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Keywords: TPACK, Teaching Practices, University Lecturers, Technology Policy Disconnect.
1. Introduction

This article is an exploratory analysis of how lecturers in an Australian regional university perceive the impact of Technological Pedagogical and Content Knowledge (TPACK) in their teaching practice. This inquiry addresses one main question: How do university lecturers use Information Communication Technology (ICT) in a context where the interaction of technology and pedagogy serves as a fundamental component of educational delivery? Using findings from a survey that mapped the teaching practices of unit (subject) coordinators, this inquiry undertakes cluster analysis in order to better understand perceived TPACK practices of university lecturers.

This exploratory inquiry is divided into four sections. Aside from providing the theoretical lens of TPACK, the initial section provides a description of the unique Australian regional context and how ICT plays a fundamental role in educational delivery. The second section provides an explanation of the methodological approach. An elaboration on the scope and limitations is included in this section. The third explores perceptions of ICT practices of university lecturers. The final section provides a discussion of the findings and its implications to teaching practice.

1.2 Background

The research reported in this article was from 2010 and 2011 in a higher education institution with over 60 years of experience in distance education. The Regional Australian University had 19,099 and 20,119 students enrolled in each of these years. Of these students, there were approximately 20% enrolled to study on-campus and 80% off-campus. Students who chose to study on-campus resided in or near Armidale, a regional centre in New South Wales, and attended lectures, workshops and tutorials in a face-to-face setting. Off-campus students studied from their home, from a distance. They received all their study materials through a Learning Management System (LMS). When studying in off-campus mode, study materials were in the form of html pages, downloadable PDF documents, podcasts, videos, discussion boards, chat rooms, blogs, Wikis and through a variety of other interactive materials. In this period of time, the School of Education (SoE) of the Regional Australian University had just over 4,000 students enrolled in each of the years with a larger percentage enrolled in off-campus mode than the university as a whole. In 2010, there were 14.84% enrolled in on-campus mode and in 2011, 13.74%. This meant that most of the teaching in the SoE was to off-campus students. Therefore, it was imperative that there be effective teaching through the use of technology.

2. Literature Review: TPACK in an Australian Context

2.1 What is TPACK?

Koehler and Mishra theorized the Technological Pedagogical and Content Knowledge or TPACK to illustrate what they claim to be the types of knowledge teachers need to teach effectively with technology (Koehler & Mishra, 2005). The foundation of TPACK is arguably based on Pedagogical Content Knowledge (PCK) that was formulated by Shulman. Shulman posited that effective teachers possess knowledge to use pedagogy appropriately in bringing about effective learning and teaching in their respective subject or content areas (Shulman, 1986). Koehler and Mishra contend that TPACK should ideally be a synthesis of teachers’ technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). More importantly, they argue that TPACK needs to recognise the interactions between technological pedagogical knowledge (TPK), technological content knowledge (TCK) and pedagogical content knowledge (PCK) (Koehler & Mishra, 2005).
The amount of research and publications on the area of TPACK has been steadily increasing in the last decade (Wu, 2013). Empirical research has traditionally been focused on pre-service educators and determining how they perceive TPACK in their teaching practice. Koh et al. derived five constructs, namely Technological Knowledge, Content Knowledge, Knowledge of Pedagogy, Knowledge of Teaching with Technology and Knowledge from Critical Reflection while carefully analysing pre-service teachers’ perceptions of technology and pedagogy interaction in a Singapore context (Koh, Chai, & Tsai, 2010). Angeli and Valanides further extend the analyses by proposing the notion of Information Communication Technology-Technological Pedagogical Content Knowledge (ICT-TPCK) while empirically testing variants of this model on pre-service teachers in a European context (2009). A careful review of extant literature on TPACK consistently identifies seven constructs that have emerged as a basis for what can be argued as quintessentially representative of the interaction of technology, pedagogy and content. These are: (1) Technological Knowledge – describes the ability to operate digital devices and using software; (2) Pedagogical Knowledge – alludes to the knowledge of methods of learning and teaching; (3) Content Knowledge – refers to knowledge of the subject matter; (4) Technological Pedagogical Knowledge (TPK) – depicts knowing how technology can be appropriately used in teaching methods; (5) Technological Content Knowledge (TCK) – suggests knowledge of how technology can represent the subject matter; (6) Pedagogical Content Knowledge (PCK) – represents knowing how appropriate teaching methods can be applied for different subjects; and (7) Technological Pedagogical and Content Knowledge (TPACK) – denotes knowing how technology and pedagogy can be used fittingly for effective learning in different subjects (Mishra & Koehler, 2006).

A review of the existing literature can arguably lead an observer to assume that TPACK has been used as a theoretical lens towards understanding the integration of technology and teaching. In documenting how preservice teachers experienced changes before and after the experience of attending ICT courses, Chai, Koh and Tsai used TPACK as a lens to interrogate the theoretical components of the framework (2010). In their empirical study they were able to measure the impact of technological knowledge, pedagogical knowledge and content knowledge on preservice teachers’ perceptions of TPACK (Chai, Koh and Tsai, 2010). Graham et al., utilized TPACK in attempting to measure levels of confidence before and after participation in a professional development program (i.e. SciencePlus) designed to improve technology integration in teaching (Graham, et al, 2009). Using the framework, they were able to detect statistically significant differences, positive improvement after the program and pointed to a hierarchy of confidence levels starting with TK, TPK, TPACK and TCK (Graham, et al., 2009). Recently, (removed for blind review) discovered a “blurred image of TPACK” amongst pre-service teachers of science. Using the lens of TPACK, (Removed for blind review) theorized that “an expectation from lecturers that the domain of teachers’ knowledge are tacit and should not necessarily be taught” is one of the main reasons for the lack of clarity in understanding the teaching and practice of TPACK (Removed for blind review).

This inquiry acknowledges the existence of theoretical limitations that have been leveled against the TPACK framework. Although widely employed, the TPACK framework has been the subject of continuous criticisms. Graham argues that TPACK suffers from “conceptual complexity” (2011, p. 1955). Gess-Newsome contends that the theoretical moorings of TPACK are questionable since it is built on Shulman’s PCK which has been described as plagued with a “substantial degree of overlapping of ideas” highlighting “the fuzzy borders between knowledge domains” (Gess-Newsome, 2002, p. 6). Perhaps, one of the most serious criticisms has been what Angeli and Valanides claim about how “the framework does not make explicit the connections among content, pedagogy and technology (2009, p. 157) in relation to the theorisation of TPACK.
2.2 Teaching Teachers for the Future (TTF) and TPACK: For Pre-Service Teachers

It is an expectation that, in Australia, students will leave school with the necessary ICT skills and knowledge to enable them to be productive members of the community (Author). The “Teaching Teachers for the Future” (TTF) initiative was a national project designed to build the Information and Communication Technology in Education (ICTE) capacity of pre-service teachers in Australian institutions. The project was led by Education Services Australia (ESA) who partnered with the Office for Learning & Teaching (OLT), the Australian Institute for Teaching and School Leadership (AITSL), the Australian Council of Deans of Education (ACDE) and the Australian Council for Computers in Education (ACCE) (Romeo, Lloyd, & Downes, 2012) All 39 teacher education institutions in Australia were involved. The project specifically targeted systematic change in the ICTE proficiency of graduate teachers across Australia by building the ICTE capacity of university lecturers and developing resources to provide rich professional learning and digital exemplar packages. An important aspect of this project was the institutional mapping of curriculum, pedagogies and assessment with awards available to pre-service teachers, especially focusing on Technological, Pedagogical Content Knowledge (TPACK) and the use of ICT in the educative process.

For this inquiry, the working definition for TPACK is the one used explicitly by the TTF project funded by the Australian government, Department of Education, Employment and Workplace Relations through the ICT Innovation Fund in 2011. As can be derived from the TTF’s working definition, TPACK has been chosen as the basis for identifying what has been described as the desired qualities of teachers of the next generation. This future crop of teachers referred to as Expert teachers of the 21st century, are those who possess the knowledge of how ICT can be used to teach and how ICT can be employed to support and enhance learning:

Expert teachers now are those who can bring knowledge of subject matter, what is good for learning, and technology (ICT). The combination is described as Technological Pedagogical Content Knowledge (TPACK). It is more than simply adding ICT to traditional approaches. It depends upon deep knowledge of how ICT can be used to access and process subject matter (TCK) and understanding how ICT can support and enhance learning (TPK) in combination with PCK. (Teaching Teachers for the Future, 2011).

2.3 TPACK: Focusing on University Lecturers

This article pays careful attention to the important role of teacher educators (university lecturers) in preparing a future teaching workforce that will be ready for ICT-intensive learning environments. A thorough search of studies on the impact of instructional development programmes focusing on technology integration let alone TPACK reveals that “limited research is available in a higher education context” (Rientes, Brouwer and Lygo-Baker, 2013, p. 124). Of the few that are available, a considerable number point to the fact about the lack of “universal satisfaction” in relation to “the progress that has been made to integrate new technologies into teaching” (Kinchin, 2012, p. E43). In a related study of how university academics experienced instructional development programmes geared towards the introduction of e-learning in a British higher education context, Hanson pointed out their active resistance and their refusal to “embrace the ‘dismobodiment’ or ‘re-positioning’ required by e-learning” (Hanson, 2009, p. 562). Unlike experienced primary and secondary education teachers as well as those just beginning their careers as pre-service teachers, it can be argued that university lecturers face a much more diverse set of challenges in relation to the implementation of teaching practices. Kinchin, Lygo-Baker and Hay argue convincingly that in carrying out their teaching, university lecturers are in fact pursuing the scholarship of teaching understood to mean that “academics are required to consult discipline-specific literature on teaching and
learning, focusing reflection on specific areas of one’s practice, focusing teaching on students and learning and publishing results of teaching initiatives through peer review mechanisms” (2008, p. 92). A systematic review on the impact of instructional development on higher education institutes by Stes et al. suggested that future research needs to consider “the core characteristics of instructional development initiatives” with a particular focus on the theory and the content that drives these programs (2010, p. 47). This article engages with this imperative by employing the theoretical lens of TPACK in investigating how university lecturers integrate ICT into their teaching practice.

3. Contextualising the Study: Focusing on University Lecturers

3.1 The Australian Regional University Context: Flexible Learning Environment

In May 2011, when the Mapping of Pre-Service Teacher Education units was undertaken, the SoE had 79 academic staff (excluding casual appointments) and 2,654 students (552 on-campus and 2,102 off-campus). A major rewrite of awards began in 2011 to address the Australian Curriculum Requirements and to reconfigure the placement of professional experiences within the award. This rewrite provided an ideal opportunity to consider the place of ICTE and to address the lack of explicit teaching of TPACK.

The mapping was designed to represent the status of the units as at that time. The Semester 1 units were audited as taught in Semester 1 2011 but Semester 2 units were audited as taught in Semester 2 2010. The audit focus was on all pre-service teacher education awards offered by the University. These awards involved 125 different units of study taught within the SoE, some of which were taught in more than one award. When there were important differences between the way a unit was taught to on-campus and off-campus students, the two units were audited separately. Each unit had a unit coordinator. Some academic staff coordinated more than one unit.

Policies and projects that were designed to impact teaching decisions at both the school (SoE) and university level also informed the mapping in terms of the integration of ICT into both curriculum and the delivery of that curriculum at the Regional University. The Policies investigated were: “University Strategic Plan 2007-2010”, “University Assessment Policy”, “University Graduate Attributes Policy”, “Principles of Online Teaching at University”, “University Learning Resources Policy” and “SoE Assessment Policy”. The Projects investigated were: “Open2Learning” and “Teaching and Learning Connection with Technology”.

On paper, TPACK is carried out at SoE through the implementation of what the Australian Regional University describes as a Flexible Learning Environment. In terms of content knowledge, the requirements of the Australian Curriculum need to be adhered to by the SoE. In other words, the courses delivered that span the wide range of subjects from Social Science Education; Health, Physical and Sports Studies Education; all the way through Mathematics and Science Education as well as Special and Inclusive Education must adhere to existing Australian Curriculum content requirements. Technology at SoE is driven mainly by the University’s LMS (i.e. Moodle). In principle, all the courses, either in on-campus, off-campus or mixed modes, rely heavily on the LMS. All course materials are accessed through the LMS and most, if not all, assessment tasks are completed via links with the LMS. This technological backdrop, complemented by the predominantly distance-education type of teaching mode at SoE, we argue, defines the what on paper is defined as the pedagogical framework at the School. The delivery of content, the implementation of assessments, as well as the interaction between university lecturers and students (i.e. pre-service as well as graduate students) all happen through the LMS in a variety of ways as planned out and implemented by unit
coordinators. This vast diversity of delivery of subject matter, primarily through the LMS, is what the SoE describes as a flexible learning environment.

3.2 Implementation: Mapping Audit Instrument

The Mapping Audit Instrument (henceforth MAI) was developed from the Curtin University Audit Instrument (Jamieson-Proctor, et al., 2013). There were eight criteria used in the SoE mapping to provide information about both “ICT Aspects of the Unit Delivery” and “ICT Knowledges”. This particular instrument formed part of the suite of evaluation tools made available to determine the impact of TTF.

**ICT aspects of Unit Delivery**
- Curriculum (ICT use contextualised in the curriculum)
- Pedagogy (ICT strategies used to support the pedagogy)
- Assessment (ICT used as part of the Assessment process)
- Resources (ICT tools provided as part of the resources)

**ICT Knowledges**
- Teaching about ICT
- Teaching about ICT relevant to specific content
- Teaching about the affordances of using ICT to support pedagogy
- Teaching about TPACK that transforms learning

For each criterion, there were four levels: Undeveloped, Fundamental, Proficient and Innovative. The descriptors for each level were based on the descriptions of levels of development used in Strategic Dimension Two (Program: Curriculum, Assessment and Practicum) of the “Leading ICT in Education Practices” (Lim, Chai, & Churchill, 2010) capacity building toolkit and were refined in consultation with SoE academic staff. An additional column was included to record the evidence to demonstrate the level of development recorded.

A three-step process was used to collect the information from the unit coordinators. First, the Information Communication Technology Pedagogy Officer (ICTPO) pre-populated the Instrument with any available information for a specific unit from the University Course and Unit Catalogue. Second, the ICTPO emailed the Instrument to the unit coordinator with a cover sheet explaining the mapping purpose and process. Finally, the ICTPO met with the unit coordinator to follow up on the Instrument entries and to clarify the evidence provided in relation to the nominated level. The process was first trialled with unit coordinators who were academics involved directly with the TTF Project and some minor adjustments were made to the expressions used in the descriptors (i.e. elaboration was provided to participants to understand the four descriptors for each level, see Appendix A) for the different levels of the eight criteria. In the process of undertaking cluster analysis, the last item “Teaching about TPACK that transforms learning” was removed as doing so improved the cluster features.

3.3 Significance of the study: Practitioners in an Australian Regional Context

This inquiry engages with current debates on how TPACK is interpreted and applied in university teaching contexts. The significance of this study was to interrogate TPACK from current teacher educators (i.e. university lecturers) and from a regional Australian perspective that relies heavily on ICT for the delivery of educational instruction. It can be argued that most of the current research and publications in TPACK from 2002 to 2011 centre on pre-service teachers (54.2%) while university or college teaching have not received equal attention
receiving only (8%) (Wu, 2013, p. E75). Harris et al. have suggested the need to plot how teachers perceive the ways in which they employ TPACK in their teaching practice:

Given the similar underlying assumptions of the interdependence of TPACK’s conceptual components described earlier, we argue that tool and resource use—both digital and non-digital—can similarly not be separated from content/theme and activity structure. Therefore, TPACK-related activity types for teachers’ use should be conceptualized and presented in terms of their specific disciplinary discourses, and in conjunction with their technological affordances. (Harris, Mishra, & Koehler, 2009, p. 405)

This inquiry contributes to continuing debates on how university lecturers, particularly “teacher-educators” who are dedicated to training and teaching future teachers, applied the principles of TPACK as this is directly related to the 2011 TTF reform initiative pushed by the Australian Department of Education for all the Higher Education Institutions in the country. Corollary to most TPACK studies that have focused on pre-service teachers, this particular inquiry intends to shed light on teacher-educators in an Australian regional university context – and their specific perceptions and practices in relation to a teaching reform that is built around TPACK. This inquiry also undertakes a critique of the TTF initiative implemented in all Higher Education Institutes in Australia. The article pays careful attention to the policy decision to choose TPACK, notwithstanding extant theoretical criticisms about it, and how this particular framework informed the implementation of TTF in the Australian Regional University context.

4. Methodology

4.1 Research Participants

In the context of this Australian Regional University, the university lecturer -- takes on multiple roles as unit coordinator of several oftentimes different subjects. Moreover, unit coordinators as the main drivers of the units employ colleagues, usually casual academic staff, to assist in the teaching and administration of the different units. In order to “take account of multiplicity” (Altman and Bland, 1997, p. 1874) of roles manifested, this study focuses on the unit coordinator -- a university lecturer -- who normally takes on several units. The corresponding research design and analysis have also been deliberately chosen to “explicitly take account of the multiplicity” (Altman and Bland, 1997, p. 1874). 127 unit coordinators consisting of a total of 51 university lecturers participated in this survey. All the participants gave their consent in participating in this study. The survey included 18 items. Two main researchers elicited responses from research participants through face-to-face interviews and coded these into the data. For the purpose of this inquiry, only nine of these items were used: Two items are grouping variables (categorical), namely: (1) the targeted level for the course (i.e. primary, lower secondary, upper secondary, secondary or applicable to all levels); and (2) the predominant mode of teaching implemented for the course (i.e. on-campus, off-campus or blended learning). The other seven items were ordered polytomous variables (these specific types of variables are used since there are no assumptions made about their distribution in this cluster analysis) measured from a four point Likert Scale. These items comprise the MAI that tracked the university lecturers’ engagement with TPACK while implementing their respective courses. The instrument that was coded by the researchers ranged from Undeveloped-Fundamental-Proficient-Innovative. An elaboration of all these items in provided in Table 1.

4.2 Data Collection and Analysis

The analytical approach used for this inquiry was cluster analysis. This approach commonly employed in market research is described as a method of data mining where information would
be divided into analogous groups or clusters that consist of “objects that are similar to one another and dissimilar to objects in other groups” (Berkhin, 2006, p. 26). Cluster analysis has also been employed to “perform data reduction” with the end of identifying “natural” groupings within a large set (Chan, 2005, p. 153). This method has also been has termed as “the art of finding groups in data” (Kaufman & Rousseeuw, 2005, p. 5). For this inquiry, the collected data would be explored for the possibility of identifying latent characteristics that are not fairly obvious:

Cluster analysis is a multivariate statistical technique for grouping cases of data based on the similarity of responses to several variables/subjects. The purpose of cluster analysis is to place subjects/objects into groups, or clusters, suggested by the data, such that objects in a given cluster are homogenous in some sense, and objects in different clusters are dissimilar to a great extent. In cluster analysis, the groups are not predefined but are rather suggested on the basis of the data. (Verma, 2013, p. 318)

4.3 Two-Step Cluster Analysis

The Statistical Package for the Social Sciences (SPSS) was the analytical tool used to explore the data collected from this inquiry. In particular, the SPSS TwoStep Cluster Component which “handles both continuous and categorical variables” as well as providing the data procedure the “capability to automatically find the optimal number of clusters” was employed for this exploratory analysis (SPSS Inc., 2001, p. 3). In conducting the TwoStep Cluster Analysis, a 5% noise handling restriction was implemented. This was done in order to minimise the dilution of “useful information provided by other variables” due mostly to “non-informative variables” or outliers that could deleteriously impact the clustering of data (Kaufman & Rousseeuw, 2005, p. 14).

Table 1
Frequency distribution- Unit of analysis (N=127)

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Course Level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>47</td>
<td>37</td>
</tr>
<tr>
<td>Lower Secondary</td>
<td>10</td>
<td>7.9</td>
</tr>
<tr>
<td>Upper Secondary</td>
<td>5</td>
<td>3.9</td>
</tr>
<tr>
<td>Combined Secondary</td>
<td>30</td>
<td>23.6</td>
</tr>
<tr>
<td>Applicable to all levels</td>
<td>35</td>
<td>27.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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<td>100</td>
</tr>
<tr>
<td><strong>Mode of Teaching</strong></td>
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<td></td>
</tr>
<tr>
<td>On Campus</td>
<td>12</td>
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</tr>
<tr>
<td>Off Campus</td>
<td>58</td>
<td>45.7</td>
</tr>
<tr>
<td>Combined (On/ Off)</td>
<td>57</td>
<td>44.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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<td>100</td>
</tr>
<tr>
<td><strong>ICT use contextualised in the curriculum</strong></td>
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</tr>
<tr>
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<tr>
<td>Fundamental</td>
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<tr>
<td>Proficient</td>
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<td>16.5</td>
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<tr>
<td>Innovative</td>
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<tr>
<td><strong>Total</strong></td>
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<tr>
<td><strong>ICT strategies used to support pedagogy</strong></td>
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<tr>
<td>Undeveloped</td>
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<td>20.5</td>
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<tr>
<td>Fundamental</td>
<td>62</td>
<td>48.8</td>
</tr>
<tr>
<td>Proficient</td>
<td>30</td>
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<tr>
<td>Innovative</td>
<td>9</td>
<td>7.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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<tr>
<td><strong>ICT used as part of the Assessment process</strong></td>
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<tr>
<td>Undeveloped</td>
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<tr>
<td>Fundamental</td>
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<td>Proficient</td>
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<tr>
<td><strong>Total</strong></td>
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<td>100</td>
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</table>
ICT tools provided as part of the Resources

<table>
<thead>
<tr>
<th>Level</th>
<th>Undeveloped</th>
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<th>Proficient</th>
<th>Innovative</th>
<th>Total</th>
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</thead>
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<td>54</td>
<td>48</td>
<td>20</td>
<td>5</td>
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Teaching about ICT

<table>
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<tr>
<th>Level</th>
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<th>Fundamental</th>
<th>Proficient</th>
<th>Innovative</th>
<th>Total</th>
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<td>40</td>
<td>24</td>
<td>4</td>
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</tbody>
</table>

Teaching about ICT relevant to specific content

<table>
<thead>
<tr>
<th>Level</th>
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<th>Fundamental</th>
<th>Proficient</th>
<th>Innovative</th>
<th>Total</th>
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<tr>
<td>Specific</td>
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<td>32</td>
<td>29</td>
<td>4</td>
<td>127</td>
</tr>
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</table>

Teaching about the affordances of using ICT to support pedagogy

<table>
<thead>
<tr>
<th>Level</th>
<th>Undeveloped</th>
<th>Fundamental</th>
<th>Proficient</th>
<th>Innovative</th>
<th>Total</th>
</tr>
</thead>
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<td>Pedagogy</td>
<td>68</td>
<td>28</td>
<td>24</td>
<td>7</td>
<td>127</td>
</tr>
</tbody>
</table>

5. Results and Discussion: Are the three clusters different?

The conduct of cluster analysis revealed interesting results. There were a total of 35 unit coordinators (27.6%) who make up Cluster 1 (M = 1.05, SD = 0.221). A total of 52 unit coordinators (40.9%) constitute Cluster 2 (M = 1.06, SD = 0.235). The scores of Cluster 2 respondents are below the median and sit right at the 1st quartile (25%). This is true for almost all cases, except for the variable “ICT used as part of the Assessment process.” In this case, their scores sit right on the median. 40 unit coordinators (31.5%) compose Cluster 3 (M = 1.435, SD = 0.558). The scores of Cluster 3 respondents’ scores are below the median and sit right at the 1st quartile (25%). This is for almost all cases, except for the variable “ICT use contextualised in the curriculum.” In this case, their scores sit right on the median.

From our analysis, we were able to identify the emergence of three clusters from the 127 unit coordinators who participated in the survey. The three clusters are groups of unit coordinators who appear to “coalesce” in terms of teaching practices in relation to their engagement with technology. The sizes of the clusters were as follows: Cluster One – 35 (27.6%); Cluster Two – 52 (40.9%) and Cluster Three – 40 (31.5%) (see Figure 1). In determining the nuances between these three clusters two questions guided the analysis: How do teacher educators use ICT? And, how do teacher educators teach with ICT?
5.1. How do teacher educators use ICT?

A series of One-Way Analyses of Variance (ANOVA) were conducted to test for differences among the three identified clusters in relation to the seven MAI items tested for this inquiry. In relation to how teacher educators use ICT, the ANOVA tests reveal statistically significant differences among the three clusters. Subsequent post hoc tests of the three a priori hypotheses were conducted using Bonferroni adjusted alpha levels of .0167 (.05/3), that also produced statistically significant results. The items of the MAI that relate to the notion of how teacher-educators use ICT reveal that Cluster 1 registered the highest mean scores followed by Cluster 3 on all except for “ICT used as part of the assessment process” where Cluster 2 has the second highest mean score after Cluster 1. A breakdown of each of the MAI items related to how teacher educators use ICT is included in this section.

ICT use contextualised in the Curriculum

Responses differed significantly across the three clusters, F(2, 126) = 44.472, MS, = 15.500, p = .00, α = .05. Results indicated that ICT contextualisation in the curriculum was significantly higher for Cluster 1 (M = 2.43, SD = .698) than were those in both Cluster 3 (M = 1.73, SD = .599) and Cluster 2 (M = 1.21, SD = .498). Figure 2 provides a graphic representation of how the mean scores of Cluster 1 are higher compared to the two other Clusters.

Figure 1
Three emerging clusters (generated from mean scores of the Mapping Audit Instrument)
ICT strategies used to support the Pedagogy

There are statistically significant differences among the three clusters, F(2, 126) = 46.426, MS_e = 18.880, p = .00, α = .05. “ICT strategies used to support the pedagogy” was significantly higher for Cluster 1 (M = 3.06, SD = .725) than were those in both Cluster 3 (M = 1.85, SD = .580) and Cluster 2 (M = 1.83, SD = .617). Figure 3 provides a graphic representation of how the mean scores of Cluster 1 are higher compared to the two other Clusters.

ICT used as part of the Assessment process

The responses measured statistically significant differences across the three clusters, F(2, 126) = 62.380, MS_e = 27.801, p = .00, α = .05. Cluster 1 (M = 2.97, SD = .822) was significantly higher on the item “ICT practices as part of assessment processes” than were those in both Cluster 2 (M = 1.58, SD = .537) and Cluster 3 (M = 1.40, SD = .672). Figure 4 provides a graphic representation of how the mean scores of Cluster 1 are higher compared to the two other Clusters.
Responses to the question differed significantly across the three clusters, $F(2, 126) = 78.644$, $MS_e = 25.013$, $p = .00$, $\alpha = .05$. Cluster 1 ($M = 2.83$, $SD = .664$) was significantly higher than those in both Cluster 3 ($M = 1.43$, $SD = .549$) and Cluster 2 ($M = 1.42$, $SD = .499$). Figure 5 provides a graphic representation of how the mean scores of Cluster 1 are higher compared to the two other Clusters.

**5.2 How do teacher educators teach with ICT?**

A series of One-Way Analyses of Variance (ANOVA) were conducted to test for differences among the three identified clusters in relation to the seven MAI items tested for this inquiry. In relation to how teacher educators teach with ICT, the ANOVA tests reveal statistically significant differences among the three clusters. Following the ANOVAs, subsequent post hoc tests of the three a priori hypotheses were conducted using Bonferroni adjusted alpha levels of $.0167 (.05/3)$. These also produced statistically significant results. The items of the MAI that relate to the notion of how teacher-educators teach with ICT reveal that Cluster 1 registered the highest mean scores followed by Cluster 2 on all except for “Teaching about ICT relevant to
specific context” where Cluster 3 has the second highest mean score after Cluster 1. A breakdown of each of the MAI items related to how teacher educators teach with ICT is included in this section.

**Teaching about ICT**

There are statistically significant differences among the three clusters, $F(2, 126) = 62.444$, $MS_e = 23.398$, $p = .00$, $\alpha = .05$. Results indicated that “Teaching about ICTs” was significantly higher for Cluster 1 ($M = 2.77$, $SD = .690$) than were those in both Cluster 2 ($M = 1.42$, $SD = .499$) and Cluster 3 ($M = 1.40$, $SD = .672$). Figure 6 provides a graphic representation of how the mean scores of Cluster 1 are higher compared to the two other Clusters.

**Teaching about ICT relevant to specific content**

Responses to the question differed significantly across the three clusters, $F(2, 126) = 77.248$, $MS_e = 28.314$, $p = .00$, $\alpha = .05$. “Teaching about ICTs relevant to specific content” was significantly higher for Cluster 1 ($M = 2.89$, $SD = .5838$) than were those in both Cluster 3 ($M = 1.40$, $SD = .672$) and Cluster 2 ($M = 1.38$, $SD = .565$). Figure 7 provides a graphic representation of how the mean scores of Cluster 1 are higher compared to the two other Clusters.
Teaching about the affordances of using ICT to support pedagogy

The responses generated statistically significant differences across the three clusters, F(2, 126) = 14.395, MS_e = 1.776, p = .00, α = .05. Cluster 1 (M = 3.00, SD = .686) was significantly higher than were those in both Cluster 2 (M = 1.38, SD = .565) and Cluster 3 (M = 1.18, SD = .385). Figure 8 provides a graphic representation of how the mean scores of Cluster 1 are higher compared to the two other Clusters.

5.3 Theorising clusters of Teacher-Educators who “use” and “teach” about ICT

The ANOVA and post hoc tests prove that the three clusters that have emerged from the analysis are distinct. Moreover, generating the omega squared (ω^2) calculations for each of the tests registers a range of 0.41 to 0.66, all of which are moderate effect sizes. Table 2 provides a summary of the practical significance that the tests are able to produce in relation to statistically significant differences in relation to ICT and technology engagement practices controlling for the three different clusters.
We theorise that in the context of this inquiry – a regional Australian University – three types of unit coordinators according to their level of technology engagement emerge. We describe these groups as Cluster 1 – unit coordinators who are able to negotiate between using and teaching technology, Cluster 2 – unit coordinators who are more inclined to state that they use technology but not necessarily expressing confidence in teaching about it and Cluster 3 – unit coordinators who are ambivalent towards using and teaching about technology.

Cluster 1: Using and teaching about ICT. Cluster 1, the smallest group with only 27.6% of unit coordinators, or what we can describe as ICT-engaged university lecturers, clearly demonstrated that they are able to negotiate between ICT knowledge and practice. The ANOVA tests conclusively indicate that those who belong to Cluster 1 recorded the highest standardised scores. The MAI item labelled as “ICT strategies used to support the pedagogy” explicitly illustrates the characteristic of this cluster: Cluster 1 members registered the highest mean score (3.06), with a large effect size ($\omega^2 = 0.42$). We theorise that those who belong to Cluster 1 perceive themselves as individuals who are able to use ICT to teach and are able to teach about ICT. Less than 30% of unit coordinators teaching in a university setting that uses ICT intensively satisfy what the TTF describes as essential characteristics of the 21st century expert teacher: successfully negotiating the knowledge and practice of TPACK.

Cluster 2: Users of ICT but not necessarily teaching about it. Cluster 2 with 31.5% of unit coordinators, were more inclined towards ICT usage as opposed to actually teaching about it. The ANOVA tests indicate that for the items that attempted to measure their technology engagement, those in Cluster 2 registered the second highest standardised scores. The MAI item labelled as “ICT use contextualised in the Curriculum” unambiguously demonstrates the distinctive trait of this cluster: Cluster 2 members registered the lowest mean score (1.21), with a large effect size ($\omega^2 = 0.41$). We interpret this to mean that this group of unit coordinators practice aspects of technology engagement, particularly using it. But they do not necessarily delve deep into knowing the ways in which technology, content knowledge and pedagogy can have greater integration. Almost 30%, or a little over one third of all unit coordinators from the School of Education, in an ICT-intensive university indicate that they practice certain aspects of what the TTF describes as TPACK; but they do not necessarily actively attempt to know more about technology integration in greater depth.

Cluster 3: Ambivalence towards using and teaching about ICT. Cluster 3, with the majority of the respondents at 40.9% of unit coordinators, were ambivalent towards the use and the willingness to teach about ICT. The ANOVA tests reveal that Cluster 3 had the lowest standardised scores compared to the other two clusters. The MAI item labelled as “Teaching about the affordances of using ICT to support pedagogy” clearly exhibits the distinguishing attribute of this cluster: Cluster 3 members registered the lowest mean score (1.18), with a large effect size ($\omega^2 = 0.66$). We theorise that unit coordinators in Cluster 3 possess the greatest dissonance in relation to engaging with technology: using it and teaching about it. Almost 41% of unit coordinators teaching at a university known for using ICT ubiquitously have indicated their ambivalence towards what the TTF describes as the expert teachers’ qualities of knowing and practicing TPACK. This statistic undoubtedly presents a complex situation to a higher degree institution that actively presents itself as an ICT-intensive learning hub.
Table 2

<table>
<thead>
<tr>
<th>ICT practices</th>
<th>Cluster 1</th>
<th>Cluster 2</th>
<th>Cluster 3</th>
<th>F</th>
<th>p</th>
<th>$\omega^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICT use contextualised in the Curriculum</td>
<td>2.43</td>
<td>1.21</td>
<td>1.73</td>
<td>44.47</td>
<td>0.00</td>
<td>0.41</td>
</tr>
<tr>
<td>ICT strategies used to support the Pedagogy</td>
<td>3.06</td>
<td>1.83</td>
<td>1.85</td>
<td>46.42</td>
<td>0.00</td>
<td>0.42</td>
</tr>
<tr>
<td>ICT used as part of the Assessment process</td>
<td>2.97</td>
<td>1.58</td>
<td>1.40</td>
<td>62.38</td>
<td>0.00</td>
<td>0.49</td>
</tr>
<tr>
<td>ICT tools provided as part of the Resources</td>
<td>2.83</td>
<td>1.42</td>
<td>1.43</td>
<td>78.64</td>
<td>0.00</td>
<td>0.55</td>
</tr>
<tr>
<td>Teaching about ICT</td>
<td>2.77</td>
<td>1.42</td>
<td>1.40</td>
<td>62.44</td>
<td>0.00</td>
<td>0.49</td>
</tr>
<tr>
<td>Teaching about ICT relevant to specific content</td>
<td>2.89</td>
<td>1.38</td>
<td>1.40</td>
<td>77.24</td>
<td>0.00</td>
<td>0.55</td>
</tr>
<tr>
<td>Teaching about the affordances of using ICT to support pedagogy</td>
<td>3.00</td>
<td>1.38</td>
<td>1.18</td>
<td>121.82</td>
<td>0.00</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Effect sizes metric: $\omega^2 \leq .01$ (small); $\omega^2 = .06$ (moderate); $\omega^2 > .16$ (large)

5.4 Limitations of the research

The unit of analysis used for this study focused on the role of university lecturers as unit coordinators. The Australian Regional University context and the actual practice of university lecturers taking on multiple roles as unit coordinators of different subjects necessitated this approach. Doing this ensured that we carefully “take account of multiplicity” (Altman and Bland, 1997, p. 1874) of coordinating and leading different and multiple units that individual university lecturers experienced at the SoE. As such, the analytical ability to individually map behaviors and practices of individual university lecturers was not possible. These preliminary findings can be investigated in greater depth: For example, what is the impact of these three clusters to the learning outcomes of students? Or using these three clusters as starting points and with additional data, what could Confirmatory Factor Analysis (CFA) reveal regarding the measurement and structure of University educators’ TPACK practices?

6. Conclusions and Policy Recommendations

For teacher educators, principals, or even colleagues, it seems worthwhile to listen to and discover more about the teachers with whom we work – before we teach, guide, or collaborate with them. Providing external stimuli, models or opportunities is only one part of engaging an individual in a learning experience (Hughes, 2003, p. 16)

This exploratory inquiry was an attempt for university lecturers at an Australian regional setting to “discover more about” the university academics “with whom we work with.” Using the very specific TPACK framework as espoused by TTF, our inquiry paved the way for us to identify preliminary models in which we engage in the knowing and practice of integrating technology,
pedagogy and content knowledge. Our empirical research explores levels of technology engagement of Teacher-Educators (as opposed to most of the empirical research that discusses Pre-Service Teachers) measured in our inquiry as “the use of ICT” and “the teaching of ICT”. It is worth mentioning that under the 2011 TTF reform initiative, technology engagement has been subsumed under TPACK skills that expert teachers of the 21st century would need to possess.

Our inquiry led us to discover several layers of technology policy disconnect with respect to the theme of ICT use and ICT teaching -- under the mantle of TPACK -- of university lecturers. At one level, our exploration revealed clusters of university lecturers spanning the continuum of using ICT and teaching about ICT. A deeper level of disconnect exists between TTF’s conception of the Educator of the 21st century built around the theoretical framework of TPACK and the actual integration of technology, pedagogy and content knowledge of supposedly ICT-engaged university lecturers on the other. Another more concerning level of disconnect is about how university-lecturers perceived use of ICT and teaching about ICT impact preservice teachers’ TPACK levels.

6.1 Disconnect: University lecturers (Teacher Educators) Use and Teaching of ICT

A key insight derived from our analysis is the existence of various levels of disconnect between the knowledge and practice of combining ICT, content and teaching. In exploring technology engagement practices of Teacher Educators we “theorise” that in a unique regional Australian university context, three distinct clusters of Teacher-Educator practitioners emerge. These three distinct clusters represent the “distance” between the disconnect of how lecturers use ICT and how lecturers teach about ICT. We particularly took note of our research finding where half of all the respondents (40.9%), who constitute Cluster Three report ambivalence as regards the idea of “using” and “teaching” ICT in their practice. Our research also revealed that a little over a third (31.5%) of all the respondents reported that they use ICT in relation to their teaching practice but do not actually teach about it. We argue that these two clusters of Teacher Educators from our sample which account for almost two-thirds of all respondents point out that in relation to the idea of integrating the technology, pedagogy, content and ICT or the hallmarks of TPACK, there exists gaps. What we see occurring at the Regional University is a fragmentation of these concepts. There is much work that needs to be done to bridge the disconnect and to achieve greater integration of these components.

6.2 Disconnect: TPACK theory and TTF’s Educators of the 21st Century

A deeper level of disconnect that we unearthed is in relation to the definition of TPACK as enunciated by Mishra and Koehler and how the TTF program has appropriated it to pave the way for designing the so-called educators of the 21st century. Of the three, only Cluster One which represented close to a third (27.6%) of the respondents indicated that they both use and teach ICT. This is the desired outcome of TTF to pave the way for Teacher Educators to use ICT and teach it as well in their teaching practice. But could a claim be made that those in Cluster One are well on their way to training educators of the 21st century? In other words, does real integration according to the tenets of TPACK really occur for teacher educators who proclaim that “they use and teach ICT”? We carefully point out that the survey instrument merely captured the use of and the teaching of ICT. In relation to the actual implementation of TPACK, and the integration of its various components, we argue that the MAI made available by the TTF programme does not accurately capture this.

6.3 Disconnect: The impact on Pre-Service Teachers

The third level of disconnect flows from the two previous ones that have been identified earlier. Careful reflection on the existence of three different clusters in our study highlight two
implications that have an impact on preservice teachers: uneven levels of ICT teaching practices among university lecturers and an apparent misalignment of TPACK theory and actual teaching practices. Existing literature points out the positive effects of aligning theory and practice (Angeli and Valanides, 2009); as well as the value of teacher educators as role models in integrating ICT in teaching and learning (Tondeur, et al., 2012). What is the impact of the absence of role-modelling behaviors of teacher educators compounded by the misalignment of theory and practice in relation to the integration of technology, teaching and learning on preservice teachers? Although this critical issue is not captured by the MAI nor included in the remit of this study, it is nonetheless an important question that warrants further careful investigation.

6.4 Policy Recommendations

One of several implications that our inquiry could surface is that in relation to large-scale investments on resources such as Australia’s TTF manifested in time, equipment and professional development for what it describes as 21st-century TPACK training, there is a need for a nuanced approach as opposed to a “one-size-fits all” style. In other words, TPACK – a concept that to date still needs theoretical clarity -- needs to be “problematised” by policy-makers, university administrators and teacher-educators. Teacher educators would need to carefully reflect on whether or not the components of TPACK are fully integrated in their teaching practice, or what types of combinations of the components work best in their respective contexts or even if TPACK is the framework that is most appropriate given the challenges they face in their respective settings. Another important problematisation that needs to be undertaken is to carefully reflect on whether the purported reform comes along with the essential wherewithals:

If either access, functionality, technical support or professional development for the task at hand is missing, the likelihood of effective use of technology is significantly reduced. Moreover, experiences in which technology use is ineffective are frustrating and leave potential users less willing to change in the future. (David, 1994, p. 144)

Taking the cue from the classic yet still highly-relevant work of David in relation to undertaking technological reform, this inquiry outlines the need to tweak the policy implementation of ICTE in Australian teacher training institutes. This inquiry, situated in one particular institution in a regional Australian university context, unearthed various stages of disconnect between ICT knowledge and ICT practice. Now that the continuum of what the TTF describes as TPACK practices of teacher educators has been provisionally mapped, the next steps would be to implement three specific policy approaches that may assist in bridging together these various stages of disconnect.

The first can be a focused approach on increasing the functionality of technology for the courses taught by the teacher educators. One very specific implication of this would be to allow for the contextualization of ICT implementation in the specific subject disciplines taught by the university lecturers. An approach that increases the functionality of technology complements the perceptions reported by Cluster 1 respondents – those who use and teach about ICT -- and particularly the search for ICT strategies that can be used to support the pedagogy. This particular item registered the highest mean scores for those who belong in Cluster 1.

Investments must be made in order to allow university lecturers in the social sciences and the natural sciences to be able to functionally employ technology in their respective discipline areas. In other words, policy modifications have to be made in order need “to harness ICT to contribute towards authentic teaching and learning” (Removed for blind review).
Secondly, technical support must become an integral part of the ICTE policy implementation. Cluster 2, or what the study describes as users of ICT but not necessarily teaching about it have implicitly expressed the need for technical support when they scored the item ICT use that is contextualised in the curriculum with the lowest mean scores. Educators have identified that supportive structures and leaders result in successful implementation of ICT programmes in their respective contexts (Granger, Morbey, Lothenigton, Owston, & Wideman, 2002). Empirical evidence have also indicated how successful school systems that have adopted ubiquitous ICT usage in teaching and learning have explicitly identified the need to provide “continued provision” of technical support in order to achieve ICT integration into the curriculum (Removed for blind review).

Finally, relevant and “just-in-time” professional development approaches need to be deliberately incorporated into the ICTE policy in Australian teacher training institutes. The use of carefully designed professional development approaches for those in Cluster 3— or what the study describes as those ambivalent towards using and teaching about ICT – have indicated as much. Members of this cluster perceive that teaching about the affordances of using ICT to support pedagogy is sorely lacking, as this item registered the lowest mean score. In numerous situations, the influx of new waves of ICT equipment have hampered much needed updating and professional development for educators using ICT. In cases such as these, successful educational organizations that have managed to keep up with regular professional development have adopted innovative ways to ensure that educators are up-to-date. One form of organic professional development that has been reported in other contexts as a result of allowing ICT to take root is creating organizational infrastructure in the area of ICTE in order to foster a “surge of collaborative learning” among colleagues (Removed for blind review). We argue that carefully designed interventions that target functionality of technology, timely and relevant technical support, as well as practical and useful professional development could help address the challenges that university lecturers experience in integrating technology and teaching. We further contend that improving university lecturers’ levels of technology and teaching engagement could redound to positive benefits – in relation to competencies, beliefs and attitudes towards the integration of technology and teaching for preservice teachers.

Our exploratory analysis has revealed that conventional models of TPACK, as espoused by the 2011 TTF initiative would need to be carefully investigated and contextualized. We have provided evidence that in an Australian regional context, the integration of technology, pedagogy and content knowledge is not that simple and is actually fraught with challenges. Perhaps the biggest challenge that we have uncovered is the need to initially “bridge the disconnect” before massive and probably wasteful investments on ICT (i.e. joining the TPACK bandwagon) training is undertaken.

References


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Highlights:

- Cluster analyses reveal interesting insights about the ICT teaching practices of university lecturers

- A three cluster configuration for determining university lecturers’ usage and teaching of ICT is proposed

- Several layers of technology policy disconnects have been discovered in the empirical analysis

- The need to problematize one-size-fits-all ICT reforms and map its impact is presented.