SOCIAL ECOLOGICAL MODEL ANALYSIS FOR ICT INTEGRATION

Dr Jason Zagami
Griffith University

Abstract

ICT integration of teacher preparation programmes was undertaken by the Australian Teaching Teachers for the Future (TTF) project in all 39 Australian teacher education institutions and highlighted the need for guidelines to inform systemic ICT integration approaches. A Social Ecological Model (SEM) was used to positively inform integration support efforts of individual academics through their personal, institutional, professional, societal and temporal perspectives on ICT integration. A pre-post test analysis using the SEM framework categorised the influence factors on each academic, determined the factor most likely to affect change in the integration of ICT in their curricula, and provided a dynamic measure of the likelihood of successful integration to inform the application of support measures and maximise institutional integration outcomes. Initial results suggest that the applied SEM model can be used to guide institutional ICT integration efforts.

Introduction

Australia is undertaking the development of a uniform national curriculum to replace state curricula with implementation beginning in 2013. While the curriculum is fundamentally structured around subject disciplines, General Capabilities provide cross-curricula integration of a range of skills and understandings, one of which is ICT. This is in addition to ICT being taught as a subject discipline from F (Formation) to Year 12.

To improve the capacity of teacher education programmes to prepare teachers to integrate ICT General Capabilities in the first four Australian Curriculum subjects to be developed - Mathematics, English, Science and History, a national project, Teaching Teachers for the Future (TTF), was implemented in 2011, funded by the Australian Government Department of Education, Employment and Workplace Relations (DEEWR) through the ICT Innovation Fund. The aim of the TTF was to first prepare academics of these subjects, in all 39 Australian teacher preparation institutions, to integrate the development of ICT General Capabilities into their discipline based teacher preparation programmes.

The integration of ICT General Capabilities is a complex undertaking and an analysis was made of this process through case studies using a Social Ecological Model (Social Ecological Model, 2012) to explore the influences and interactions occurring on seven academics making curriculum reforms to the Mathematics curriculum area at a single institution. The institutional ICT Pedagogy Officer (ICTPO) appointed as a specialist in ICT integration by the TTF project provided individual support to academics for 12 months, conducted case study research interviews, suggested strategies and resources, organised and provided specific professional development sessions, and implemented wider TTF surveys and research.

To explore the processes occurring towards the successful integration of ICT General Capabilities into academic courses, a Social Ecological Model (SEM) was used to provide a framework to examine the multiple effects and interrelatedness in the social ecology of academics in an educational faculty environment (Hawley, 1950). This model allowed for the integration (Oetzel, Ting-Toomey, & Rinderle, 2006) of multiple levels and contexts to establish a wider perspective on the curriculum

reform efforts. Urie Bronfenbrenner's (1977, 1979) Ecological Systems Theory divides influence factors into five levels: micro (individual), meso (institutional), exo (professional), macro (societal), and chrono (temporal). SEM is a Systems Theory approach to understanding development that occurs in various spheres due to actions in interrelated systems.

In exploring the influence of each SEM factor on academics, particular focus was placed on identifying how academics experienced influencing factors in relation to ICT Integration in terms of an ecological model (Tatnall & Davey, 2004) in which ICT integration factors were viewed as Competing, Complementary or fulfilling a non-competitive and non-complementary niche. Measured initially by the SEM survey instrument, academic perspectives on each SEM influencing factor were confirmed by case study interviews, with the successful integration of ICT into academic courses determined by textual analysis of course profiles, teaching and learning activities, and assessment tasks.

Influence Factors

Microsystems consist of individual and intrapersonal aspects of groups that comprise an academics social identity (Gregson, 2001) including roles that the academic plays (mathematician, programme convenor, professional association leader, etc.) and characteristics they may have in common with others in these roles. These intrapersonal attributes influence how an academic perceives themselves as a mathematician, teacher educator, teacher, researcher, etc. The individuals' microsystem is constantly shaped, not only by the environment, but by encounters with other individuals and ICTPO relationships with academics were focused on understanding and developing a perspective that ICT General Capabilities integration is a complementary component of these roles and not in competition or a niche that can be ignored.

Mesosystems are faculty and institutional factors that shape or structure the environment within which individual and interpersonal relations occur for academics (Gregson, 2001). These aspects included rules, policies, existing curriculum structures and institutional aspirational objectives. Mesosystems are the norm-forming component of a department, faculty and university, and the individual is an active participant in these groups. Bronfenbrenner (1979) identified that the richer the medium for communication in this system, the more influential it is on the microsystem and this was approached by the ICTPO towards understanding academic perspectives on their influence on and by mesosystems, framing TTF outcomes in terms of these systems - the structures, policies and aspirations of the institution, and focusing attention on complementary aspects from the academics perspective.

Exosystems refer to discipline level influence. Mathematics educators develop interpersonal relationships and this web of organisations and individuals creates a strong community that establishes norms, standards, and networks (Gregson, 2001). The community is larger than the meso; however, it is considerably smaller than the macro cultural context. Australian academic disciplines are generally internally homogeneous but considerable differences exist between disciplines. This provided a basis for comparison and contrasting of ICT General Capability integration approaches, with positive examples of ICT integration by peers.

Macrosystems are the cultural contexts (Bronfenbrenner, 1979), geographically, emotionally and ideologically, and they are easily identifiable due to the magnitude of their impact. Computers and particularly the Internet have had a dominant influence on modern culture and provide a strong positive argument for ICT General Capability development and integration into all disciplines, including Mathematics. Pressure from students, school systems, politicians, the general public, and the

Australian Curriculum development process contribute to macro influences. Positioning academic teaching and research within these trends and wider perspective provided academics with positive Macro examples to influence ICT integration.

Chronosystems encompasses the dimension of time as it relates to an academics environment. Elements within this system can be either external, such as the timing and pace of reforms, or internal, such as the maturity of academics and their perspective on change, technology and curriculum reform. Demands on an academics time and crowding curriculum pressures were discussed with examples of ICT based alternatives and efficiencies to existing practices, while reform timings and an academics career stage were explored through positive Chrono examples where ICT integration can complement other reforms and the opportunities ICT provides to support alternative work environments for academics.

Survey

The following survey questions were administered to the seven participating academics at the start and end of 12 months of ICT integration support. Participants were asked to indicate their answers on a scale of -2 to +2 with +2 being extremely important and -2 being not at all important. ICT General Capabilities were defined as the expectations of the National Standards for Beginning Teachers and the capacity to develop in students the ICT General Capabilities detailed in the Australian Curriculum.

1. In your role, how important is the development of ICT General Capabilities in education students?
2. How important for your curriculum decision making is your personal view of ICT integration?

3. In your institution, how important do you think is the development of ICT General Capabilities in education students?
4. How important for your curriculum decision making is your institutions view of ICT integration?

5. In your professional networks, how important do you think is the development of ICT General Capabilities in education students?
6. How important for your curriculum decision-making is your professional networks view of ICT integration?

7. In society, how important do you think is the development of ICT General Capabilities in education students?
8. How important for your curriculum decision-making is societies view of ICT integration?

9. In your experience, for yourself, how timely is the development of ICT General Capabilities in education students?
10. How important for your curriculum decision making is the current timing of ICT integration?

Results

Based on the results of the initial SEM survey (Tab. 1), those areas that were initially identified as most significant for the academic (Odd numbered survey questions) and most likely to shift attitudes (Even numbered survey questions) were identified and became the focus of subsequent TTF project ICT integration support efforts.

Table 1. Initial SEM Survey

	Q1 Micro	Q2 Microw	Q3 Meso	Q4 Mesow	Q5 Exo	Q6 Exow	Q7 Macro	Q8 Macrow	Q9 Chrono	Q10 Chronow
A1	1	1	1	2	1	1	1	0	0	0
A2	1	-1	1	0	-1	0	1	1	0	0
A3	1	2	1	1	2	1	2	1	1	2
A4	1	-1	1	1	0	0	2	2	1	1
A5	-1	-1	0	0	-1	-1	1	2	-1	-1
A6	-1	-2	1	2	1	-1	-1	-1	-1	-1
A7	1	1	-1	-1	-2	-2	-1	-1	-1	-1

An overall SEM score (Tab. 2) for each academic was derived using the following formula:

$$\text{SEM} = \sqrt{\text{Micro}}^2 * \text{Microw} + \sqrt{\text{Meso}}^2 * \text{Mesow} + \sqrt{\text{Exo}}^2 * \text{Exow} + \sqrt{\text{Macro}}^2 * \text{Macrow} + \sqrt{\text{Chrono}}^2 * \text{Chronow}$$

Table 2. Initial SEM Scores

	Q1	Q2	Q1 & Q2	Q3	Q4	Q3 & Q4	Q5	Q6	Q5 & Q6	Q7	Q8	Q7 & Q8	Q9	Q10	Q9 & Q10	SEM
A1	1	1	1	*1*	2	2	1	1	1	1	0	0	0	0	0	4
A2	1	-1	-1	1	0	0	-1	0	0	*1*	*1*	*1*	0	0	0	0
A3	*1*	2	2	1	1	1	2	1	2	2	1	2	1	2	2	9
A4	1	-1	-1	1	1	1	0	0	0	2	2	*4*	1	1	1	5
A5	-1	-1	-1	0	0	0	-1	-1	-1	*1*	2	2	-1	-1	-1	-1
A6	-1	-2	-2	*1*	2	2	1	-1	1	-1	-1	-1	-1	-1	-1	-1
A7	*1*	*1*	*1*	-1	-1	-1	-1	-2	-2	-1	-1	-1	1	-1	-1	-4

By coupling Influence factors (odd questions) with Weighting factors (even questions) those influence factors that in this model were likely most negative and most positive avenues to influence the academics integration of ICT General capabilities were identified. Based on the highlighted influence factors identified as most likely to effect the greatest change in an academics overall likelihood to positively integrate ICT General Capabilities into their curricula, support was tailored to address these specific factors for individual academics.

In three cases, societal influences (Macrosystem) were identified as most important to the academic and their curriculum decision-making. Specific focus was made in providing resources, examples and advice on ICT General Capability integration into teacher preparation mathematics courses using broader societal pressures as a rationale for ICT integration. These included a focus on mobile technologies, computer games, and social media.

In two cases, institutional influences (Mesosystem) were identified as most important to the academic and their curriculum decision-making. Specific focus was made in providing resources, examples and advice on ICT General Capability integration into teacher preparation mathematics courses using specific institutional pressures as a rationale for ICT integration. These included a focus on university blended learning strategies, course development templates, the institutional learning management system, and internal grant applications.

In two other cases, the academics personal view (Microsystem) was identified as most important to the academic and their curriculum decision-making. Specific focus was made in providing resources, examples and advice on ICT General Capability integration into teacher preparation mathematics courses that addressed the academics personal perspectives as a rationale for ICT integration. These included complementary pedagogical approaches, the historical integration of mathematics and computing, and current uses of ICT by mathematicians and mathematics educators.

Table 3. Final SEM Scores

	Q1	Q2	Q1 & Q2	Q3	Q4	Q3 & Q4	Q5	Q6	Q5 & Q6	Q7	Q8	Q7 & Q8	Q9	Q10	Q9 & Q10	Initial	Final	Change
A1	1	1	1	1	2	2	1	1	1	1	1	1	1	0	0	4	5	+1
A2	0	0	0	0	0	0	0	0	0	2	1	2	0	0	0	0	2	+2
A3	2	2	4	1	1	1	1	1	1	2	2	4	1	2	2	9	12	+3
A4	1	1	1	0	1	0	0	0	0	2	2	4	1	1	1	5	6	+1
A5	1	-1	-1	0	0	0	-1	-1	-1	2	2	4	0	0	0	-1	2	+3
A6	-1	-2	-2	2	2	4	1	-1	1	-1	-1	-1	-1	-1	-1	-1	1	+2
A7	2	1	2	-1	0	0	-1	-1	-1	-1	-1	-1	1	-1	-1	-3	-1	+2

Conclusions

Where SEM scores were overall positive sqrt(Micro)^2 * Microw + sqrt(Meso)^2 * Mesow + sqrt(Exo)^2 * Exow + sqrt(Macro)^2 * Macrow + sqrt(Chrono)^2 * Chronow > 0 this suggested that the TTF project interventions would likely effect change with minimal support. In three cases (one in each of Macro (A4), Meso (A1), and Micro (A3)), the initial SEM survey identified an overall positive SEM score, each of these academics retained a positive SEM score in the final survey (Tab. 3), and all three academics positively integrated ICT General Capability development into their course curricula as

evidenced by substantive changes to course profiles, teaching and learning activities, and assessment tasks.

Where SEM scores were initially negative, $sqrt(Micro)^2 * Microw + sqrt(Meso)^2 * Mesow + sqrt(Exo)^2 * Exow + sqrt(Macro)^2 * Macrow + sqrt(Chrono)^2 * Chronow <= 0$ this suggested that the TTF project interventions would likely not effect change without significant support. Focused support was made to increase those factors identified by the academic as most likely to influence their curriculum decisions and to which they were positively inclined. In four cases (two of Macro influence (A2 & A5), with one each of Meso (A6) and Micro (A7)) the initial SEM survey identified an overall negative SEM score. While all four academics increased their overall SEM score during the TTF project (Tab. 3), in once case (a Micro influence focus) the score remained below zero and changes to course profiles were minimal with no substantive change made to teaching and learning activities, or assessment tasks. Where SEM scores were increased to above zero, academics positively integrated ICT General Capability development into their course curricula as evidenced by substantive changes to course profiles, teaching and learning activities, and assessment tasks. The difference between positive and negative outcomes was supported by wider TTF survey results of students in these courses.

While an insufficient population to generalise causal effects, the results were supportive of the expectations of the SEM model when applied to ICT General Capabilities integration of a select group of mathematics teacher education academics. For this sample, the model was able to identify factors that effected a positive change in the studied academics and SEM scores correlated with positive ICT integration outcomes.

Further research on a wider sample may develop a generalisable SEM model that:

1. verifies that the most positive factors identified in the model effect the most positive change;

2. that focusing on the most positive factors is more effective than most negative factors; and

3. applicability of the model to a broader range of academic disciplines and educational levels.

Overall, the SEM model provides a structure on which to approach systemic ICT integration reform, identifying areas of support likely to affect positive integration of ICT into academic programmes, and tailor support to more efficiently assist academics and teachers engage in ICT curriculum integration. The implementation of the Australian Curriculum ICT General Capabilities in all curriculum areas makes this reform urgent in teacher preparation academics, and no less so in the teaching profession. The SEM model provides an additional process in which educational leaders; ICT integration specialists; and individual academics and teachers can use to support this process.

References

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist, 32*, 513-531.

Bronfenbrenner, U. (1979). *The ecology of human development*. Cambridge, MA: Harvard University Press.

Gregson, J. (2001). System, environmental, and policy changes: Using the social-ecological model as a framework for evaluating nutrition education and social marketing programs with low-income audiences. *Journal of Nutrition Education, 33*(1), 4-15.

Hawley, A. (1950). *Human ecology: A theory of community structure*. New York: Ronald Press.

Oetzel, J., Ting-Toomey, S., Rinderle, S. (2006). Conflict communication in contexts: A social ecological perspective. In J. Oetzel & S. Ting-Toomey (Eds.), *The SAGE handbook of conflict communication*. Thousand Oaks, CA: Sage.

Social Ecological Model. (2012). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Social_ecological_model

Tatnall, A., & Davey, B. (2004). Improving the chances of getting your IT curriculum innovation successfully adopted by the application of an ecological approach to innovation. *Information Sciences Journal*, 7, 87-104.

Author Details

Dr Jason Zagami is a lecturer in the school of Education and Professional Studies of Griffith University on the Gold Coast in Queensland, Australia where he conducts research in cognition, professional learning and expertise, and all aspects of educational technologies – with a current focus on 1:1 computing, mobile learning, games in education, augmented reality, virtual environments, neural interfaces, and the emergence of computing as a school discipline. Jason has many years experience in K-12 computer education and the recipient of an Outstanding National Achievement by a Teacher and Queensland Computer Educator of the Year awards. He is an Apple Distinguished Educator, Google Certified Teacher, the Australian HP Innovations in Education Mentor, president of the Australian College of Educators (Gold Coast Region), and past president of the Queensland Society for Information Technology in Education and the board of the Australian Council for Computers in Education. Dr Jason Zagami's research and contact details are available at http://jason.zagami.info