Provenancing Qualifications in Higher Education: An Australian-Chinese Case Study

Xiaochen Li and Xuemei Tian
Faculty of Business and Enterprise,
Swinburne University of Technology, Hawthorn, VIC, Australia

vli@swin.edu.au stian@swin.edu.au

Raymond Chiong
Faculty of Science and Information Technology
The University of Newcastle, Callaghan, NSW, Australia

Raymond.Chiong@newcastle.edu.au

Abstract

Individuals move across educational institutions, learning modes and borders to pursue further study and employment opportunities. Properly provenanced learning credentials can be recognised and carried across institutions and borders, thus facilitating individuals' mobility. Provenance is the origin or source from which an item is generated, and the history of subsequent owners or proof of authenticity. Provenance data has been collected and used in areas such as online learning, social networks, and e-science research for a range of purposes. This paper models the current qualification assessment workflows and examines how verified qualifications are used as a form of learning credential provenance in a higher education case scenario. The workflow model has implications related to the weaknesses of the current procedures and the significance of provenancing learning credentials for authentication and verification purposes.

Keywords: Provenance, Higher education, Conceptual modelling, Learning credential

Introduction

Globalisation of the higher education industry has increased the mobility of students and the workforce. For example, in 2010 over 4.1 million students undertook study overseas in the Higher Education sector (OECD, 2012). They are both able to move across educational institutions, learning modes, and even borders. However, higher education offered in different countries is not identical, making it difficult to recognise learning credentials gained in another country (Department of Education, Employment and Workplace Relations, 2008; Teichler, 2012). The lack of portability in learning credentials poses problems to stakeholders of the higher education industry (e.g., students, universities, professional associations and employers) in terms of collecting sufficient evidence of previous learning and facilitating mobility for individuals.

This paper accepted by special expedited review

It is sometimes difficult to maintain cohesive and logical records in multiple institutions, in various countries, and in multiple languages and formats. At present evidencing the learning credentials offered by issuing universities is truly ad-hoc, and validity of learning credentials is at best circumstantial and hardly efficient (Department of Education, Employment and Workplace Relations, 2008).

Provenancing learning credentials relates to attestation at the point of origin. In this paper, we model the current workflows adopted between an Australian university and a Chinese university to assess overseas qualifications and to use verified qualifications as a form of provenance. An analysis and representation of the current system provides insights on the gaps of current workflows and lays the foundation for a provenance protocol that endeavours to solve the portability and mobility issues.

Individual Mobility

Individual mobility is increasing globally, where it is a common practice for individuals to study or work away from their native environment. Many countries also view mobility as an attractive opportunity to attract international students as well as expand their exporting of education services. However, the incompatibility of higher education systems in different countries hinders mobility and acts as a barrier to some countries when considering recruitment of international students (Assefa, 2009; Wei, 2013).

Mobility of students is a well-recognised issue in today's higher education, due to the industries' globalisation. Students have opportunities to broaden their horizon and develop an international perspective, which has led to a competitive environment among global educational institutions (Souto-Otero, Huisman, Beerkens, de Wit &Vujić 2013; Ternouth, 2007). Ternouth (2007) further recognises that a single staged education system is no longer the most viable mainstream. Instead, a lifelong learning pattern is gaining popularity which has resulted in mobility becoming more fashionable than in previous generations. Individuals can move from country to country, for purposes of further study or employment. Emerging technology enables individuals to select a variety of study modes, such as full-time on-campus study or part-time distance learning (Teichler, 2003).

Although movements of students and professionals are gaining popularity, it is not without barriers. Notwithstanding the barriers of language, culture and religion, the portability of learning credentials is one of the main barriers to mobility. Although there is an increasing focus on competences gained through learning, it is undeniable that competency based on certain educational paths or stated by learning credentials is better accepted (Department of Education, Employment and Workplace Relations, 2008;Teichler, 2003).

According to the Oxford English Dictionary, portability is defined as

1. The quality or state of being portable; suitability for being carried or moved from place to place, especially with ease.

2. In computing terms, the property of software of being usable on different types of computer or operating system with little or no modification.

The portability barriers have been recognised in a number of countries and regions, and substantial efforts have been instituted to address this issue and promote individual mobility.

Efforts on Promoting Individual Mobility

The Bologna Process

A number of countries initiated the "Bologna Process" to strive for consistency and portability of their higher education systems. Areas such as degree structure, credit transfer and quality assurance systems are being renovated and reconstructed. The Bologna Process was initiated in Europe but countries outside Europe have also joined forces in trying to make their tertiary education more compatible (Department of Education, Science and Training, 2006). By 2013 there were 49 member states and a range of consultative members.

The Bologna Process aims at easing the recognition and assessment of qualifications offered by institutions for purposes of further study or employment. Stakeholders involved in the implementations include governments, academic institutions, student organisations and professional bodies. In particular, employers, who might have problems with the recognition of the restructured degree structures, play a vital role in its implementation (Department of Education, Science and Training, 2006).

Europe proposed the Bologna Process to facilitate the mobility of students and workforce by issuing student qualifications that are "portable internationally and aligned to the evolving needs of the global workforce" (Department of Education, Science and Training, 2006). Mobility was identified as one of the priorities in its 2012 Bucharest Communiqué. In 2010 the Bologna Process launched the European Higher Education Area (EHEA), which promotes more compatible higher education systems in Europe and allows students to benefit from smooth recognition procedures (Department of Education, Science and Training, 2006; European Commission, 2013).

The EHEA has used the Bologna Process to harmonise degree structures in signatories, furthermore, to solve the problems encountered in qualification recognition and quality assurance. However, it does not mean an automatic recognition for the restructured degrees because a wide diversity still exists in admission requirements, subject contents, learning objectives and functions, and in the rights they confer (Rauhvargers, 2004).

Besides the diversity in national higher education systems, the constant reforms and changes to the systems also complicate the recognition of learning credentials. Only a relatively small number of countries have signed up to the Bologna Process, and even if more countries agree to align their education systems, the changes to education systems over time will eventually cause incompatibility (Shah, Long, & Windle, 2007).

Portability issues of learning credentials will remain static unless compatibility of all global education systems is achieved. To overcome individual mobility and portability issues of learning credentials, we propose the adoption of a universal provenance-based protocol, encompassing basic and durable principles.

Qualification Recognition

Recognition is defined by Rauhvargers (2004) as the assessment of a foreign qualification with a view of finding ways for its application for further studies and/or employment in the host country. Qualification recognition is a prerequisite to satisfy two major purposes – academic recognition for further studies and professional recognition for employment purposes. Two sub-types exist in the latter – professional recognition for regulated professions (e.g., Medicine, Accounting, and Engineering) and for non-regulated professions (Department of Education, Employment and Workplace Relations, 2008; Rauhvargers, 2004; Teichler, 2003).

The recognition of foreign qualifications in Australia is performed at three major levels (Rauhvargers, 2004):

- Institutional, e.g. Higher education institutions recognise qualifications for academic purposes (further study) and employers for employment purposes in the non-regulated sector of the labour market;
- National, e.g., professional bodies or other nationally appointed competent authorities recognise qualifications for employment purposes in regulated professions; and
- Regional (i.e., Europe, Asia-Pacific).

It is incumbent on credential evaluators to both decide the domestic equivalence for a foreign qualification and aim to promote cross-border mobility for both study and employment purposes, with a view to finding the most appropriate pathway for further studies or employment in the host country (Rauhvargers, 2004).

Qualification Recognition in Australia

Via a discussion paper issued in 2006 (Bishop, 2006), Australia considered the merits of joining the Bologna Process through a process of seeking responses from Australian Higher Education stakeholders. However, respondents, including universities, industry bodies, unions, university peak bodies and other interested parties proffered the perspective that alignment with Europe would not provide competitive advantages, as Australian universities do not lag behind European counterparts. Some stakeholders even expressed concerns regarding the loss of key advantages if Australia followed Europe inflexibly (Donaghue, 2008).

Australian Higher Education qualifications are administered and issued according to the Australian Qualification Framework (AQF). In terms of recognising learning credentials issued in Australia, the AQF provides guidelines and facilitation to accredited bodies holding qualification approval. It provides online links to databases and a public access point to accredited bodies, acquiring information via the access point and verified qualifications. Approved qualifications are updated in the database maintained by the AQF (Australian Qualifications Framework, 2013).

In terms of the verification of overseas qualifications, a governmental agency titled the Australian Education International-National Office for Overseas Skills Recognition (AEI-NOOSR) compares overseas qualifications to Australian qualifications and decides what equivalent Australian qualification is relevant (Australian Government – Australian Education International, 2013). Bodies such as the Overseas Qualification Unit in each state also recognise qualifications gained overseas by migrants for further education, training and general employment purposes (Live in Victoria, 2013).

Professional associations assess qualifications and work experience gained overseas for regulated sectors of the job market. For example, the Australian Computer Society uses "Body of Knowledge" as the basis of performing skill assessments and qualification recognition (Graham, 2012).

Qualification Recognition in China

China has shown interest in investigating compatibility of education systems proposed by the Bologna Process and attended the 2007 ministerial meeting as an observer (Shah et al., 2007).

Chinese Higher Education qualifications are administered and issued by the central government's Ministry of Education. Affiliates of this entity are responsible for qualification recognition. Qualifications gained in China are accredited by the Accreditation department, and are subsequently authenticated and verified by the China Higher Education Student Information and Career Centre, with both overseen by the Ministry of Education. The Chinese Service Centre for Scholar Exchange, an affiliate of the Ministry of Education, verifies the validity of foreign qualifications and

endorses authentication. A nation-wide database, the National Higher Education Qualification Certificates Information Database has been instituted, and is responsible for recording all the higher education qualification certificates issued after 2001. The database supports certificate-related enquiries and verifies qualifications (China Higher Education Student Information and Career Center, 2004; Lin, Bao, & Tao, 2008).

Australia and China currently adhere to an arrangement on higher education qualifications recognition. It aims to facilitate the recognition of higher education degrees and graduate awards to students in Australia and China as well as their academic credentials, with the aim of providing a smoother and accessible pathway for students to pursue further academic studies in either country (Shah et al., 2007).

Provenance

Types of Provenance

Provenance is defined as the origin or source from which something comes, and the history of subsequent owners or proof of authenticity, according to the Oxford English Dictionary. Provenance for artwork has taken the form of Certificates of Authenticity since the late 19th century. The "authorities" and "experts" of artwork sign Certificates of Authenticity, which provide background information regarding both the artwork and the artist. However, Certificates of Authenticity can often be regarded as a weak provenance as they can be the subject of forgers. There have been documented cases whereby so-called experts created fake Certificates of Authenticity to suit their own purposes (Durrani, 2007). This leads to a debate as to the availability of current technology and documentation manipulation, which has implications in the provenancing of learning credentials--for example, the creation of fake degree certificates and academic transcripts.

The definition of provenance can vary depending on the domain of application. For example, *knowledge provenance* is defined as the approach to determining the origin and validity of web information by means of modelling and maintaining information sources and dependencies, as well as trust structures (Fox & Huang, 2003). This definition has a narrow focus of merely the provenance of information on the web and suggests a provenance structure constructed around the web information. Nevertheless, the study of knowledge provenance can be used as a theoretical and technical basis of the research on learning and credentialing provenance, as both knowledge provenance and learning and credentialing provenance deal with authenticating the origins and validity of information, albeit through an alternative focus (Fox & Huang, 2003; Moreau, 2010).

The provenance of a piece of data is the process that leads to that piece of data (Groth, Jiang, et al., 2006). Data provenance does not only apply to database entries of data, as all objects in the process can attract provenance (Goble, 2002). A recording protocol of data provenance has been proposed by Groth, Miles, Tan, Ibbotson, and Moreau (2006). This protocol is offered in the context of service-oriented architectures. Services are initiated by actors (a client or other services) to receive inputs and generate outputs. A set of services can be bundled to form a workflow to solve a specific problem. The execution of a workflow is called a process. An actor can be a sender or receiver of a message. The message exchange between senders and receivers is referred to as an interaction. Actors can possess internal states that change during the course of execution.

Data provenance literature is critical to the learning and credentialing provenance research, as it involves evidencing credentials, which are also a form of data. However, in a data provenance context it involves evidencing single data objects and their change over time through different stages. For learning and credentialing provenance, it involves a number of credentialing objects,

and the changes occur to the objects over time. The provenance of learning credentials is used predominantly for ensuring the authenticity and validity of learning credential assessments, reusability of assessments, and tracking the changes and evolution of assessments.

Correlation of Provenance Types

There are similarities as well as distinctions between antiquity provenance, knowledge provenance, data provenance, and learning and credentialing provenance.

Provenance can be categorised into four levels: static, dynamic, uncertain and judgment-based, depending on the validity of the provenance. The more certain the provenance is, the stronger it is (Fox & Huang, 2003). Antiquity provenance involves evidencing a single object over time (Durrani, 2007); knowledge and data provenance involve evidencing a set of objects at a specific point-in-time, similar to a snapshot of the world (Fox & Huang, 2003); while learning and credentialing provenance involves evidencing a set of objects over time. The learning objects to be evidenced are created by one individual learner, while the objects themselves can be totally irrelevant from each other (Beetham, 2006).

A 7Ws model is used to define major questions that provenance needs to address, the data provenance needs to capture, and how the provenance information is used. The 7Ws (who, what, where, why, when, which, how) model can be applied to define the semantics of all types of provenance (Cheney, Chiticariu, & Tan, 2009; Goble, 2002):

- Who – "who" refers to agents involved in actions leading up to an event;
- What – "what" defines the actions that lead to an event in broad terms;
- Where – "where" represents space and captures the location of an event;
- Why – "why" is defined as the decision rationale of an action;
- When – "when" records the temporal dimension of an event;
- Which – "which" refers to the method that is selected from a set of possible approaches; and
- How – "how" documents actions that lead to the occurrence of an event with particular instance.

Case Development Analysis & Discussion

Case Description – A Higher Education Case Scenario

An Australian university S University and its partner university C University in China have agreed to employ Collaborative Articulation Programs (CAPs) as a form of co-operation (Bolton & Nie, 2010; Li, Calway, & Sinnappan, 2008). CAPs allow bilateral accreditation and credentialing between two universities, which means students who have successfully completed specific studies stipulated in CAPs in one university can articulate to another and will be granted exemptions for the specific subjects. Partner universities agree to teach equivalent contents or programs and accredit students for the subjects undertaken in partner universities.

When such an agreement is in place, accreditation and exemptions should be automatically granted to students enrolled in the CAP by either university. However, program contents and learning credentials tend to drift from the original concept and are no longer equivalent over time, making accreditation of students quite challenging.

Figure 1 and Table 1 depict the credentials involved in the collaborative education program offered by S and C Universities.
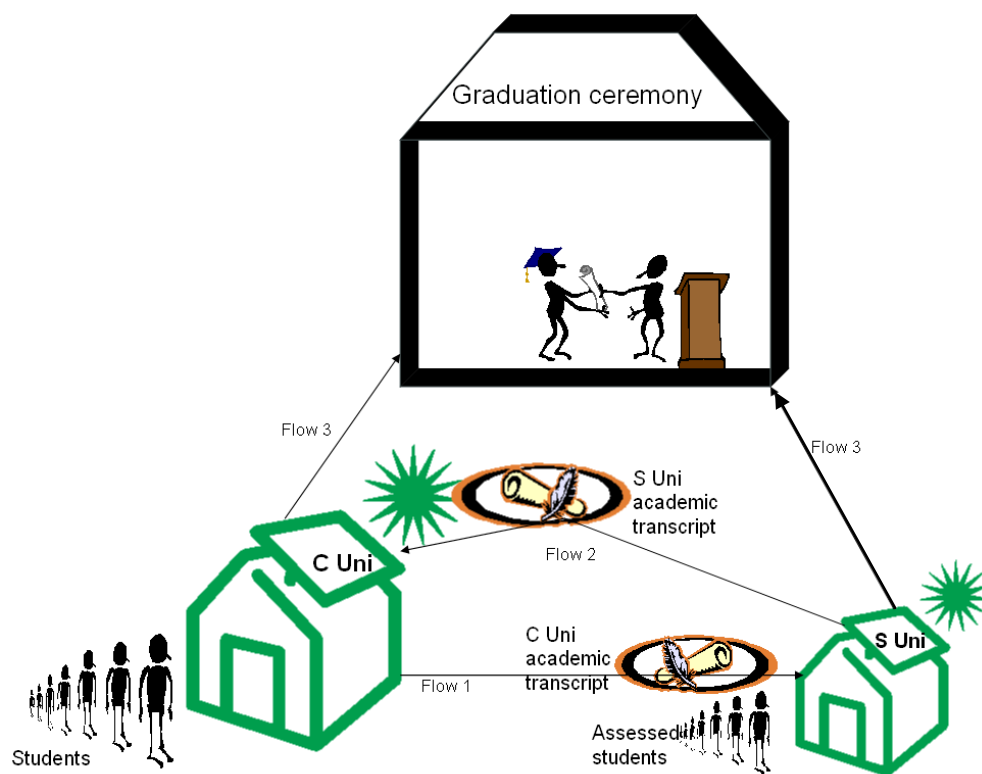
Figure 1: A Rich Picture on the CAP between S University and C University

Table 1: Illustrating the flows depicted in Figure 1

Flows	Credentials	Activities involved in workflow
Flow 1:	The C University academic transcripts that assessed students take to S University	Students enrol in the collaborative education program and study two years at C University in China. Students who pass all the assessments of the program are able to apply to S University in Australia for a further two-year study period.
Flow 2	The S University academic transcripts that are sent to C University	S University academic transcripts are returned to C University for credentialing.
Flow 3	The graduation ceremony	Students who complete the two-year study at S University are awarded two degrees, one from each university, after their units of study undertaken at S University are back-credited at C University.

Case Analysis

This research adopts the concepts and technologies of knowledge provenance, data provenance and learning provenance, which are highly-relevant to the problem domain the research targets. It also serves as an information system research in the context of the higher education industry, specialising in higher education agreements between partner universities.

We have adopted the enterprise information systems modelling approach of MEASUR (Du & Yu, 2011; Liu, 2000) to record the workflow and data for the case scenario due to the universality of the method. The MEASUR approach views technical systems as the by-product of solving organisational problems and has been used extensively on various information system projects such as land resources information systems and computerised test construction systems. The MEASUR approach involves a set of methods and techniques that can be utilised to understand and articulate the complexity of credentialing problems and contexts under the study of the S University case and also to implement technical information systems that are flexible and adaptable to the changes occurring in the education program (Liu, 2000). Information systems are divided into two functions according to the MEASUR approach: human information functions and information and communication technology functions. Our research has commenced with the social representation of the human information function and is expected to extend to the pragmatic and semantic representations as the study progresses.

Qualification Assessment

Based on current Credit Transfer and Accreditation procedures and policies adopted by CAP-offering universities, workflows of how qualification assessments are completed for admission and exemption purposes are generalised. A semantic model of the qualification assessment workflows, the actors involved, and the actors' behaviour patterns (known as affordances) is developed using MEASUR (Liu 2000). The semantic model depicts the interactions between actors and the causal relationships between inputs and outputs of a data flow. The semantic model of the current system provides insights on how provenance data can be collected on the qualifications to be assessed, and enquires as to how the existing provenancing protocol proposed by Groth, Miles, et al. (2006) can be applied to the provenancing of qualifications.

The actors identified in the workflows are:
- Universities
- Academics
- Applicants
- Student Program Staff

Figure 2 depicts the generic workflows on qualification assessment adopted by universities using MEASUR (Liu, 2000). Figure 2 is comprised of two parts: Figure 2a depicts how academics assess applicants' qualifications, which is performed on a daily basis and Figure 2b depicts the workflows of how universities develop policies, protocols and precedents, and provides a basis for qualification assessment. The development of policies and protocols is performed periodically.
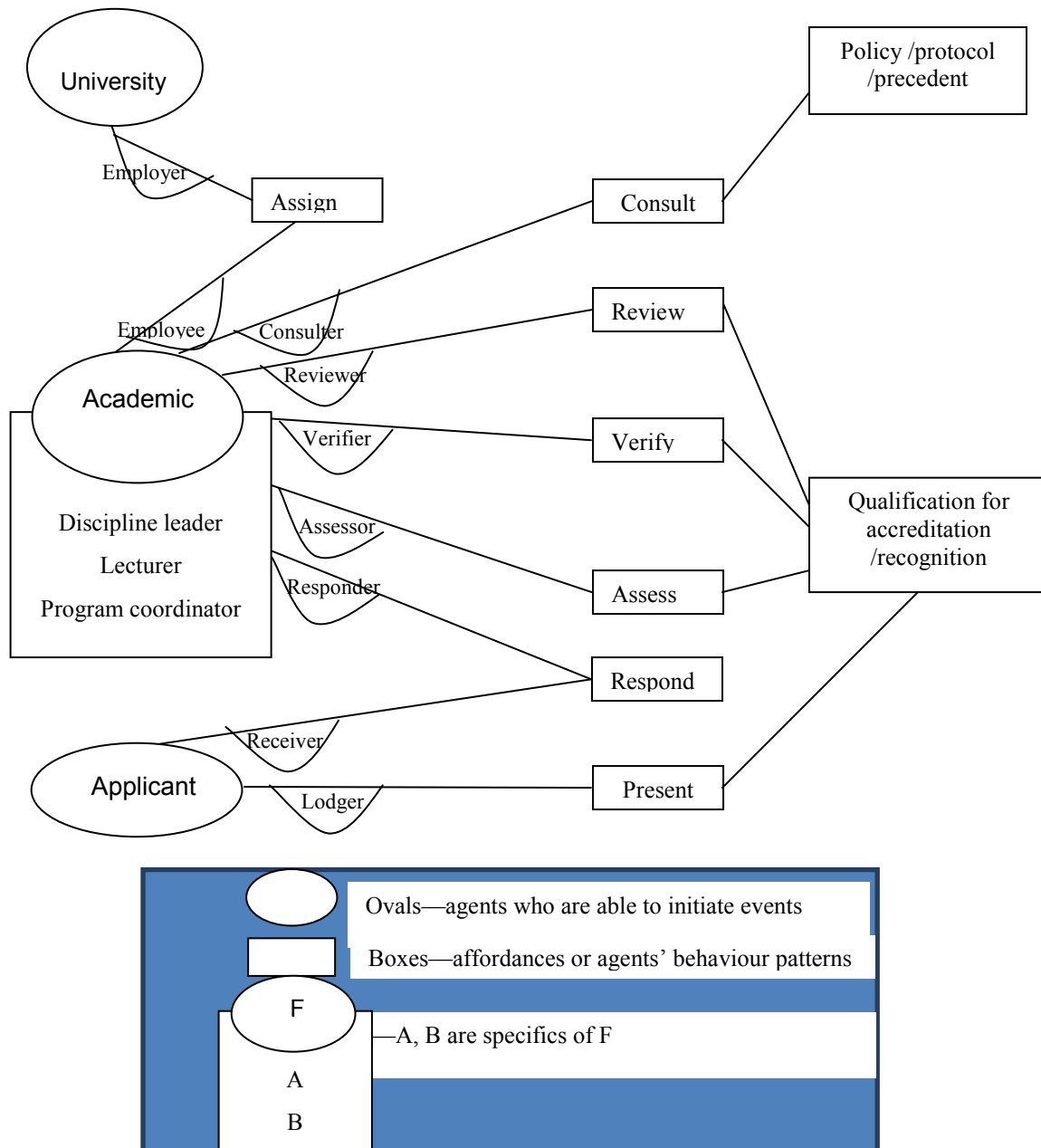
Figure 2a: The MEASUR model (Liu, 2000) on how academics assess applicants' qualifications

Figure 2a demonstrates the following workflows and interactions between actors:

- Universities assign academics as qualification assessors, who have experience and knowledge in assessing qualifications gained both domestically and overseas. Specifics of academics who might perform qualification assessments include discipline leaders, lecturers and program coordinators;
- Applicants lodge applications (with their educational and occupational qualifications) for admission or exemption;
- Assessors consult the university policies, protocols and precedents;

- Assessors review, verify and assess applicants' educational and occupational qualifications;
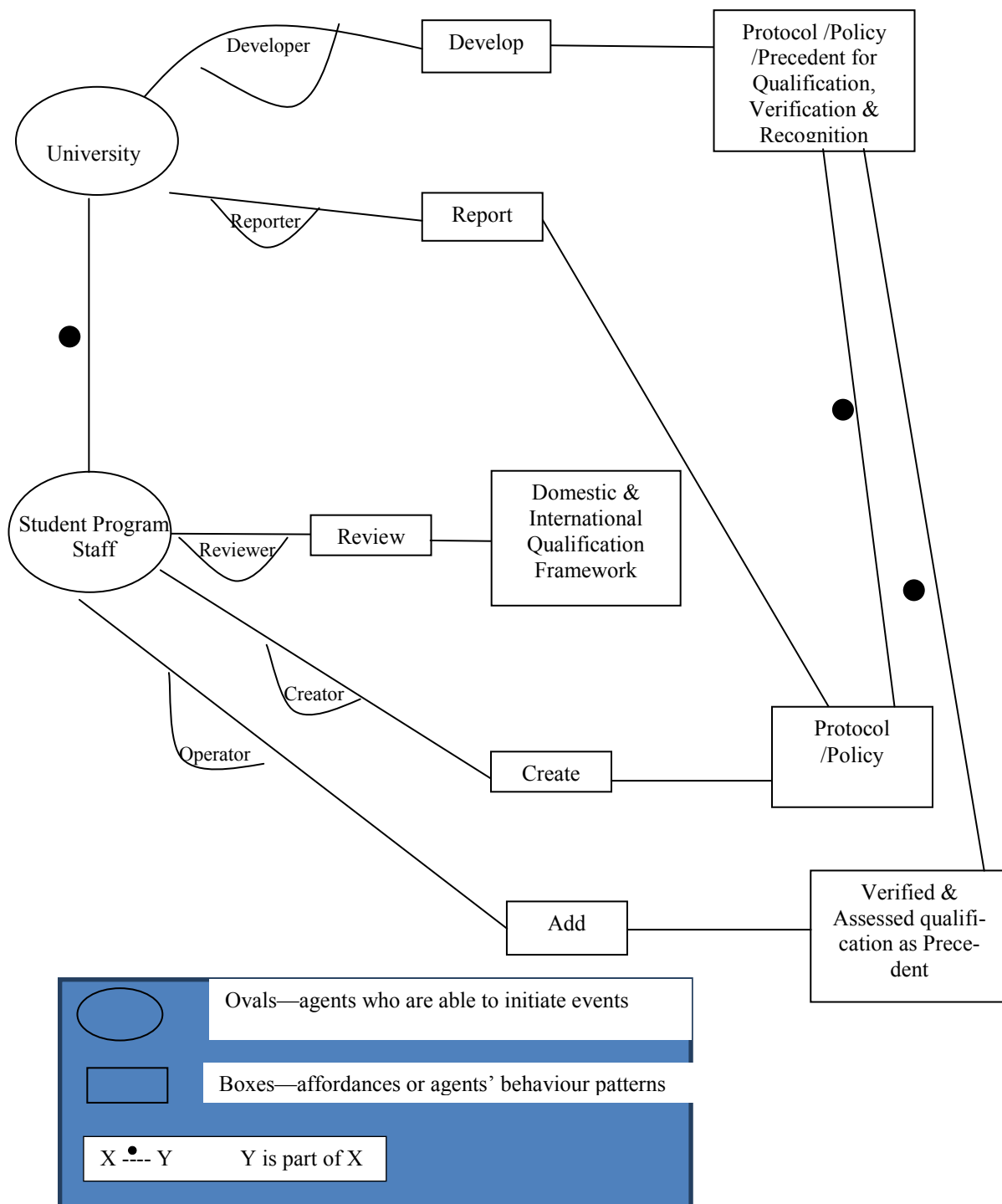- Assessors respond to applicants with decisions on assessment; and

Figure 2b: The MEASUR model (Liu, 2000) of the development of university policies, protocols and precedents on qualification assessment

- Qualifications lodged for accreditation and recognition are processed and become verified qualifications, which are recorded as precedents by Student Program Staff in Figure 2b.

Figure 2b demonstrates the following workflows and interactions between actors:
- Organisations such as AEI-NOOSR provide information on how overseas qualifications compare with Australian qualifications, covering over 100 countries through a web-based system called Country Education Profiles Online;
- Universities develop institutional level Credit Transfer and Exemptions Policy and Accreditation and Re-accreditation Policy by reviewing and consulting databases. Other supporting systems are also developed, based on precedents of qualification assessment;
- Universities report organisational policies and protocols;
- Student Program Staff review NOOSR guidelines, the domestic and international qualification framework, and any other relevant information, and proceed to create protocols and policies on the assessment of qualifications, which comprises part of the university-wide development process.
- Student Program Staff record verified qualifications as precedents, which is also part of the university-wide development process.

Verified Qualification as Learning Credential Provenance

The following analysis is based on interviews with staff at both S and C Universities who have responsibilities for:

- CAP design;
- CAP implementation;
- CAP administration; and
- Credential recognition

Data collected from interviews has been generalised based on the 7 Ws model of provenance illustrated earlier in this paper. The data collected is analysed using the content analysis approach, which is widely used to analyse open questions qualitatively. The following analysis attempts to answer the research question of:

What are the current credentialing workflows of the CAP and what are the technological gaps?

This research question can be further broken into the following questions and these questions serve as the basis of our interview questions:

- the credentialing workflows at both universities;
- the changes that deviate the CAP from its original agreement over time;
- the effect on credentialing workflows and the changes occurring to the CAP over time;
- the actions CAP-related staff have adopted or have meant to adopt to manage the changes and authenticate credentials over time;
- the current procedures both universities adopt to evidence changes in the education program, the location and point-in-time of actions;
- people involved in the CAP at both universities and those who perform reciprocal credentialing; and
- the current technology and systems that support the reciprocal credentialing at each university.

The research question can be separated into two parts: How credentialing is done currently at the CAP can be viewed as a close-ended question and the answers to this question are factual. What the technological gaps are is an open question. Depending on their roles, CAP-related staff will have different perspectives on how the changes over time have influenced their credentialing work. Therefore, their views on the technological difficulties caused by the changes may differ; and the answers to this part of the question can be varied.

The interview questions are derived from the 7Ws model. Records of interviews are integrated to form an overall perspective of credentialing workflows of the CAP at both universities. While analysing the interviews, two manifest categories were identified: credentialing workflows (factual) and technological gaps (subjective). Within the two categories, seven manifest or underlying themes are considered: Who, what, where, why, when, which, and how.

Answers to each of the interview questions were initially categorised and then examined against the seven themes (e.g., location and temporal dimension). In particular, whether and how changes related to the CAP recorded at both universities are identified. Interviews were grouped to the individual universities, and how interviewees at each university recognise and manage credentials was compared for similar patterns and gaps.

The results of content analysis of the interviews are presented as follows:

Table 2: Learning credential provenance defined using the 7Ws Model

7 Ws	Learning and Credentialing Provenance
Who	The staff members at both universities who manage and teach in the education program are required to record the changes. The CAP program is offered by both S and C Universities. The program was initiated in 2002 and it has experienced a significant turnover of staff, which is not recorded.
What	The actions that incur credentials, such as the completion of the course and graduation.
Where	The locations where information is stored and used, e.g., paper archives, databases.
Why	The changes should be fully evidenced as a reliable and repeatable method is required to ensure the veracity of reciprocal credentialing of the education program.
When	The time of creation and modification of the information. The partner agreement and information are eroded over time. The erosion should be counted as the most important temporal issue.
Which	Paper forms of communication between the two universities are used to notify each other when changes occur in the program. Quality assurance teams from both universities travel overseas to check the veracity of reciprocal credentialing
How	Classify information according to their certainty. For example, a subject taught by the same teacher following the same syllabus at each university undergoes changes in parallel. Provenance of this subject will assume a high certainty than subjects that have undergone different changes in each university respectively.

Figure 3 depicts part of the workflows and demonstrates how learning credentials can act as provenance for further study and immigration purposes, using MEASUR.
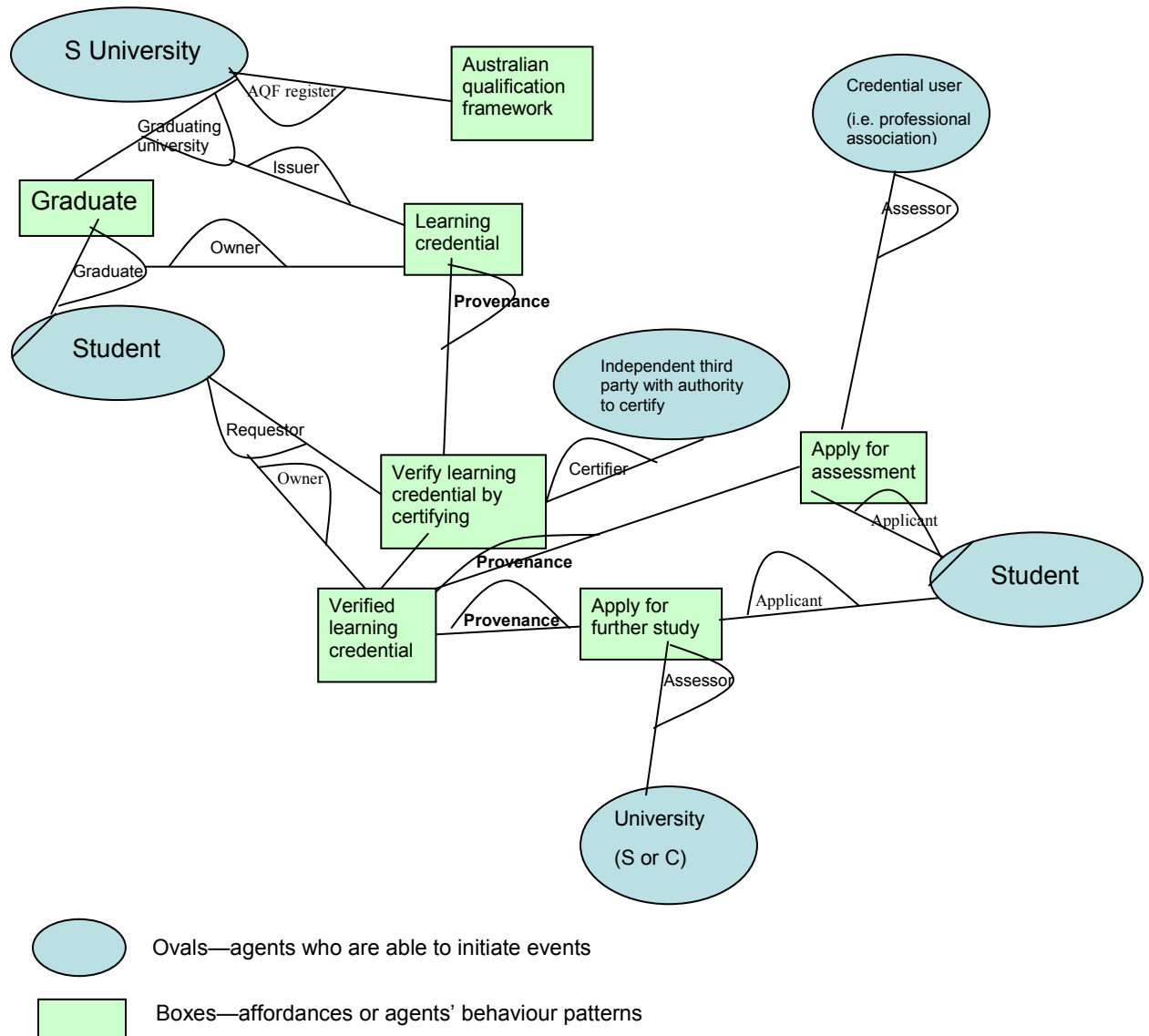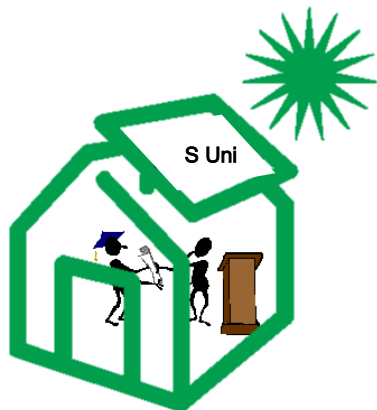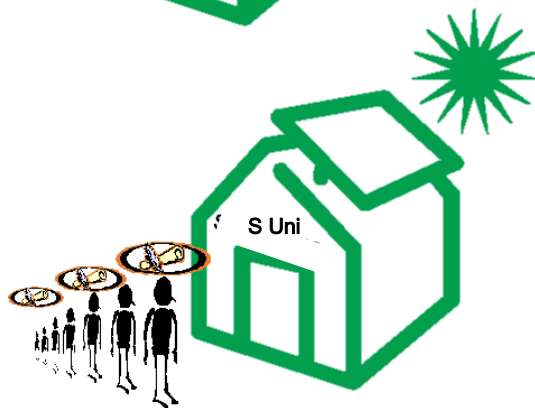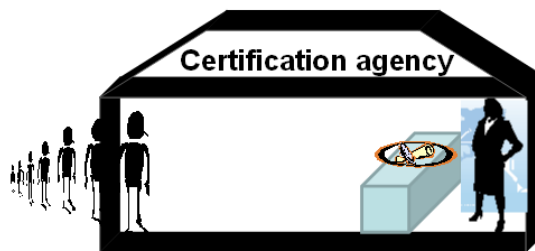

Figure 3: A MEASUR model of how verified learning credentials are used as provenances

Issuing of learning credentials upon graduation   **Students request learning credentials to be verified**

Figure 4: A Rich Picture showing how verified learning credentials are used as provenances, constructed based on Figure 3.

Workflows depicted in Figures 3 and 4:

- S University registers to the AQF and follows its guidance in terms of graduating students and issuing learning credentials;
- S University graduates students;
- S University issues learning credentials when graduating students;
- Students who have graduated are owners of the learning credentials;
- Students can request learning credentials to be verified;
- Verification is done by third parties who are independent and authorised;
- The originals of learning credentials are used as provenance to evidence the successful completion of study;
- Students own the verified learning credentials;
- Verified learning credentials then serve as provenances for further study or other assessments;
- Assessment for further study or other assessments are initiated by student;

- Assessments are completed by universities (for further study), professional associations (for skill assessment) or other third parties, based on the provenances submitted by students.

Contribution

Provenance methods and concepts are traditionally used in art and antiquities credentialing and have been adopted in information industry solutions for credentialing data and information. This research contributes to the domain of knowledge by applying provenance theory and technology to the education industry. To date, little research has been completed in this field.

The study on provenance on the Web (Fox & Huang, 2003; Groth,Gil, & Cheney, 2012; Moreau, 2010) has provided an important theoretical and technical basis for the provenance of information assets, e.g., web information. Our research utilises the electronic provenance techniques and extends provenance to include learning and credentialing in higher education, which are a combination of information assets and workflows.

Limitations

This study has several limitations that need to be considered in future work:

- Our research focuses on investigating the qualification mobility at a certain point in time; mobility over time is outside the scope of this research;
- Our research is not concerned at this time in recovering historical data related to the recording of credentials, but focuses on proposing a protocol for current and future use.
- Our research uses a Chinese – Australian case and is restricted to a single organisation. Generalisation of the provenancing protocol will be achieved through repeated applications of the data collection method; and
- Our research solely focuses on provenancing qualifications in the higher education sector while leaving other sectors within the education industry outside the research scope.

Conclusion and Future Work

In this paper, the problems of individual mobility and qualification mobility within the higher education context have been considered. The current qualification assessment workflows and how verified credentials are currently being used as a form of provenance in the case scenario have been analysed and modeled using the MEASUR method, which provide implications on the generalisation and application of the provenancing protocol.

To date, the research has concentrated on modelling the existing workflows in the case scenario. The next step of the research involves collecting data on organisation-specific assessment workflows and generalising the provenancing protocol.

References

Australian Government -- Australian Education International. (2013). *Assessment of overseas qualification*. Retrieved November 21, 2013, from https://aei.gov.au/Services-And-Resources/Services/Assessment-of-Overseas-Qualifications/Our-Assessments/Pages/default.aspx

Australian Qualifications Framework. (2013). *AQF Register of authorised accrediting authorities*. Retrieved November 21, 2013, from http://www.aqf.edu.au/register/aqf-register/

Assefa, M. (2009). *Degree recognition and its impact on student mobility*. DAAD Seminar.

Beetham, H. (2006). *E-portfolios in post-16 learning in the UK: Developments, issues and opportunities, current e-portfolio developments in the UK*. Report to the JISC e-Learning and Pedagogy Strand of the JISC e-Learning Programme.

Bolton, D., & Nie, R. (2010).Creating value in transnational higher education: The role of stakeholder management. *Academy of Management Learning & Education, 9*(4), 701-714.

Bishop, J. (2006). Preface. *The Bologna Process and Australia: Next steps*. Canberra: Australian Federal Department of Education, Skills and Training. Retrieved from http://www.ihep.org/assets/files/gcfp-files/Bologna_Process_Australia_Next_Steps.pdf

Cheney, J., Chiticariu, L., & Tan, W.C. (2009). Provenance in databases: Why, how, andwhere. *Foundations and trends in databases, 1*(4), 379-474.

China Higher Education Student Information and Career Center. (2004). *Procedures of digital qualification register.* Retrieved November 30, 2013, from http://www.chsi.com.cn/xlrz/ct06.shtml

Department of Education, Employment and Workplace Relations. (2008). *Recognition of higher education qualifications across the Brisbane Communique Region*.

Donaghue, G. (2008). *The Bologna Process and Australia: A study of the attractiveness, diffusion and rejection of a global reform idea*. Faculty of Education, University of Olso.

Du, H., & Yu, W. (2011). A MEASUR and RUP combined business modeling method. *Journal of Computers, 6*(6), 1086-1093.

Durrani, A. (2007). *The certificate of authenticity: Rely on it at your own risk*. Fine Art Registry.

European Commission. (2013). *The Bologna Process - Towards the European higher education area*. Retrieved November 21, 2013, from http://ec.europa.eu/education/higher-education/bologna_en.htm

Fox, M., & Huang, J. (2003). *Knowledge provenance: An approach to modeling and maintaining the evolution and validity of knowledge*. Enterprise Integration Laboratory, University of Toronto.

Goble, C. (2002). *Positions statement: Musings on provenance, workflow and (semantic web) annotations for bioinformatics*. Paper presented at the Workshop on Data Derivation and Provenance, Chicago, USA.

Graham, R. (2012). *The ICT profession body of knowledge. Core body of knowledge for information technology professionals.Australian Computer Society*. Retrieved November 21, 2013, from https://www.acs.org.au/__data/assets/pdf_file/0007/7792/The-ICT-Profession-Body-of-Knowledge.pdf

Groth, P., Jiang, S., Miles, S., Munroe, S., Tan, V., Tsakakou, S., & Moreau, L. (2006). *An architecture for provenance system*. Provenance Consortium.

Groth, P., Miles, S., Tan, V., Ibbotson, J., & Moreau, L. (2006). *The P-assertion recording protocol in technical report*. University of Southampton.

Groth, P., Gil, Y., Cheney, J., & Miles, S. (2012). Requirements for provenance on the web. *International Journal of Digital Curation, 7*(1), 39-56.

Li, X., Calway, B., & Sinnappan, S. (2008). *A learning and credential provenance (LCP) protocol development case study*. Paper presented at the the 11th Annual Australian Conference on Knowledge Management and Intelligent Decision Support (ACKMIDS 08), Ballarat, Victoria, Australia.

Lin, J., Bao, T., & Tao, A. (2008). Digitalisation of student registration and qualification. *Journal of Ningbo University (Education Edition), 30*(2).

Liu, K. (2000). *Semiotics in information systems engineering*. Cambridge UK: Cambridge University Press.

Live In Victoria. (2013). The overseas qualification unit. Retrieved November 21, 2013, from http://www.liveinvictoria.vic.gov.au/employing-overseas-talent/settle-and-retain-new-workers/the-overseas-qualifications-unit

Moreau, L. (2010). The foundations for provenance on the web. *Foundations and Trends in Web Science, 2*(2-3), 99-241.

OECD. (2012). *Education at a glance 2012: Highlights. OECD Publishing*. Retrieved November 30, 2013, from http://dx.doi.org/10.1787/eag_highlights-2012-en

Rauhvargers, A. (2004). Improving the recognition of qualifications in the framework of the Bologna Process. *European Journal of Education, 39*(3), 331-347.

Shah, C., Long, M., & Windle, J. (2007). *Recognition of skills and qualifications: Labour mobility and trade in services*. Monash University - ACER Cetre for the Economics of Education and Training.

Souto-Otero, M., Huisman, J., Beerkens, M., de Wit, H., &Vujić, S. (2013). Barriers to international student mobility: Evidence from the Erasmus program. *Educational Researcher, 42*(2), 70-77.

Teichler, U. (2003). Mutual recognition and credit transfer in Europe: Experiences and problems. *Journal of Studies in International Education, 7*(4), 312-341.

Teichler, U. (2012). International student mobility in Europe in the context of the Bologna Process. *Journal of International Education and Leadership, 2*(1), 1-13.

Ternouth, P. (2007). *Bologna Process, Lisbon Agenda*. Paper presented at the Fedora 2007.

Wei, H. (2013). An empirical study on the determinants of international student mobility: A global perspective. *Higher Education, 66*(1), pp.105-122.

Biographies

Xiaochen Li is currently a PhD candidate and a sessional academic at Swinburne University of Technology, Australia. She has been teaching in the field of information systems for over five years. Her research interest is in information systems and internationalisation of Higher Education.

Xuemei Tian is currently a senior lecturer with the Information Systems and Logistics Group of Faculty of Business and Enterprise, Swinburne University of Technology, Australia. She has been teaching both undergraduate and postgraduate courses in the areas of information systems and management for many years. On completion of her Master's degree in Australia in 2001, she held teaching positions at various universities in Melbourne. In 2006, she undertook her PhD study, which was completed in just over two years in June 2008. The research into business models for digital publishing undertaken at the School of Business IT, RMIT University, was funded by the Australian Research Council. It subsequently resulted in a book co-authored by her entitled 'Books, Bytes and Business' published by Ashgate in the United Kingdom. She has authored and co-authored refereed papers for academic journals and conferences, both in the business and the educational spheres, and currently serves as referees for a number of journals and conferences.

Raymond Chiong is a tenured academic with the School of Design, Communication and Information Technology at the University of Newcastle, Australia. He obtained his PhD degree from the University of Melbourne, Australia, and his MSc degree from the University of Birmingham, England. He has been teaching both undergraduate and postgraduate courses in the areas of computer science and information systems for many years. Besides teaching, he has been actively pursuing research in evolutionary game theory, optimisation, and technology enhanced learning. He is the Editor-in-Chief of the Interdisciplinary Journal of Information, Knowledge, and Management, and an Editor of the journal Engineering Applications of Artificial Intelligence. He also served/is serving as Guest Editors for a number of reputable international journals such as the International Journal of Production Economics, European Journal of Operational Research and IEEE Computational Intelligence Magazine. He was the Vice Chair of the task force "Education" of IEEE Computational Intelligence Society's Emergent Technology Technical Committee, and one of the Founding Chairs of the IEEE Symposium on Computational Intelligence in Production and Logistics Systems. To date, he has produced over 80 refereed publications.