This is a preprint. Please cite as:
Dave Towey, James Walker, and Ricky Yuk-kwan Ng (2018), "Traditional Higher Education Engineering versus Vocational and Professional Education and Training: What can we Learn from Each Other?", in Proceedings of the 2018 International Conference on Open and Innovative Education (ICOIE 2018), pp. 474-486.

Traditional Higher Education Engineering versus Vocational and Professional Education and Training: What can we Learn from Each Other?

Dave Towey*, James Walker
University of Nottingham Ningbo China, 199 Taikang East Road, Ningbo, 315100, China
Dave.Towey@nottingham.edu.cn

Ricky, Yuk-kwan Ng
Centre for Learning and Teaching, Vocational Training Council, Hong Kong SAR, China

Abstract. This paper examines and contrasts learning and teaching practices in some traditional higher education engineering (THEE) and in vocational and professional education and training (VPET). As education evolves and new and alternative technologies and tools appear — especially in the form of more open, flexible, and lightweight technology-enhanced learning (TEL) options such as massive open online courses (MOOCs) and other open educational resources (OERs) — the need for THEE and VPET institutions to adapt and reinvent has never been more urgent. The paper introduces some recent changes in education, and the Chinese contexts of the authors. The history and parallels between THEE and VPET are presented. Then, current challenges for both THEE and VPET institutions are discussed, with potential strategies and solutions outlined. Insights from Agile development methodologies in software engineering are discussed as themes for how THEE and VPET institutions may be able to address current challenges and maintain a sustainable trajectory into the future.

Keywords: Traditional Higher Education Engineering (THEE); Vocational and Professional Education and Training (VPET); Technology-enhanced Learning (TEL); Open and Flexible Learning; Open Educational Resources (OERs); Reflection.

1 Introduction

Although traditional higher education engineering (THEE) and vocational and professional education and training (VPET) may not seem like obvious bed-fellows, the authors of this paper have recently had an opportunity to examine both, within a Chinese context, to identify where one may offer insight to benefit the other.

The paper is laid out as follows: Section 2 presents the background, including a brief explanation of recent education evolution (Section 2.1), the Chinese context of the authors (Section 2.2), and the motivation and methodology behind the paper (Section 2.3). Section 3 outlines some of the history of THEE and VPET. Section 4

* Corresponding author

examines some THEE and VPET similarities, and is followed in Section 5 by a discussion of some of the most important challenges to both THEE and VPET. Finally, Section 6 concludes the by paper by returning to an earlier theme of agility, explaining how it could be employed by both THEE and VPET to better position both for a more sustainable future development.

2 Background

In this section, we briefly summarise some recent changes in higher education (HE) and VPET. We also introduce the Chinese context of the authors, and explain the background and motivation behind this paper.

2.1 Recent HE and VPET Evolution

Innovations in teaching and learning have impacted on the perception and delivery of education. New technologies and approaches, including more open and flexible technology-enhanced learning (TEL) options such as massive open online courses (MOOCs) and other open educational resources (OERs), have led to advances in classroom practices and HE delivery. Unfortunately, as well as their positive impact, these advances have also raised challenges and threats to both VPET and THEE.

2.2 Our Chinese Context

The authors of this paper have had extensive exposure to HE and/or VPET in China, both in the mainland, and in Hong Kong SAR.

As previously discussed (Li et al., 2012; Towey, 2014; 2016), China has witnessed not only enormous economic changes, but also significant expansion of HE provision. This expansion has included the creation of Sino-foreign higher education institutions (SFHEIs), the first of which opened in 2004, and is the current HE institution (HEI) for two of the authors: University of Nottingham Ningbo China (UNNC).

Prior to working at UNNC, Towey had previously worked at a different SFHEI, a liberal arts college established as a collaboration between Hong Kong and mainland China: BNU-HKBU: United International College (UIC) (Huang & Towey, 2010). Walker was the founding member of Civil Engineering (CE) and the Faculty of Science and Engineering (FoSE) at UNNC, and was the first engineering academic to arrive at the China campus. He was involved in the successful 2015 Institute of Civil Engineers (ICE) CE accreditation, which made the CE degree course the first in mainland China to be accredited by the ICE, the Institute of Structural Engineers, the Chartered Institution of Highways and Transportation, and the Institute of Highway Engineers. Ng has 22 years HE teaching and 16 years management experience. He has been involved in curriculum and programme planning, development, and quality assurance for both local and non-local qualifications (higher diploma and bachelor degrees). He also has extensive experience in VPET staff development and training.

2.3 A Recent Chance to Reflect

Much has been said on the importance and impact of reflective practice in education (Moon, 2013; Schön, 1987), especially in HE (Towey et al., 2016). We recently had occasion to apply this exercise to the differences in how engineering (especially civil and software) is taught or learned in both traditional HE, and in VPET. Our reflections involved not only examining our own experiences in the relevant educational context, but in at least one case, also included a short autoethnographic journey into an author's time as student and educator. While ethnography requires field participation and engagement, using observation, in-depth interviews, documentation by written logs to observe social patterns (Gummensson, 1991) and enables researchers to identify the "essence" of human experiences and to understand the "lived experiences" through extensive and prolonged engagement to observe patterns and relationships of meaning (Moustakas, 1994 as quoted in Creswell, 2003 p.15); autoethnography is a type of research involving "self-observation and reflexive investigation in the context of ethnographic field work and writing" (Maréchal, 2009, p.43), and has also been used as a "rigorous approach and framework for reflection" (Towey, 2015, p.11).

3 THEE and VPET History

This section briefly summarises the history of civil engineering, a very traditional engineering discipline, VPET, and software engineering, a much more recent addition to the engineering family.

3.1 Civil Engineering History

CE has a long history in Europe; however, prior to the 18th century there was little formal engineering education anywhere in the world. At this time, the importance of CE and its place in society was gaining recognition, and places for CE education (CEE) were first established in Europe in the Czech Republic and France before spreading to Germany and Spain (Watson, N.D.).

Between 1750 and 1850, industry was developing in Britain and the CE profession was emerging through necessity. However, these developments were with established practitioners, not at educational establishments. It was Smeaton who is credited as the first person to call himself a civil engineer (Denny, 2007), which led to the establishment of the CE profession. The ICE was founded in 1818, and gained royal charter in 1828 (ICE, 2018), an important excerpt in which reads (ICE, 2017, p.4):

> *[…] there should be ready means of ascertaining persons, who by proper training and experience, are qualified to carry out such works. It requires a broad understanding of scientific principles, a knowledge of materials and the art of analysis and synthesis. […] A civil engineer is one who practices all or part of this art.*

The royal charter, and ICE specifically, continues to influence CEE today. Modern, qualified civil engineers can be awarded the internationally recognised chartered status, and graduates from ICE-accredited HEI courses can obtain credit towards it.

3.2 VPET History

In the last decade, many governments and VPET providers have begun to make significant effort to enhance their curricula and learning and teaching strategies (Ng, 2016). VPET students increased by 11% in 2009, driven largely by students undertaking vocational courses at schools (BBC News, 2009). School students aged 15 to 19 participating in Australian VPET also increased by nearly 30% between 2006 and 2009 (NCVER, 2010).

VPET in Hong Kong has also been the focus of more government attention (Ng, 2016), with a recent government address stating that "mainstream education is not a straightjacket that fits all young people as everyone has his or her own interests and abilities" (HKSAR, 2014, p.102). A government taskforce was established to enable VPET to equip learners with "practical skills, attitude and knowledge for the relevant professions and specific industries" (HKSAR EdB, 2015, pp.86-87).

Currently, Hong Kong VPET has a very clear position and articulation paths that stress trade-specific skills to nurture work-ready students, and prepare them for further studies.

3.3 Software Engineering History

The year 2018 marks the fiftieth anniversary of what many consider to be the birth of software engineering (SE): a NATO sponsored conference in Garmisch, Germany in 1968 (Naur & Randell, 1969). It was here for the first time that the words "software" and "engineering" were paired in a deliberate call to practitioners to apply structured, rigorous "engineering" approaches to address the on-going software crisis: software development was running over schedule, over budget, and often producing low quality systems ... or not producing a system at all (Charette, 2005). The cause of this crisis was famously described as follows in Dijkstra's 1972 Turing Award lecture (Dijkstra, 1972, p.861):

> *"The major cause of the software crisis is that the machines have become several orders of magnitude more powerful! To put it quite bluntly: as long as there were no machines, programming was no problem at all; when we had a few weak computers, programming became a mild problem, and now we have gigantic computers, programming has become an equally gigantic problem."*

It was anticipated that applying the rigour and formal methodology of traditional engineering (such as civil engineering) would, as Dijkstra again said, make it possible to "design and implement the kind of systems that [were] straining our programming ability at the expense of only a few percent in man-years of what they cost us [then], and [...] these systems [would] be virtually free of bugs" (ibid., p.863).

Although Dijkstra's vision was not realized, over its half-century history, SE has evolved significantly. While the processes and lifecycles identified through SE have yielded improvements in the quality of software being produced, they did not become a "silver bullet" (Brooks, 1987). In contrast to the "heavyweight," plan-driven processes associated with much of SE, newer, more lightweight and agile approaches have become very popular and effective. The philosophy behind these agile approaches is expressed in the Agile Manifesto (Beck et al., 2001) as:

- *Individuals and interactions over processes and tools*
- *Working software over comprehensive documentation*
- *Customer collaboration over contract negotiation*
- *Responding to change over following a plan*

Paralleling the development of SE itself, SE education has also been changing, with more agile and innovative elements featuring both in content and delivery style (Towey et al., 2016). A favourite approach used by Towey in the classroom, for example, draws on "dirty tricks" to help give students exposure to more realistic software development experiences (Dawson, 2000). This, claims Towey, resonates with many of the motivations behind VPET training (Towey, Ng, & Wang, 2016).

4 THEE and VPET Parallels

In spite of their very different origins and history, THEE and VPET currently share many similarities and parallels. This section briefly outlines some of the most important of these connections.

4.1 Goal: Equip Students with Appropriate Skills

VPET developed with a very clear mandate to serve the local community, providing and supporting very specific and relevant skill sets. This contrasts with the liberal arts approach of aiming to provide a broad and general education (Huang & Towey, 2010) — an aim that has been increasingly pursued by many newer HEIs in China and elsewhere (Towey, 2014; 2016). Indeed, given the changes to expected career paths, and the disappearance of the concept of remaining at one company for an entire career, the definition of what skills are necessary and appropriate in a graduate has also been evolving. THEE, in many ways, may have begun with more traditional academic intention, but now most, if not all, engineering-related curricula are professional body certified and accredited. This very clear input from the target professional community represents an overlap with VPET.

4.2 Student Similarities

Anecdotally at least, it would seem that perceptions of which students choose THEE and which students choose VPET retain the earlier biases surrounding both modes: the high achievers aim for THEE, and those who do not directly get into THEE

consider VPET. The emergence of more articulations and pathways from VPET into THEE has blurred this progression route somewhat.

Aside from possible differences in academic performance, however, a more interesting inquiry is into how similar these THEE or VPET students are. Clearly, for example, a student interested in pursuing computer science at VPET is likely to share commonalities and interests with her counterpart in THEE. An impression that Towey has voiced relates especially to mature students: given the perceived practicalities in VPET (including scheduling and modularity), VPET may well represent a more sensible pathway for practitioners to upgrade their skills than THEE. Such a practical mindset would clearly appeal to potential employers. Since a key indicator of the success of HEIs (both THEE and VPET) is graduate employability, this is an important consideration. Through workplace learning, VPET students can receive on-the-job training. While theoretical knowledge is taught in VPET, the learning and practice of authentic, trade-specific and generic competences — such as communication, team-work, problem solving, transferability and work ethics — are core to the workplace learning (Deissinger, 1997; Van Merriënboer, 2001; Tremblay & Le Bot, 2003): workplace learning provides "a fertile opportunity for learners to appropriate knowledge that connects theory to practice in a realistic and efficient way" (Billett, 1996 in Smith, 2003, p.53)

Another impression of the contrast between modern THEE students and those coming through THEE in the past (e.g. twenty or thirty years ago) is that students on entry are often far less certain about their choice of degree program, which, as mentioned in Section 4.1, is a natural consequence of the move away life-long employment at a single venue. The typical commitment of three to four years for completion of a THEE degree may well be not only daunting to a new student (THEE or VPET), but may actually be inadvisable (Towey, 2016). Alternatives, perhaps in the form of more open and flexible educational offerings may be more appropriate for potential students at both VPET and THEE (Towey, 2014).

Being in a Chinese context means that many of our students share some ethnic and cultural background. Although it may be easy to ascribe some of our experiences and impressions to this background, we are not specifically discussing the so-called "Chinese Learner" (Towey, 2014; Watkins & Biggs, 2002; Wong, 2004).

4.3 Teachers

There is on-going debate over the role and qualification of the teacher in HE. THEE, for example, often focuses on academic or research records rather than actual teaching skills. Recent controversy over the treatment of adjunct professors in the US, where some are so poorly remunerated or cared for that they are officially below the poverty line, has highlighted the challenges facing HEI teachers.

Controversy aside, however, there is increasing attention paid to enhancing teaching skills in THEE and elsewhere. Reported student feedback on teaching cites the desirability of practicing or industrially experienced faculty (Xie, Towey, & Jing, 2014) — adjunct faculty, in other words. Unfortunately, academics with significant industrial experience are very scarce, a natural consequence of their academic focus, and thus if THEE continues with the traditional model of its research staff composing

the majority of its teaching staff, the tension will continue. VPET, in contrast, has typically looked to practical or industrial practitioners for its teaching staff (Pan, 2007). Although this is less common in THEE, it is nonetheless increasing.

4.4 Stigma

Towey notes that computer science (CS), like other STEM subjects, has often struggled with gender-imbalance, stereotypes, and stigma. The CS community – professionals, students, and academics – is frequently presented as socially inept males. While this was especially true in the past, in the west, our experience in greater China has been more positive. CS at UNNC, for example, has a much more even gender balance (Towey et al., 2015). The wealth generated (and possessed) by many of the so-called geeks and nerds of the 1980s also seems to have tempered much of the negativity surrounding their image.

VPET may also have some associated stigma. If perceived as a lesser HE option than THEE, the stigma could permeate both the student and teacher communities, and persist into the careers of both. The recent enhancements to VPET in Hong Kong (HKSAR, 2014; HKSAR EdB, 2015) and elsewhere suggest that, like the rich geeks of the 1980s, a VPET without (or with less) stigma may be in the near future.

5 THEE and VPET Challenges

In spite of their very different origins and original motivations, both VPET and THEE face many similar and overlapping challenges.

5.1 What and How to Teach and Learn

Related to the earlier discussion of parallels between VPET and THEE skill provision (Section 4.1) is the core issue of what the students should learn. Even more significant, especially given the changing landscape of teaching and learning, is the question of how they should learn it. VPET depends heavily on workshop practices and workplace learning rather than lectures, literature reviews, and tutorials (Towey, Ng, & Wang, 2016). This mode of delivery may be more appropriate for both the skills involved, and the learning preferences of the VPET students (Ng, 2016), but may also not be scalable or sustainable in the way lecture-based delivery is. In contrast, while lectures have been identified as a very efficient mode of information delivery, their actual positive impact in learning has been challenged (King, 1993).

These questions of content and method of delivery are not unique to either THEE or VPET, but do remain important challenges to both. The increasing availability of alternatives to traditional delivery, and to both VPET and THEE themselves, is also raising again the need for VPET and THEE to adapt and evolve. Alternatives such as open and flexible learning resources may indeed represent an attractive and viable alternative to VPET and THEE (Towey, 2014).

5.2 Funding

A core tension at the heart of many HEIs is that of funding. How are the buildings, classes, teachers, materials, and so on, all paid for? Where government funding or subsidy is available, are there attached conditions? How sustainable are HEIs that rely on such intervention?

A common funding model, and one quite prevalent in the various SFHEIs that have appeared recently, is that the majority of funding may come from student tuition. Where the SFHEI also has a research portfolio, this may also form part of the expected income and funding (as is the case in UNNC, for example).

The funding problem, of course, is two-fold: where is the necessary funding coming from, and what implications may some funding sources have for the operations of the HEI. SFHEIs, with their much shorter history, and their frequent need to adapt and overcome obstacles (Towey, 2016), may have an already adopted agility in managing this issue from which other THEE and VPET may learn.

5.3 Attracting Students

If student tuition fees are an important part of the funding model for an HEI, then clearly attracting students is an essential activity. Even apart from funding, though, the recruitment of students is an increasingly competitive process. The expanded provision of HE combined with the now plateauing of potential student numbers has meant increasing emphasis on getting the students.

Whatever the motivation for trying to attract students, it remains a challenge for both VPET and THEE. In spite of the reported attitude of some academics (who may claim that the HEI's most important role is research, not teaching), it seems that student opinion of an HEI (and of both THEE and VPET) may continue to be an important influence on the HEI's potential continuation and survival.

5.4 Outcomes and Ambiguity

The recent series of disruptions to traditional industries, including accommodation through AirBnB and taxis through Uber, has not bypassed education. Disruption has come in many forms, including an accountability for teaching that has long been overdue. The cost of HE for students has risen so substantially, worldwide, that their natural reaction of demanding more for their investment is not surprising. Recent attempts to centre the educational experience around the student are welcome, but given the increasing provision of alternatives, such as flexible and more open education, HE may face more serious disruption.

A traditional goal or intended outcome of THEE is to attain a qualification, typically a degree, and thus become qualified for a career path. VPET, too, was focused around skill development and provision, and eventually, through potential articulation with HE, a path to a degree. The problem with all this, and something that is seldom openly discussed, is the issue of qualification compared with actual skill sets: as industry (especially IT) has been complaining, they are not synonymous.

Some of the most highly qualified graduates are not immediately ready for the workplace; and some of the most skilled programmers have few, if any, formal qualifications. The opportunity to develop skills outside of THEE and VPET, and to do so at relatively little financial cost, has become a major threat to both. One cited potential future for HEIs in the face of such threats is as a potential gatekeeper, in an examination or certification role.

These changing outcomes and roles represent an ambiguity of purpose for THEE and VPET, and are disrupting the related institutions. Some institutional responses include attempts to address everything, presenting themselves as one-stop solutions to all challenges. Unfortunately, such a response has little chance of actual success, and may simply serve to reinforce the disrupted state of the institution.

6 Conclusion: Agility

As was acknowledged in the field of software engineering in the late 1990s, uncertainty is not something that can be ignored. Indeed, the modern, agile approaches have embraced it, leading to customer or stakeholder-oriented interactions and emphasis that were previously unheard of. The SE Agile movement has seen a lot of success, and while also not a universal a silver bullet (Brooks, 1987), may have some principles that could be applied to THEE and VPET to help address and overcome the current and future challenges. Most urgently, an identification of the major stakeholders in both THEE and VPET is a prerequisite to any attempt at better communication and interaction. These stakeholders must include the students, and must emphasise their input. The ambiguity surrounding many THEE and VPET organisations should not be seen as a purely negative force, but rather, as has been seen in CS, an opportunity to call the stakeholders together and develop a better communication and provision.

Acknowledgements

A preliminary version of part of this paper was given as a keynote presentation at the Hong Kong Learning and Teaching Expo 2017, supported by the Vocational Training Council, Hong Kong. This research was partly supported by a UNNC FoSE Teaching and Learning Conference Grant.

References

BBC News (2009). "Vocational exams on the increase", *BBC News June 23, 2009*, http://news.bbc.co.uk/2/hi/uk_news/education/8115674.stm (accessed 3 April 2018).

Beck, K., Grenning, J., Martin, R. C., Beedle, M., Highsmith, J., Mellor, S., van Bennekum, A. Hunt, A., Schwaber, K., Cockburn, A., Jeffries, R., Sutherland, J., Cunningham, W., Kern, J., Thomas, D., Fowler, M., & Marick, B. (2001). "Manifesto for Agile Software Development," Agile Alliance. Available at http://agilemanifesto.org/ (accessed 28 March 2018).

Brooks, F. P. (1987). "No Silver Bullet — Essence and Accidents of Software Engineering," *IEEE Computer*, 20 (4): 10–19.

Charette, R. N. (2005). "Why software fails [software failure]," *IEEE Spectrum*, vol. 42, no. 9, pp. 42–49.

Creswell, J. (2003). *Research Design, Qualitative, Quantitative, and Mixed Methods Approaches.* Second Edition. California: Sage Publication.

Dawson, R. (2000). "Twenty dirty tricks to train software engineers," in *Proceedings of the 22nd International Conference on Software Engineering*, ser. ICSE '00. New York, NY, USA: ACM, pp. 209–218.

Deissinger, T. (1997). "The German dual system – A model for Europe". *Education and Training*, 39(8), 297-302.

Denny, M. (2007). *Ingenium: Five Machines That Changed the World*, Johns Hopkins University Press.

Dijkstra, E. W. (1972). "The Humble Programmer," *Communications of the ACM*, vol. 15, no. 10, pp. 859–866.

Gummesson, E. (1991). *Qualitative Methods in Management Research*, SAGE, London.

HKSAR (2014). Hong Kong Special Administrative Region Government. "The 2014 Policy Address – Support the Needy, Let Youth Flourish, Unleash Hong Kong's Potential." Available at http://www.policyaddress.gov.hk/2014/eng/index.html (accessed 3 April 2018).

HKSAR EdB (2015). Education Bureau of the Hong Kong Special Administrative Region. "Report of the Task Force on Promotion of Vocational Education." Available at http://www.edb.gov.hk/en/edu-system/other-edu-training/vocational-other-edu-program/promotion-vet.html (accessed 3 April 2018).

Huang, H. & Towey, D. (2010). "Teaching introductory information technology through English in China: Innovative approaches to information technology education," in *Proceedings of the 2010 International Conference on Educational and Information Technology (ICEIT)*, Vol. 2, IEEE, pp. V2–29–V2–33.

ICE (2017). *The Institute of Civil Engineers: Royal Charter, By-laws, Regulations and Rules*. Available at https://www.ice.org.uk/ICEDevelopmentWebPortal/media/Documents/About%20Us/Royal-Charter-By-laws-Regulations-and-Rules-2017.pdf (accessed 3 April 2018).

ICE (2018). Our history. Available at https://www.ice.org.uk/about-ice/our-history (accessed 3 April 2018).

King, A., (1993). "From sage on the stage to guide on the side," *College Teaching*, vol. 41, no. 1, pp. 30–35.

Li, Y., Whalley, J., Zhang, S. & Zhao, X. (2012). "The higher educational transformation of China and its global implications," in C. Ennew & D. Greenaway (eds), *The Globalization of Higher Education*, Palgrave Macmillan, chapter 10, pp. 135–162.

Maréchal, G. (2009). "Autoethnography," *Encyclopedia of case study research*, SAGE Publications, Thousand Oaks, CA, pp. 43–45.

Moon, J. (2013), *A Handbook of Reflective and Experiential Learning: Theory and Practice*. Taylor & Francis, 2013.

Naur, P. & Randell, B. (eds) (1969). *Software Engineering: Report on a conference sponsored by the NATO Science Committee*, Garmisch, Germany, 7th to 11th October 1968. Scientific Affairs Division, NATO.

NCVER (2010). National Centre for Vocational Education Research, *Australian Vocational Education and Training Statistics: Young People in Education and Training 2009*. Retrieved from http://apo.org.au/node/23745 (accessed 3 April 2018).

Ng, R. (2016). "A Report on the Cross-institutional Study of Vocational Education and Training (VET) Students' Learning Needs as well as Teachers and Workplace Mentors' Teaching Practices" for the Quality Enhancement Support Scheme (QESS) Project: Development of Effective Pedagogical Practices and a Cross-institutional Online Sharing Platform for Hong Kong's VET. Available at https://vpetcity.vtc.edu.hk/doc/8_study_report.pdf (accessed 3 April 2018).

Ng, R., Lam. R., Ng, K., & Lai, K. (2016). "A Cross-Institutional Study of Vocational and Professional Education and Training (VPET) Students and Teachers' Needs of Innovative Pedagogical Practices," in *Proceedings of 2016 International Symposium on Educational Technology (ISET)*, Beijing, pp. 101-105

Ng, R., Lam, R., Ng, K., & Lai, K. (2017). "A Study of Vocational and Professional Education and Training (VPET) Students and Teachers' Preferred Support for Technology Based Blended Learning," in *Proceedings of the International Symposium on Educational Technology*, Hong Kong, 27 to 29 June 2017.

Pan, M. (2007). "The Important Position of the Issue of Higher Vocational Education in Pedagogy," *Chinese Education and Society*, 40(3), 11-26.

Schön, D. A. (1987), *Educating the reflective practitioner*. San Francisco: Jossey-Bass.

Smith, P. J. (2003). "Workplace Learning and Flexible Delivery," *Review of Educational Research, 73*(1), 53-88.

Tremblay, D. G., & Le Bot, I. (2003). *The German Dual Apprenticeship System. Analysis of its Evolution and Present Challenges*. Quebec, Canada: University of Quebec. Research Note no. 2003-4A.

Towey, D. (2014). "Open and flexible learning as an alternative in mainland Chinese higher education," in K. C. Li & K. S. Yuen (eds), *Emerging modes and*

approaches in open and flexible education, The Open University of Hong Kong Press, Hong Kong, chapter 2, pp. 12–26.

Towey, D. (2015). "Lessons from a Failed Flipped Classroom: The Hacked Computer Science Teacher," in *Proceedings of the IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE) 2015*, pp. 11–15.

Towey, D. (2016). "Preparing the next Generation of China's Computer Scientists: A Snapshot of Challenges for Sino-foreign Computer Science Education," in *Proceedings of the Third International Conference on Open and Flexible Education (ICOFE 2016)*, Hong Kong, China, pp. 224–231.

Towey, D., Chen, T. Y., Kuo, F.-C., Liu, H., & Zhou, Z. Q. (2016). "Metamorphic Testing: A New Student Engagement Approach for a New Software Testing Paradigm," in *Proceedings of the IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE 2016)*, pp. 228–235.

Towey, D., Foster, D., Gilardi, F., Goria, C., Martin, P. & White, A. (2015) "Researching and Supporting Student Note-taking: Building a Multimedia Note-taking App," in *Proceedings of the IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE) 2015*, pp. 54–58.

Towey, D., Ng, Y-k., R., & Wang, T. (2016). "Open Educational Resources (OERs) and Technology Enhanced Learning (TEL) in Vocational and Professional Education and Training (VPET)", in *Proceedings of the IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE 2016)*, pp. 301–305.

van Merriënboer, J. J. G. (2001). "ID for competency-based learning: new direction for design, delivery and diagnosis," *Interactive Educational Multimedia*, 3, 12-26.

Watkins, D. & Biggs, J. (2002). *Teaching the Chinese Learner: Psychological and Pedagogical Perspectives*, Acer Press.

Watson, J. G. (N.D.). "Civil Engineering. History," *The Encyclopaedia Britannica*. Available at https://www.britannica.com/technology/civil-engineering (accessed 3 April 2018).

Wong, J. K.-K. (2004). "Are the learning styles of Asian international students culturally or contextually based?" *International Education Journal* 4(4): 154–166.

Xie, C., Towey, D. & Jing, Y. (2014). "Current trends in the use of student input in teacher evaluation in universities in mainland China," in *Proceedings of the Fourth Asian Conference on Language Learning (ACLL2014)*, Osaka, Japan, April 17-20, 2014, IAFOR, pp. 12–21.