the #npf14lmd project provides useful insights on how Kaupapa Māori philosophies and values can be interwoven with mobile learning theories and practices, in order to address the implementation and use of mobile learning in culturally responsive ways across educational contexts.

Cultural responsiveness here not only refers to the notion of embracing locally relevant cultural values and practices, such as Kaupapa Māori philosophies of learning in the context of Aotearoa New Zealand, but also to consider universal values-based approaches to mobile learning in the design of learning experiences. In particular, the consideration of such values-based approaches to the use and integration of mobile learning within free-choice learning settings are of critical importance when promoting ecological literacy. This is because the knowledge and attitudes that support environmentally friendly behaviours, ideally, must be grounded in ethical considerations and values (Dresner, 2008; Orr, 2004).

In addition, in a recent review of mobile learning literature targeting key themes in mobile learning, and their prospects in relation to heutagogy, or learner-generated content and contexts, Aguayo, Cochrane, and Narayan (in press), in citing Traxler (2016), indicate that research and practice within mobile learning has failed to realise the transforming potential of mobile technology, with current practice simply substituting prior pedagogical practice with new technology. In that sense, these authors make a call for the use and implementation of the unique affordances of mobile learning, such as authentic augmentation of educational practices through augmented reality (AR) and virtual reality (VR), into the research and practice of technology-enhanced education. Current mobile learning affordances, like AR and VR, are seen here as unique affordances that can support the design and implementation of learner-generated learning environments (Aguayo et al., 2017), and most definitely represent types of technological possibilities that could promote and enhance the provision of ecological literacy within free-choice educational settings.

### **New patterns of connected social learning**

Recent mobile learning research has examined new patterns of connected social learning, and the designing of education around the transformative possibilities of digital tools (Cook & Santos, 2016). In that regard, we recognise that learning in the twenty-first century can occur practically anywhere at any time, in school and out (i.e., in free-choice settings), between students, teachers, non-formal educators, and parents/adult learners, and the connectedness that mobile devices provide can enable this. Twenty-first century learning outcomes focus on enhancing access to knowledge and promoting organic and distributed social learning throughout the community, with an awareness that learning can be influenced by such technological innovations and affordances (Aguayo et al., 2014; Bull, Petts, and Evans, 2008; Pachler et al., 2010). In addition to these social connections, the socio-cultural context

provided by the setting and those within it can build on, disrupt and challenge the personal constructs learners bring to those settings (Aguayo, 2016; Rennie & Johnston, 2004). Mobile learning tools offer conditions for self-determined, socially connected learning (Cochrane, 2011; Hase & Kenyon, 2013; Narayan & Herrington, 2014), and could potentially contribute to teaching and learning within free-choice educational settings.

### Free-choice educational settings

Free-choice educational settings, such as zoos, aquariums, museums and visitor centres, offer unique learning experiences for relevant, context-based education (Ballantyne & Packer, 2011; Boyer & Roth, 2005). Learning in these settings can be described as either non-formal, in which a structured, guided educational programme is provided in which learners choose to participate, or informal, in which unstructured, unguided learning opportunities are provided. The learning then may be governed by individuals' or groups' needs and motivations (Brookfield, 1986; Falk & Dierking, 2002). These settings provide important experiential learning opportunities; for example, in promoting eco-literacy (knowledge, attitudes and behaviours) that can supplement learning within formal contexts (Falk, 2005). Therefore free-choice educational contexts, such as nature-based visitor centres, can offer the opportunity to complement and reinforce indoor and outdoor experiences, and bring about positive and lasting outcomes that can potentially be life-changing, by promoting reflection and meaning-making processes around socio-ecological issues (Ballantyne & Packer, 2005, 2011). As free-choice settings are inherently learner-centred, the synergy between these settings and mobile learning becomes clear, as the mobile affordance has the potential to mediate and enhance the learner's interests in highly responsive ways. An example of where this potential could be realised to meet the objectives of the *New Zealand Curriculum* around science and sustainability within the local environment is the development of eco-literacy (i.e., 'ecological literacy') (Ministry of Education, 2009, 2016; Warner, Eames, & Irving, 2014).

### A more eco-literate citizenry

Education has a critical role in creating a more eco-literate citizenry (Orr, 2004; United Nations, 2012). Eco-literacy, in this context, involves having knowledge and attitudes for a sustainable future, and the intentions and ability to act towards it. An ecologically literate citizenry is critical for addressing the profound and complex global challenges and social transformations taking place worldwide (Hackmann & St. Clair, 2012; United Nations Educational, Scientific and Cultural Organization (UNESCO), 2006). In New Zealand, concern has been raised regarding a general lack of scientific knowledge (Bull, Gilbert, Barwick, Hipkins, and Baker, 2010; Gluckman, 2011), and regarding levels of eco-literacy that are required to address the social and ecological issues that we face (Parliamentary Commissioner for the Environment (PCE), 2007). This gap in understanding undermines the possibility of New Zealanders' informed social participation and engagement with key overarching priorities for the country, such as, for example, adaptation to, and mitigation of, climate change (Ministry for the Environment, 2007; PCE, 2014; Royal Society of New Zealand, 2016).

### Partnerships

Improving ecological literacy requires interventions across, and partnerships between, different sectors of society, as the challenges we face are complex and multi-layered, and knowledge and capabilities to address them are spread within the community. This includes those incorporating free-choice educational settings as well as those providing technological expertise in education, in order to promote engagement, literacy, participative action and transformative change towards socio-ecological sustainability within the wider society (Aguayo & Eames, 2017; Aguayo et al., 2016; Ministry of Education, 2007; Tilbury & Wortman, 2008; UNESCO, 2006). Eco-literacy requires more than just knowledge development (Kollmuss & Agyeman, 2002), but also includes experiences that can lead to attitudinal development, and both knowledge and attitudes are intrinsically linked to the action required to bring about change for sustainability (Jensen & Schnack, 1997). Significant life events research has indicated the importance of time spent in nature in influencing pro-environmental behaviour in later life (Liddicoat & Krasny, 2013), and place-based research has illustrated the importance of (re)-connecting people to places to support adoption of sustainable ways of living, both

internationally and within New Zealand (Gruenewald, 2003; Penetito, 2009; Smith, 2007). The case is strong for the considerable value of free-choice educational experiences in developing eco-literacy, and the potential key role of mobile learning within such settings.

However, as noted by Ballantyne and Packer (2011), research also indicates that although visitors often leave a free-choice educational setting with enhanced knowledge and an intention to adopt more environmentally-friendly behaviour, only a small number of visitors actually do so. Ballantyne and Packer (2005, 2011) stress the need for further research to

- develop empirically-based principles for the design of learning experiences in non-formal settings that optimise learning for sustainability; and
- develop ways of complementing and reinforcing the free-choice learning experience with post-visit action resources.

Recent studies into the use of post-visit action resources have illustrated that provision of written materials and follow up emails encouraging sustainable behaviour have been shown to positively affect free-choice learning outcomes (Bueddenfeld & Van Winkle, 2016), and the use of mobile learning opportunities can stimulate nature tourism visitors to remain engaged with the visit site through social media (Wheaton et al., 2015). These studies recommend further research into the use of mobile technologies for educating and supporting visitors during their experiences, and into the use of social media “to build community and norms around a place or an issue” (Wheaton et al., 2015, p. 610) and encourage sustained commitment to pro-environmental behaviour. This indicates that mobile learning could not only facilitate wider and deeper learner-centred education at free-choice settings, but also encourage enduring behaviour change well beyond the learning experience.

### Digital affordances

Having argued the case that mobile learning could complement and enhance learning in free-choice educational settings, how exactly might this be done? Recent research also indicates that learning technologies (e.g., videos, augmented reality, virtual reality) afford the reconnecting of people to places, and promote eco-literacy (Aguayo, 2014; Aguayo, Cochrane, & Narayan, 2016). However, there is as yet no clear framework for using the tools and affordances within mobile learning and social media in free-choice educational settings to enhance the teaching and learning that could promote development of eco-literacy (Aguayo, 2015; Aguayo et al., 2016; Warner, Eames, & Irving, 2014). We see social media as a powerful tool to facilitate and maintain collaborative connections between educators and learners beyond visits to free-choice educational settings to enable reinforcement of learning. Social media can also play a key role in keeping key educational partners connected and engaged to benefit from free-choice learning experiences; for example, in adapting mobile learning interventions to the changing conditions of the socio-technological environments, and/or in curating social media content and outputs related to particular free-choice learning experiences and thus facilitating post-intervention collection of information.

An understanding of how mobile technology can be integrated into the teaching and learning of key sustainability education outcomes that incorporate free-choice learning contexts is of strategic importance to education in New Zealand and beyond. As an example, it has become increasingly clear that models of mobile learning must focus upon BYOD (bring your own device) strategies that are not dependent on large amounts of external funding and sophisticated infrastructure (Johnson, Becker, Estrada, and Freeman, 2015; Traxler, 2010). Our understandings of how mobile learning tools, affordances and experiences can be shaped to offer such ideal conditions for promoting learning within free-choice educational settings remain unknown.

### A need for further research

We have set out the case here for readers to consider how learning experiences that enhance education within free-choice learning settings through mobile technology can potentially generate positive impacts on learners. Theorising and research evidence to date indicate that mobile learning and free-choice education are learner-centred and embedded in a socio-cultural framework. We have suggested here that this synergy holds potential for development of eco-literacy in learners. We acknowledge

that there are risks of alienating people from nature through use of technology; however, our view is that it is not the technology *per se* which is the potential conflicting problem in such a case, but the way technology is shaped, used and fitted within learning contexts (Aguayo, 2017a, 2017b). We don't know yet how this could happen effectively and therefore research is required to test this theoretical stance. Technology can connect learners in ways that can deepen knowledge, influence attitudes and motivate behaviour, and bring together educational opportunities across space and time. This potential is well worth investigation.

## References

- Aguayo, C. (2014). *The use of education for sustainability websites for community education in Chile* (doctoral thesis, The University of Waikato, Hamilton, New Zealand). Retrieved from <http://hdl.handle.net/10289/8640>
- Aguayo, C. (2015). Editorial—La cuestión ambiental: De la razón a las cosas del corazón. *TED—Tecné, Epistemes Y Didaxis*, 38(2), 7–13. Retrieved from <http://revistas.pedagogica.edu.co/index.php/TED/article/view/3702/3254>
- Aguayo, C. (2016). Activity theory and community education for sustainability: When systems meet reality. In D. Gedera & J. Williams (Eds.), *Activity theory in education: Research and practice* (pp. 139–151). Rotterdam, The Netherlands: Sense. [https://doi.org/10.1007/978-94-6300-387-2\\_9](https://doi.org/10.1007/978-94-6300-387-2_9)
- Aguayo, C. (2017a, May). *AR/VR/MR & RR in learning and teaching digital projects*. Paper presented at the THETA 2017 Conference: Connecting Minds. Creating The Future. Auckland, New Zealand.
- Aguayo, C. (2017b, September). (Dis)connecting people to oceans through learning technologies: Critical considerations. Paper presented at the 4th International Marine Protected Areas Congress 2017. La Serena-Coquimbo, Chile.
- Aguayo, C., Cochrane, T., & Narayan, V. (In press). Key themes in mobile learning: Prospects for learner-generated learning through AR and VR. *Australasian Journal of Educational Technology*.
- Aguayo, C., Cochrane, T., & Narayan, V. (2016, February). *Mobile learning technologies for sustainability education*. Paper presented at the New Zealand Association for Environmental Education Conference 2016—Activate, agitate, Advocate. Auckland, New Zealand.
- Aguayo, C., & Eames, C. (2017). Community partnerships in sustainability education research. In R. McNae & B. Cowie (Eds.), *Realizing innovative partnerships in educational research* (pp. 235–244). Rotterdam, The Netherlands: Sense. [https://doi.org/10.1007/978-94-6351-062-2\\_24](https://doi.org/10.1007/978-94-6351-062-2_24)
- Aguayo, C., Higgins, B., Field, E., Nicholls, J., Pudín, S., Tiu, S. A., ... Mah, J. (2016). Perspectives from emerging researchers: What next in EE/SE research? *Australian Journal of Environmental Education*, 32(1), 17–29. <https://doi.org/10.1017/ae.2015.57>
- Aguayo, C., Holley-Boen, W., Mathrani, A., Mentis, M., Merriman, M., Parsons, D., & Thomas, D. (2014, November). *Learners and mobile devices: Distance and distributed learning at Massey University*. Poster presented at ASCILITE 2014 Conference. Dunedin, New Zealand.
- Ballantyne, R., & Packer, J. (2005). Promoting environmentally sustainable attitudes and behaviour through free-choice learning experiences: What is the state of the game? *Environmental Education Research*, 11(3), 281–295.
- Ballantyne, R., & Packer, J. (2011). Using tourism free-choice learning experiences to promote environmentally sustainable behaviour: The role of post-visit 'action resources'. *Environmental Education Research*, 17(2), 201–215. <https://doi.org/10.1080/13504622.2010.530645>
- Becta. (2009). *Becta: Our work, its impact*. Coventry, England: Becta.
- Boyer, L., & Roth, W.-M. (2005). Individual | collective dialectic of free-choice learning in a community-based mapping project. *Environmental Education Research*, 11(3), 335–351. <https://doi.org/10.1080/13504620500081210>
- Brookfield, S. (1986). *Understanding and facilitating adult learning: A comprehensive analysis of principles and effective practices*. Milton Keynes, England: Open University Press.
- Bueddenfeld, J. N. H., & Van Winkle, C. M. (2016). The role of post-visit action resources in facilitating meaningful free-choice learning after a zoo visit. *Environmental Education Research*. <https://doi.org/10.1080/13504622.2016.1198952>

- Bull, R., Petts, J., & Evans, J. (2008). Social learning from public engagement: Dreaming the impossible? *Journal of Environmental Planning and Management*, 51(5), 701–716. <https://doi.org/10.1080/09640560802208140>
- Bull, A., Gilbert, J., Barwick, H., Hipkins, R., & Baker, R. (2010). *Inspired by science: A paper commissioned by the Royal Society of New Zealand and the Prime Minister's Chief Science Advisor*. Wellington, New Zealand: New Zealand Council for Educational Research.
- Cochrane, T. (2011). mLearning: Why? What? Where? How? In G. Williams, P. Statham, N. Brown, & B. Cleland (Eds.), *Changing demands, changing directions. Proceedings Ascilite Hobart 2011* (pp. 250–262). Tasmania, Australia: University of Tasmania. Retrieved from <https://www.learntechlib.org/p/43557/>
- Cochrane, T., Buchem, I., Camacho, M., Cronin, C., Gordon, A., & Keegan, H. (2013). Building global learning communities. *Research in Learning Technology*, 21, 21955. <http://dx.doi.org/10.3402/rlt.v21i0.21955>
- Cochrane, T. (2014). Critical success factors for transforming pedagogy with mobile Web 2.0. *British Journal of Educational Technology*, 45(1), 65–82. <https://doi.org/10.1111/j.1467-8535.2012.01384.x>
- Cook, J., & Santos, P. (2016). Three phases of mobile learning state of the art and case of mobile help seeking tool for the health care sector. In D. Churchill, J. Lu, T. K. F. Chiu & B. Fox (Eds.), *Mobile learning design* (pp. 315–333). Singapore: Springer. [https://doi.org/10.1007/978-981-10-0027-0\\_19](https://doi.org/10.1007/978-981-10-0027-0_19)
- Dresner, S. (2008). *The principles of sustainability* (2nd ed.). London, England: Earthscan. <https://doi.org/10.1080/13504620500081129>
- Falk, J. H. (2005). Free-choice environmental learning: Framing the discussion. *Environmental Education Research*, 11(3), 265–280.
- Falk, J. H., & Dierking, L. D. (2002). *Lessons without limit*. Boston, MA: AltaMira.
- Frielick, S., & Sciascia, A. D. (Eds.). (2016). *#npf14lmd: Learners and mobile devices*. National Project Fund report. Wellington, New Zealand: Ako Aotearoa. Retrieved from <http://mobilelearners.nz>
- Gluckman, P. (2011). *Looking ahead: Science education for the twenty-first century*. Auckland, New Zealand: Office of the Prime Minister's Science Advisory Committee.
- Gruenewald, D. A. (2003). The best of both worlds: A critical pedagogy of place. *Educational Researcher*, 32(3), 3–12. <https://doi.org/10.3102/0013189X032004003>
- Hackmann, H., & St Clair, A. (2012). *Transformative cornerstones of social science research for global change*. Paris, France: ISSC.
- Hase, S., & Kenyon, C. (2013). *Self-determined learning: Heutagogy in action*. London, England: Bloomsbury Academic.
- Jensen, B. B., & Schnack, K. (1997). The action competence approach in environmental education. *Environmental Education Research*, 3(2), 163–179. <https://doi.org/10.1080/1350462970030205>
- Johnson, L., Becker, S. A., Estrada, V., & Freeman, A. (2015). *NMC horizon report: 2015 higher education edition*. Austin, TX, The New Media Consortium.
- Kollmuss, A., & Agyeman, J. (2002). Mind the gap: Why do people act environmentally and what are the barriers to pro-environmental behaviour? *Environmental Education Research*, 8(3), 239–260. <https://doi.org/10.1080/13504620220145401>
- Liddicoat, K., & Krasny, M. E. (2013). Research on the long-term impacts of environmental education. In R. B. Stevenson, M. Brody, J. Dillon, & A. E. J. Wals (Eds.), *International handbook of environmental education* (pp. 289–297). New York, NY: Routledge. <https://doi.org/10.4324/9780203813331.ch29>
- Lindsay, L. (2015). Transformation of teacher practice using mobile technology with one-to-one classes: M-learning pedagogical approaches. *British Journal of Educational Technology*, 47(5), 883–892. <https://doi.org/10.1111/bjet.12265>
- Luckin, R., Clark, W., Garnett, F., Whitworth, A., Akass, J., Cook, J. ... Robertson, J. (2010). Learner-generated contexts: A framework to support the effective use of technology for learning. In M. Lee & C. McLoughlin (Eds.), *Web 2.0-based e-learning: Applying social informatics for tertiary teaching* (pp. 70–84). Hershey, PA: IGI Global.

- Merchant, G. (2012). Mobile practices in everyday life: Popular digital technologies and schooling revisited. *British Journal of Educational Technology*, 43(5), 770–782. <https://doi.org/10.1111/j.1467-8535.2012.01352.x>
- Ministry for the Environment. (2007). *Adapting to the impacts of climate change*. Wellington, New Zealand: Author.
- Ministry of Education. (2007). *The New Zealand curriculum*. Wellington, New Zealand: Learning Media.
- Ministry of Education. (2009). *EOTC guidelines: Bringing the curriculum alive*. Wellington, New Zealand: Learning Media.
- Ministry of Education. (2016). *EOTC Guidelines 2016: Bringing the curriculum alive*. Wellington, New Zealand: Learning Media.
- Narayan, V., & Herrington, J. (2014). Towards a theoretical mobile heutagogy framework. In B. Hegarty, J. McDonald, & S.-K. Loke (Eds.), *Rhetoric and reality: Critical perspectives on educational technology. Proceedings Ascilite Dunedin 2014* (pp. 150–160). Dunedin, New Zealand: ASCILITE.
- O’Carroll, A. D. (2013). Virtual whanaungatanga: Maori utilizing social networking sites to attain and maintain relationships. *AlterNative: An International Journal of Indigenous Peoples*, 9(3), 230. Retrieved from <https://doi.org/10.1177/117718011300900304>
- Orr, D. (2004). *Earth in mind: On education, environment, and the human prospect* (10th anniversary ed.). Washington, DC: Island Press.
- Pachler, N., Bachmair, B., & Cook, J. (2010). *Mobile learning: Structures, agency, practices*. Boston, MA: Springer. Retrieved from <https://doi.org/10.1007/978-1-4419-0585-7>
- Parliamentary Commissioner for the Environment. (2007). *Outcome evaluation. See change: Learning and education for sustainability*. Wellington, New Zealand: Author.
- Parliamentary Commissioner for the Environment. (2014). *Climate change and rising seas: Understanding the science*. Wellington, New Zealand: Author.
- Parsons, D. (Ed.). (2013). *Innovations in mobile educational technologies and applications*. Hershey, PA: IGI Global. <https://doi.org/10.4018/978-1-4666-2139-8>
- Penetito, W. (2009). Place-based education: Catering for curriculum, culture and community. *New Zealand Annual Review of Education*, 18, 5–29.
- Rennie, L., & Johnston, D. J. (2004). The nature of learning and its implications for research on learning from museums. *Science Education*, 88(1), S4–S16. <https://doi.org/10.1002/sce.20017>
- Royal Society of New Zealand. (2016). *Climate change implications for New Zealand*. Wellington, New Zealand: Author. Retrieved from <http://www.royalsociety.org.nz/expert-advice/papers/yr2016/climate-change-implications-for-new-zealand/>
- Sciascia, D., & Aguayo, C. (2016). He whare ako, he whare hangarau—a house of learning, a house of technologies. In Frielick, S. & Sciascia, A. D. (Eds.), *#npf14lmd: Learners and Mobile Devices*. National Project Fund report. Wellington, New Zealand: Ako Aotearoa. Retrieved from <http://mobilelearners.nz>
- Smith, G. A. (2007). Place-based education: Breaking through the constraining regularities of public school. *Environmental Education Research*, 13(2), 189–207. <https://doi.org/10.1080/13504620701285180>
- Tilbury, D., & Wortman, D. (2008). How is community education contributing to sustainability in practice? *Applied Environmental Education and Communication*, 7(3), 83–93. <https://doi.org/10.1080/15330150802502171>
- Traxler, J. (2010). Will student devices deliver innovation, inclusion, and transformation? *Journal of the Research Centre for Educational Technology (RCET)*, 6(1), 3–15.
- Traxler, J. (2016). What killed the mobile learning dream? Retrieved from <https://www.jisc.ac.uk/inform-feature/what-killed-the-mobile-learning-dream-26-feb-2016?>
- United Nations. (2012). *Resilient people, resilient planet: A future worth choosing*. New York, NY: Author.
- United Nations Educational, Scientific and Cultural Organization (UNESCO). (2006). *Education for sustainable development: Memo bureau of public information*. Retrieved from [http://www.unesco.org/bpi/pdf/memobpi39\\_sustainabledevpt\\_en.pdf](http://www.unesco.org/bpi/pdf/memobpi39_sustainabledevpt_en.pdf)

- Warner, A., Eames, C., & Irving, R. (2014). Using social media to reinforce environmental learning and action-taking for school students. *International Electronic Journal of Environmental Education*, 4(2), 83–96. <https://doi.org/10.18497/iejee-green.53452>
- Wheaton, M., Ardoin, N. M., Hunt, C., Schuh, J. S., Kresse, M., Menke, C., & Durham, W. (2015). Using web and mobile technology to motivate pro-environmental action after a nature-based tourism experience. *Journal of Sustainable Tourism*, 24(4), 594–615. <https://doi.org/10.1080/09669582.2015.1081600>